IEc

Regulatory Impact Analysis for Proposed Regulation of Geological and Geophysical Activities in the Gulf of Mexico

DRAFT | April 3, 2018

prepared for:

U.S. Department of the Interior

Bureau of Ocean Energy Management

prepared by:

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

TABLE OF CONTENTS

EXECUTIVE SUMMARY

INTRODUCTION

This draft regulatory impact analysis (RIA) evaluates the potential costs and benefits of incidental take regulations (ITR) proposed pursuant to the Marine Mammal Protection Act (MMPA). The proposed ITR addresses take of marine mammals incidental to geological and geophysical (G&G) activities conducted by the oil and gas industry in the Gulf of Mexico (GOM). The Bureau of Ocean Energy Management (BOEM), which has petitioned The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) for the issuance of the ITR on behalf of industry, manages the exploration and development of the Nation's offshore resources—including oil and gas, renewable energy, and marine minerals—in Federal waters.

In accordance with Section 11 of the Outer Continental Shelf Lands Act (OCSLA) and supporting regulations, BOEM issues G&G permits for collection of data regarding the potential location, extent, and properties of energy and mineral resources as well as geotechnical and geologic properties and hazards. Under the OCSLA, BOEM ensures that G&G activities not cause undue harm to aquatic life, property, or the marine, coastal, or human environments.

NMFS is responsible for the stewardship of the Nation's ocean resources and their habitat. For example, under Section 101(a)(5) of the MMPA, the Secretary of Commerce[1] shall allow the incidental, but not intentional, take of marine mammals associated with a specified activity and geographical region if NMFS finds that the total taking will have a negligible impact on the species or stocks and will not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses (where relevant). In this capacity and if appropriate, NMFS must issue MMPA incidental take regulations prescribing: a) the permissible methods of taking; b) other means of effecting the least practicable adverse impact on the species or stocks and their habitat;[2] and c) monitoring and reporting requirements.

[1] Relevant to NMFS's trust species. Certain species of marine mammal are under the jurisdiction of the U.S. Fish and Wildlife Service and, for these species, incidental take authorizations are allowed by the Secretary of Interior.

[2] NMFS routinely refers to this requirement as "mitigation" for shorthand.

STATEMENT OF NEED FOR REGULATORY ACTION

The MMPA (16 U.S.C. 1371; 50 CFR Subpart 216) generally prohibits the taking of marine mammals, but also contains a number of exemptions and exceptions, including Section 101(a)(5)(A). The Natural Resources Defense Council and other non-governmental organizations filed suit against the Department of the Interior alleging that BOEM violated the National Environmental Policy Act (NEPA) when issuing G&G permits in the Gulf of Mexico before completing an Environmental Impact Statement. Following a 2013 litigation stay agreement to stay the litigation (*NRDC v. Jewell*, No. 2:10-CV-01882 (E.D. La.), BOEM re-submitted a final, revised petition for regulations under Section 101(a)(5)(A) of the MMPA so that industry operators may conduct G&G activities in the GOM in compliance with the MMPA. Ultimately the final ITR would establish a framework for issuing letters of authorization for the take of marine mammals incidental to G&G activities related to oil and gas activities in GOM waters.

ANALYTIC REQUIREMENTS MET BY THIS RIA

Executive Order (E.O.) 12866, as amended by E.O. 13563, directs Federal agencies to consider the costs and benefits of available regulatory alternatives and to select approaches that maximize net benefits, unless a statute requires another regulatory approach. In addition, the Office of Management and Budget (OMB) provides direction to Federal agencies on the characteristics of a methodologically sound regulatory analysis in *Circular A-4*. This RIA provides the public with the information required for evaluating the NMFS regulatory proposal as defined by these Executive Orders in a manner consistent with OMB guidance.

In addition, this analysis evaluates the distributional effects of the regulatory alternatives, providing information on how particular economic sectors or groups of people will be affected. The distributional analyses included in Appendices B and C of this RIA address the requirements of multiple statutes and Executive Orders.

REGULATORY BASELINE FOR ANALYSIS

Circular A-4 directs Federal agencies to measure the costs and benefits of a regulatory action against a baseline, which it defines as the "best assessment of the way the world would look absent the proposed action."[3] In other words, the baseline reflects the existing regulatory and socio-economic burden imposed on regulated entities potentially affected by a new rulemaking. Impacts that are incremental to that baseline (i.e., occurring over and above existing constraints or conditions) are considered to be attributable to the rule.

This analysis evaluates the impacts of the proposed rule relative to two different baselines. The first baseline for this analysis corresponds with the management of G&G activities in the GOM prior to the 2013 stay agreement, which is set to expire in November 2018. Given the current industry practice of implementing the stay agreement-related mitigation measures over the past several years, however, it is possible that industry would continue to implement some of the measures included in the stay agreement following its expiration. Therefore, we additionally evaluate the costs and

[3] OMB, Circular A-4, September 17, 2003.

benefits of the ITR relative to a baseline that reflects the stay agreement-related mitigation measures for G&G activities in the GOM. The costs and benefits of the regulatory alternatives described in the main text of this RIA (Chapters 4 and 5) are presented as the incremental impacts of the MMPA rule as compared to pre-stay agreement regulatory conditions for G&G activities in the GOM. The analysis of costs and benefits compared to the "stay agreement baseline" is included as Appendix A to the RIA.

DESCRIPTION OF THE PROPOSED RULE AND MORE STRINGENT ALTERNATIVE

This RIA evaluates the incremental impacts of the Proposed Rule and a More Stringent Alternative against the baseline. The ITR will pertain specifically to G&G surveys associated with oil and gas exploration and development activities; G&G surveys related to BOEM's marine minerals and renewable energy programs, or scientific research, will not be subject to the requirements of the rulemaking.

PROPOSED RULE

The Proposed Rule would require additional mitigation measures for both seismic airgun surveys as well as non-airgun high-resolution geophysical (HRG) surveys with frequencies less than 200 kilohertz (kHz) over and above baseline requirements, as follows:

1. **Mitigation Requirements for Protected Species Observer (PSO) Dolphin Observations:** The Proposed Rule requires seismic airgun survey power downs for small dolphins and shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys.
2. **PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Waters and Associated Mitigation for Whale Observations:** The Proposed Rule requires that seismic airgun surveys in water depths less than 200 meters in the Western and Central Planning Areas include PSOs and implement shutdowns for observations of whales in the exclusion zone. Prior to the stay agreement these requirements pertained only to seismic airgun surveys in waters greater than 200 meters in depth.
3. **Additional Mitigation Requirements for PSO Whale Observations:** The Proposed Rule requires deep penetration seismic airgun survey shutdowns due to PSO sightings of Bryde's whale, Kogia species, and beaked whales outside of the 500-meter exclusion zone.
4. **Passive Acoustic Monitoring (PAM) Implementation Requirements and Associated Mitigation for Whale Detections:** The Proposed Rule requires implementation of PAM constantly (24 hours/day) for deep penetration airgun surveys in water depths greater than 100 meters. PAM detections of any whales require shutdown of deep penetration seismic airgun surveys.
5. **PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations:** The Proposed Rule requires that non-airgun HRG surveys in deep water (greater than 200

meters depth) include PSO observers. In addition, the Proposed Rule requires shutdowns for observations of any whales and of large dolphins within a 200-meter exclusion zone.

6. **PSO Equipment Requirements:** For deep penetration airgun surveys and for non-airgun HRG surveys in deep water (greater than 200 meters in depth), the Proposed Rule requires vessels to provide pedestal-mounted "bigeye" binoculars for PSOs.
7. **PSO Training and Experience Requirements:** The Proposed Rule requires that: a) all observers (PSOs) must have appropriate training and must be third-party (i.e., not crew members); b) at least one visual PSO must have a minimum 90 days relevant experience, completed not less than 18 months prior; and c) at least two acoustic PSOs must have a minimum 90 days relevant experience, completed not less than 18 months prior. For PAM use in shallow penetration airgun surveys and non-airgun HRG surveys in shallow water, the PAM operator may be a crew member.
8. **Reporting Requirements:** The Proposed Rule specifies that all surveys (with the exception of non-airgun HRG using sources > 200kHz) must submit reports within 90 days of the conclusion of the survey concerning the activity conducted, observations of marine mammals, and details of mitigation implementation, as applicable.
9. **Seasonal Area Closures:** The Proposed Rule specifies seasonal restrictions on seismic airgun surveys between February 1st and May 31st in the Coastal Waters Closure Area, as identified in Exhibit ES-1. The Coastal Waters Closure Area includes coastal waters shallower than 20 meters depth.
10. **Year-Round Area Closures:** The Proposed Rule includes complete closure (year-round) to seismic airgun surveys in the Eastern Planning Closure Area and the Dry Tortugas Closure Area. Both closure areas fall within BOEM's GOM Eastern Planning Area, with the exception of a small fraction of the Eastern Planning Closure Area, as identified in Exhibit ES-2.

EXHIBIT ES-1. MAP OF SEASONAL COASTAL WATERS CLOSURE AREA

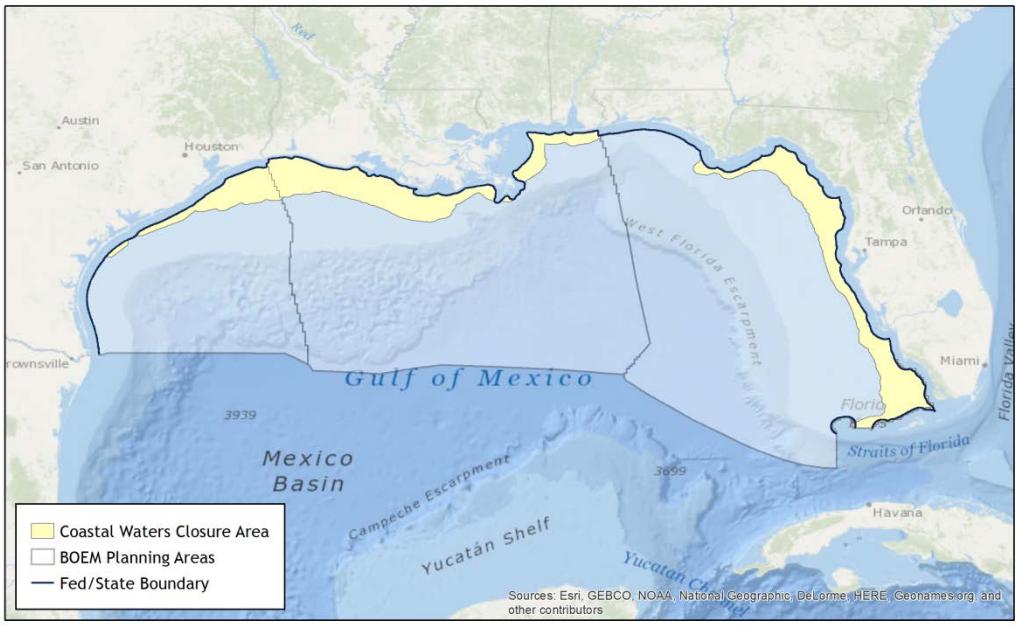
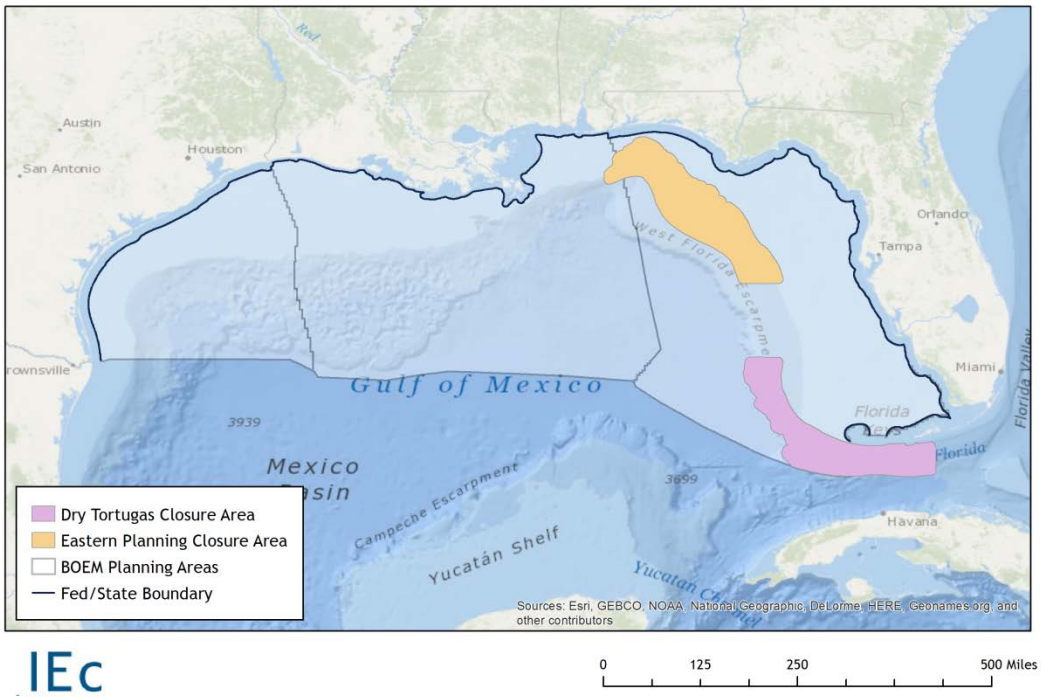


EXHIBIT ES-2. PROPOSED RULE YEAR-ROUND CLOSURE AREAS

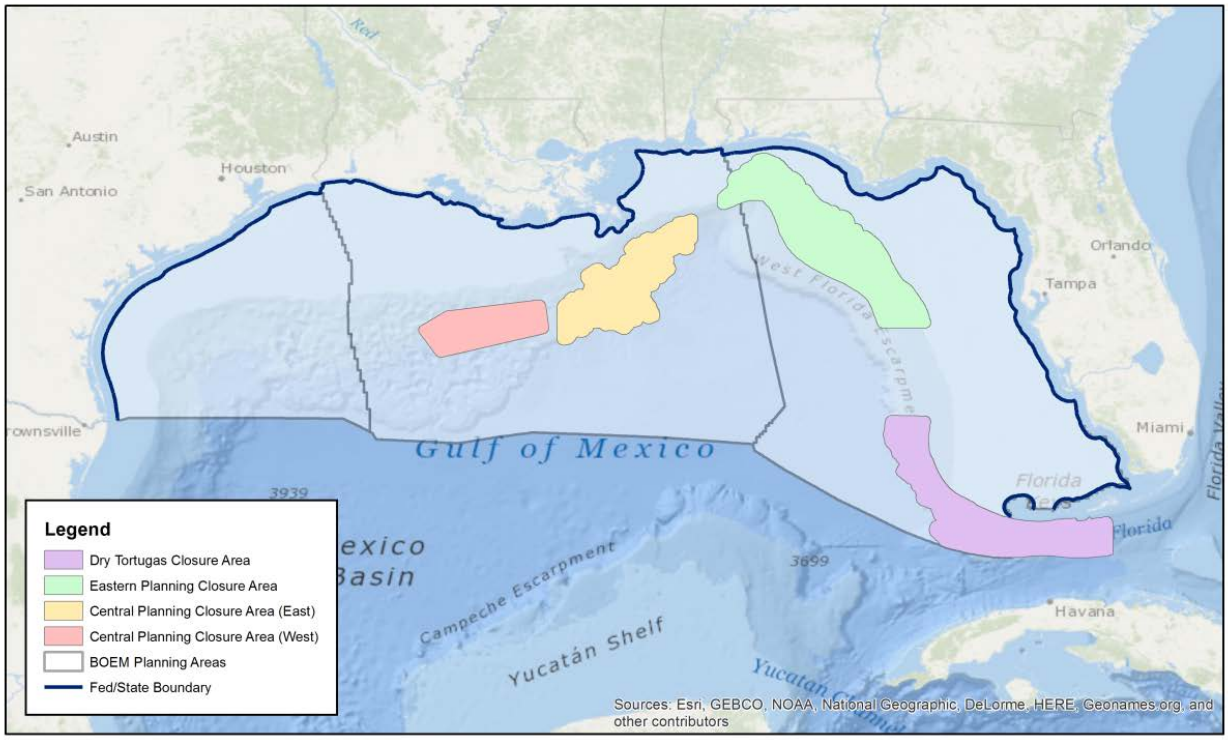


MORE STRINGENT ALTERNATIVE

The More Stringent Alternative includes the same requirements as the Proposed Rule for: use of PAM and associated mitigation for whale detections; PSO implementation for shallow water airgun surveys and associated shutdown requirements for whale observations; PSO implementation for non-airgun surveys and associated shutdown requirements for whale and dolphin observations; PSO equipment requirements; PSO training and experience requirements; reporting requirements; and seasonal area closures. The More Stringent Alternative includes additional requirements, however, as follows:

1. **Mitigation Requirements for PSO Dolphin Observations:** In line with the Proposed Rule, the More Stringent Alternative requires seismic airgun survey shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and the 200-meter exclusion zone for shallow penetration surveys. The Proposed Rule and More Stringent Alternative differ in terms of mitigation for small dolphins. The Proposed Rule requires power downs for all observations of small dolphins within the exclusion zone whereas the More Stringent Alternative requires shutdowns for observations of non-bow-riding dolphins but does not require shutdown or power down for bow-riding small dolphins.
2. **Additional Mitigation Requirements for PSO Whale Observations:** While the Proposed Rule requires shutdowns only for observations of Bryde's whale, Kogia species, and beaked whales outside the exclusion zone, the More Stringent Alternative also requires shutdowns for sperm whales outside the exclusion zone.
3. **Year-Round Area Closures:** The More Stringent Alternative includes complete closure (year-round) to seismic airgun surveys of the Eastern Planning Closure Area and the Dry Tortugas Closure Area (consistent with the Proposed Rule), as well as the additional Central Planning Closure Area (East and West portions), as identified in Exhibit ES-3.

EXHIBIT ES-3. MORE STRINGENT ALTERNATIVE CLOSURE AREAS



RESULTS OF COST ANALYSIS

This analysis evaluates the costs of compliance with the Proposed Rule and More Stringent Alternative, including: a) quantifying the increased cost of conducting G&G surveys due to the additional requirements of the rule (direct compliance costs); and b) qualitatively assessing the economic implications of potential reductions in the overall level of G&G survey activity in the GOM (indirect costs). In addition to historical BOEM G&G permit data, this analysis employs cost information provided to BOEM by the International Association of Geophysical Contractors (IAGC), follow-on communication with the IAGC and the American Petroleum Institute (API), and public comments submitted on the September 2016 Draft Programmatic Environmental Impact Statement (Draft PEIS) for G&G activities in the GOM.

QUANTIFIED DIRECT COMPLIANCE COSTS

As described in Exhibit ES-4, the annualized direct compliance costs of the Proposed Rule range from $49 million to $182 million over the rule's five-year timeframe (assuming a seven percent discount rate).[4] Approximately 70 percent of the high-end costs are due to the requirement to use PAM at all times in waters greater than 100 meters in depth and to shut downs for any PAM detections of whales. Another 22 percent of the high-end costs are associated with the potential need to reshoot the airgun array following a power down due to PSO observations of small dolphins within the exclusion zone. The shut downs and time required to reshoot effectively lengthen the time it takes a survey operation to gather the needed data.

The broad range in the direct compliance costs is driven in large part by uncertainty associated with how many G&G surveys will be conducted over the rule's five-year timeframe. While the difference in projected survey activity between the low- and high-ends varies by survey type, overall the high-end forecast of survey activity is approximately 65 percent higher than that of the low-end forecast.

As summarized in Exhibit ES-4, the annualized compliance costs of the More Stringent Alternative range from $78 million to $218 million. In addition to the regulatory requirements and associated costs described for the Proposed Rule, the costs of the More Stringent Alternative include shutdowns for PSO observations of small dolphins that are not bow-riding and for observations of sperm whales outside the exclusion zone.

Exhibits ES-5 and ES-6 present the incremental annualized compliance costs for the Proposed Rule and More Stringent Alternative by survey type and planning area using 7 percent and 3 percent discount rates, respectively. Under a 3 percent discount rate, annualized incremental compliance costs range from $53 million to $195 million for the Proposed Rule and $83 to $234 million for the More Stringent Alternative. As the exhibits show, quantified direct compliance costs are concentrated among WAZ surveys in the Central Gulf of Mexico Planning Area.

QUALITATIVE ASSESSMENT OF POTENTIAL INDIRECT COSTS

In addition to the quantified direct costs, the Proposed Rule and More Stringent Alternative include seasonal restrictions and area closures where G&G activities would be precluded over the timeframe of the rule, as depicted in Exhibits ES-1, ES-2 and ES-3.

Closing areas to G&G surveys can have real implications on the value of the GOM for oil and gas development. The closures have the potential to affect the overall levels of G&G activities that occur in the GOM over the five-year timeframe of the analysis. In the case that the closures delay or reduce the ability of industry to collect the necessary data to identify and recover oil and gas resources, the overall level of oil and gas production in the GOM may in turn be delayed or reduced. In addition to affecting the oil and gas and G&G industries, reductions in exploration and development activities in the GOM can

[4] All monetized cost estimates in this executive summary are presented in 2016 dollars. Present value and annualized costs are calculated assuming a seven percent real discount rate, unless otherwise indicated. Appendix D provides information on present value and annualized costs assuming a three percent discount rate for comparison.

have consequences on regional economies that are tied to these industries. Significant uncertainty exists regarding whether or how the Proposed Rule or More Stringent Alternative will delay or reduce oil and gas development in the GOM, as discussed in detail in Section 4.3.

Quantifying the impacts of precluding G&G surveys in the Proposed Rule closure areas over the timeframe of the rule would be speculative in light of layered uncertainties. In particular, demand for new survey data for these areas, while likely to increase over the timeframe of this analysis, is significantly uncertain. In recent history, these areas have not been the target of the oil and gas industry, in particular, due to the Gulf of Mexico Energy Security Act (GOMESA) moratorium. Oil and gas development has occurred primarily in the Central and Western Planning Areas of the GOM. As these areas become developed, however, the industry may seek to expand into the Eastern Planning Area given the estimated Undiscovered Technically Recoverable Resources (UTRR) in this area. While the timeframe of this rule is five years, if the Eastern Planning Closure Area were available for leasing while seismic activity is prohibited, companies may be hesitant to risk capital investments. Absent the ability to gather updated seismic data over the five-year time of the rule, future production of currently undiscovered hydrocarbon resources may be delayed even beyond the timeframe of the rule and could represent a social welfare loss. Both the quantity of undiscovered resources in the year-round closure areas and future oil and gas prices make quantification of potential welfare losses significantly uncertain. This analysis does find, however, that two factors could limit the extent to which the Proposed Rule closures delay or reduce oil and gas production: 1) the ability for the G&G industry to plan surveys around seasonal closures; and 2) the year-round closures being limited to areas that overlap the existing GOMESA moratorium.

On the other hand, the Central Planning Area Closure Area included in the More Stringent Alternative is relatively more likely to delay or reduce development of oil and gas resources due to the historically high levels of exploration and development activity in this area and because the closure is year-round as opposed to seasonal. The potential More Stringent Alternative closure areas overlap with 21 percent (645) of active GOM leases and four percent (95) of active platforms in the GOM.[5] All of these active platforms and 643 (>99 percent) of the active leases are located in the Central Planning Closure Areas. According to GIS data maintained by BOEM on the location and value of leases and the spatial extent of the closure areas, 308 lease blocks in the Central Planning Area Closure Areas received bids between 2012 and 2016.[6] The accepted bids across these leases totaled nearly $2 billion over this five-year period. Over the past five years, the two Central Planning Area Closure Areas accounted for a significant portion of the total bonus bid payments for leases in the GOM, ranging from roughly 30 to 60 percent.

[5] The BOEM database did not provide an install date or removal date for 245 platforms. Absent this information, we assumed that these platforms are currently active. 67 of these 245 platforms overlap with the Central Planning Closure Area. Platform counts are not necessarily a helpful metric since the Central Planning Closure Areas are in deepwater and fewer GOM platforms are installed in deepwater.

[6] BOEM. GOMR Historical Lease Sale Information. Accessed December 16, 2016 at: https://www.boem.gov/GOMR-Historical-Lease-Sale-Information/.

This reflects the relatively high value of these areas to industry and indicates a potentially significant impact of closing these areas to seismic airgun surveys for the next five years under the More Stringent Alternative.

EXHIBIT ES-4: ANNUALIZED COSTS BY ALTERNATIVE AND MITIGATION MEASURE, 2018-2022 (2016$, 7 PERCENT DISCOUNT RATE)

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS	MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS
QUANTIFIED DIRECT COMPLIANCE COSTS			
Mitigation Requirements for PSO Dolphin Observations: Shutdowns for large dolphins in the exclusion zone and power downs for small dolphins in the exclusion zone	$3.9 – $49.7	*Mitigation Requirements for PSO Dolphin Observations:* Shutdowns for large dolphins in the exclusion zone and for small dolphins that are not bow-riding in the exclusion zone	$15.2 - $40.2
PSO Implementation Requirements and Associated Mitigation for Whale Observations in Shallow Waters (in addition to baseline requirement for PSO implementation in deep waters): Shutdowns for all whale species in the exclusion zone for seismic airgun surveys in water depths less than 200m in the Central and Western Planning Areas	$0.02 - $2.1	*PSO Implementation Requirements and Associated Mitigation for Whale Observations in Shallow Waters (in addition to baseline requirement for PSO implementation in deep waters):* Shutdowns for all whale species in the exclusion zone for seismic airgun surveys in water depths less than 200m in the Central and Western Planning Areas	$0.02 - $2.1
Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone: Shutdowns for Bryde's/beaked/Kogia whales for deep penetration airgun surveys	$1.1 - $3.0	*Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone:* Shutdowns for Bryde's/beaked/Kogia and sperm whales for deep penetration airgun surveys	$18.4 - $48.8
PAM Implementation Requirements and Associated Mitigation for Whale Detections: Shutdowns for all whale detections for deep penetration airgun surveys	$43.9 - $127	*PAM Implementation Requirements and Associated Mitigation for Whale Detections:* Shutdowns for all whale detections for deep penetration airgun surveys	$43.9 - $127
PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations: Shutdowns for whale and large dolphin observations in the exclusion zone	$0. 12 - $0.39	*PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations*: Shutdowns for whale and large dolphin observations in the exclusion zone	$0.12 - $0.39
Proposed Rule Total Direct Compliance Costs	**$49 - $182**	**More Stringent Alternative Total Direct Compliance Costs**	**$78 - $218**
QUALITATIVE ASSESSMENT OF POTENTIAL INDIRECT COSTS*			
Seasonal Restrictions: Precludes use of airguns in coastal waters between February 1 and May 31	Some potential for impacts to oil and gas productivity in the GOM over the next 5-10 years	*Seasonal Restrictions:* Precludes use of airguns in coastal waters between February 1 and May 31	Some potential for impacts to oil and gas productivity in the GOM over the next 5-10 years

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS	MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS
Area Closures: Precludes use of airguns year round within the Eastern Planning Closure Area and Dry Tortugas Closure Area	Some potential for impacts to oil and gas productivity in the GOM over the next 5-10 years	*Area Closures:* Precludes use of airguns year round within the Central Planning Closure Area, Eastern Planning Closure Area, and Dry Tortugas Closure Area	Substantial potential for impacts to oil and gas productivity in the GOM over the next 5-10 years

Notes:

1. Costs are presented in terms of 2016 US Dollars and are annualized over the five-year time frame (2018-2022) applying a 7% discount rate.
2. Estimates are rounded to three significant digits.
3. This exhibit reflects incremental costs of the Proposed Rule and More Stringent Alternative relative to the pre-stay agreement baseline. Appendix A presents incremental costs relative to the stay agreement mitigation measures.

* The rationale for the characterization of the potential economic implications of these mitigation measures are discussed in Section 4.3.

EXHIBIT ES-5: ANNUALIZED INCREMENTAL COSTS SURVEY TYPE AND PLANNING AREA, 2018-2022 (MILLION 2016$, 7% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.00	$0.01 - $0.05	$0.20 - $0.64	$0.00 - $0.07	$0.00 - $1.21	$0.00 - $0.29	$0.00 - $3.18	$0.00 - $2.79	$5.2 - $38.1	$5.5 - $46.3
	Central	$0.00 - $0.02	$0.11 - $0.32	$0.61 - $1.65	$0.11 - $0.31	$0.00 - $1.21	$0.00 - $0.29	$1.55 - $13.3	$1.39 - $11.7	$39.8 - $97	$43.6 - $126
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.06	$0.00 - $0.00	$0.00 - $1.21	$0.00 - $0.29	$0.00 - $2.20	$0.00 - $1.87	$0.00 - $3.55	$0.00 - $9.2
	TOTAL	$0.01 - $0.02	$0.12 - $0.38	$0.82 - $2.35	$0.11 - $0.38	$0.00 - $3.63	$0.00 - $0.86	$1.55 - $18.7	$1.39 - $16.4	$45.1 - $139	$49 - $182
More Stringent Alternative	Western	$0.00 - $0.00	$0.01 - $0.05	$0.22 - $0.74	$0.00 - $0.08	$0.00 - $1.44	$0.00 - $0.37	$0.00 - $3.92	$0.00 - $3.61	$8.4 - $45.2	$8.6 - $55.4
	Central	$0.01 - $0.03	$0.11 - $0.32	$0.69 - $1.89	$0.12 - $0.36	$0.00 - $1.44	$0.00 - $0.37	$2.43 - $16.4	$2.16 - $15.2	$63.5 - $115	$69.0 - $151
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.07	$0.00 - $0.00	$0.00 - $1.44	$0.00 - $0.37	$0.00 - $2.72	$0.00 - $2.45	$0.00 - $4.21	$0.00 - $11.3
	TOTAL	$0.01 - $0.03	$0.12 - $0.38	$0.91 - $2.71	$0.12 - $0.44	$0.00 - $4.33	$0.00 - $1.11	$2.43 - $23.0	$2.16 - $21.2	$71.9 - $165	$78 - $218

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. This exhibit reflects incremental costs above the pre-stay agreement baseline. Appendix A presents incremental costs relative to the stay agreement-related mitigation measures.
3. Cost estimates less than $50,000 are reported as $0 million due to rounding.

EXHIBIT ES-6: ANNUALIZED INCREMENTAL COSTS SURVEY TYPE AND PLANNING AREA, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.00	$0.01 - $0.05	$0.22 - $0.69	$0.00 - $0.07	$0.00 - $1.31	$0.00 - $0.31	$0.00 - $3.42	$0.00 - $2.99	$5.7 - $41.1	$5.9 - $50.0
	Central	$0.01 - $0.02	$0.12 - $0.35	$0.66 - $1.77	$0.12 - $0.33	$0.00 - $1.31	$0.00 - $0.31	$1.63 - $14.3	$1.45 - $12.6	$42.7 - $104	$46.7 - $135
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.07	$0.00 - $0.00	$0.00 - $1.31	$0.00 - $0.31	$0.00 - $2.37	$0.00 - $2.02	$0.00 - $3.99	$0.00 - $10.1
	TOTAL	$0.01 - $0.02	$0.13 - $0.42	$0.88 - $2.53	$0.12 - $0.41	$0.00 - $3.92	$0.00 - $0.93	$1.63 - $20.0	$1.45 - $17.6	$48.4 - $149	$53 - $195
More Stringent Alternative	Western	$0.00 - $0.00	$0.01 - $0.05	$0.24 - $0.80	$0.00 - $0.09	$0.00 - $1.56	$0.00 - $0.40	$0.00 - $4.21	$0.00 - $3.87	$9.0 - $48.8	$9.3 - $59.8
	Central	$0.01 - $0.03	$0.12 - $0.35	$0.74 - $2.03	$0.13 - $0.38	$0.00 - $1.56	$0.00 - $0.40	$2.54 - $17.5	$2.26 - $16.2	$68.1 - $124	$74.0 - $162
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.08	$0.00 - $0.00	$0.00 - $1.56	$0.00 - $0.40	$0.00 - $2.94	$0.00 - $2.65	$0.00 - $4.74	$0.00 - $12.4
	TOTAL	$0.01 - $0.04	$0.13 - $0.42	$0.98 - $2.91	$0.13 - $0.47	$0.00 - $4.68	$0.00 - $1.20	$2.54 - $24.7	$2.26 - $22.7	$77.2 - $177	$83 - $234

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. Cost estimates less than $50,000 are reported as $0 due to rounding.

ECONOMIC BENEFITS

G&G activities may negatively affect marine mammals and other marine wildlife in a number of ways, including underwater acoustic disturbances; vessel traffic (risk of ship strikes to marine organisms, vessel noise, and disruption of other marine-based activities); entanglement of commercial fishing equipment with G&G equipment; impacts of stand-off distances on commercial fishing activity; and impacts of accidental spills on biological resources and commercial fishing activity. The purpose of the Proposed Rule is to establish a regulatory framework under which authorizations of marine mammal take incidental to survey activities may be issued. The proposed rule would establish mitigation, monitoring, and reporting requirements to be prescribed through such authorizations, as required by Section 101(a)(5)(A) of the MMPA. Under the MMPA, "take" means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362).

The potential for exposure of an animal to survey noise to result in harassment depends not only on the sound level of the survey, but also on other sound sources that are present, the type of marine mammal, and the distance from and position of the animal relative to the sound source. The significance of a disturbance event for an exposed animal depends on all of these factors plus the duration of the exposure, the age and sex of the animal, and the particular behavior in which the animal is engaged at the time of exposure. These uncertainties complicate a quantitative analysis of the expected benefits of the Proposed Rule in terms of reductions in injury and behavioral disruption.

With respect to the biological benefits of the Proposed Rule to the species, Appendix D of BOEM's PEIS includes a detailed set of test scenarios.[7] Chapter 5 of this RIA includes a discussion of the economics literature focused on the economic value of marine mammals in order to provide perspective on the multiple ways in which the marine mammals in the GOM support economic activity and contribute to people's well-being.

INITIAL REGULATORY FLEXIBILITY ANALYSIS

In total, 34 U.S.-based small businesses applied for acoustic G&G permits in the Gulf of Mexico between 2006 and 2015. While small businesses represent nearly half of the *entities* who applied for permits (41 percent of 82 entities), small businesses applied for only 12 percent of total permit *applications* (75 surveys out of 614). This means that foreign businesses and U.S.-based large businesses applied for more permits *per business* than small businesses. Foreign businesses and U.S.-based large entities put forth an average of 16.5 and 7.5 survey applications per entity, respectively, while U.S.-based small entities put forth 2.2 surveys per business between 2006 and 2015. As described in Appendix B, companies involved in crude petroleum and natural gas extraction (NAICS 211111) and support activities for oil and gas (NAICS 213112) applied for the majority of the survey permits by small companies (87 percent of companies).

[7] For more information, see Appendix D of: Bureau of Ocean Energy Management, August 2017, Gulf of Mexico OCS Proposed Geological and Geophysical Activities: Final Programmatic Environmental Impact Statement.

While other industries do apply for permits, we expect it is unlikely they are bearing the costs of the surveys. We expect it is most likely that the companies commissioning the surveys or purchasing the data gathered will bear the increased cost; this is generally the oil and gas extraction industry. This analysis, however, profiles the various industries applying for G&G surveys in the GOM.

Approximately 7 to 11 small entities are anticipated to be involved in survey application activities annually over the next five years. Impacts of the proposed action would not be universally experienced by all small entities, and would depend what types of surveys the companies undertake.

Between 2006 and 2015, 85 percent of survey permit applications by small businesses were for HRG surveys. Incremental costs of the proposed rule for non-airgun surveys, which accounted for most of the HRG surveys (95 percent are forecast to be non-airgun, as opposed to airgun, surveys), are anticipated to range from $5,100 to $11,300 per survey. Airgun HRG survey costs are anticipated to range from $6,630 to $17,200 per survey. Incremental impacts for HRG surveys, which historically comprised most small business surveys, are anticipated to increase costs to small entities by one percent or less of annual revenues. For those entities engaged in other types of surveys, costs could comprise a larger portion of annual revenues.

In summary, the Initial Regulatory Flexibility Analysis (IRFA) in Appendix B finds:

1. The majority of the time (88 percent), survey permit applicants are large businesses.
2. When the permit applicants are small businesses, the majority of the time (63 percent) they are oil and gas extractors (NAICS 211111).
3. Together these permits (for large businesses and small businesses with high annual revenues for which rule costs are a small fraction) account for 96 percent of the permits for G&G surveys.
4. While small entities in other industries occasionally apply for permits (four percent historically), these businesses are quite small, with average annual revenues in the millions or even less. Given their size, it is unlikely that these permit applicants bear G&G survey costs or else it would be reflected in their annual revenues (i.e., their revenues on average would reflect that they recover their costs). Accordingly, we expect it is most likely the survey costs are passed on to oil and gas extraction companies who commission the surveys or purchase the data.
5. Overall, up to five small businesses (NAICS 211111) per year may experience increased costs of between 0.1 and 1.1 percent of average annual revenues.

KEY UNCERTAINTIES

As discussed throughout this RIA, several uncertainties affect the social welfare implications of the Proposed Rule. The range of cost estimates reflect the uncertainty related to the direct compliance costs. Exhibit ES-7 summarizes the major sources of

uncertainty associated with the Proposed Rule cost analysis (with some notes on the implications on the More Stringent Alternative) that are not reflected in the range of costs quantified. The exhibit also describes the direction of any potential bias associated with each source of uncertainty, and describes the likely significance with respect to impacts.

As part of the public comment period for the proposed rule, we request feedback on the data, assumptions, and uncertainties associated with this analysis, as characterized in Exhibit ES-7. Following public comment, this analysis will integrate, as appropriate, any improvements or refinements to the data and assumptions.

EXHIBIT ES-7. SOURCES OF UNCERTAINTY REGARDING COSTS OF THE PROPOSED RULE

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
DIRECT COMPLIANCE COSTS		
The estimated frequencies of encountering marine mammals are the primary driver of the cost analysis. We relied on historical marine mammal observer reports from G&G surveys to estimate the expected rate of survey shut downs. Absent more specific data, this analysis assumes the rate of shutdowns is uniform throughout the study area.	**Unknown.** May overestimate or underestimate incremental impacts.	**Potentially major.** The shutdown rates for future G&G surveys is the key uncertainty in the direct compliance cost estimates. It is difficult to forecast with any reasonable precision how frequently these vessels will encounter marine mammals and, further, whether that varies by location within the GOM. The historical monitoring reports we rely on are the best available information to inform this assumption. However, in the case that the estimated shutdown rates, particularly for the more expensive WAZ surveys, are low or high, this has significant implications in the quantified direct compliance costs.
The analysis relies on a forecast of surveys developed by BOEM based on historical activity levels and feedback provided through public review.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** This analysis includes a broad range in G&G activity levels to forecast impacts and we expect this range encompasses the likely future activity levels. That is, it is unlikely that actual future levels of activity will fall above or below this range.
The analysis relies on baseline G&G survey cost estimates from a 2014 IAGC survey and follow on communication with API and IAGC in 2016 to confirm the costs provided were still reflective of the G&G activities in the GOM.	**Unknown.** May overestimate or underestimate incremental impacts.	**Unknown.** The 2014 IAGC survey costs were used to inform the PEIS which was subject to public comment. Thus, industry operators in the GOM were able to comment on the cost estimates provided in that document; no comments were provided that improved upon the G&G survey cost information as a result of public comment. Additionally, we discussed the cost estimates from the survey with IAGC and API in 2016 and they verified that the estimates were accurate to their knowledge. As a result, we think that these baseline costs are likely representative of current survey costs. However, any inaccuracies in the baseline cost estimates would affect the estimated costs of the proposed rule as many of the mitigation requirements are calculated as a percentage of baseline costs.
The analysis assumes that the proportion of future 2D and 3D surveys that use OBS technology will match the proportion observed in the G&G permit history.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** Estimated incremental costs do not differ greatly between OBS and non-OBS 2D and 3D surveys, so the exact proportion using OBS technology in the future is not likely to significantly affect the overall costs associated with the alternatives.
The analysis assumes that the costs of SWD surveys are similar to VSP surveys.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** We were not able to identify any recent data on the costs of SWD surveys. However, given that SWD surveys are relatively inexpensive and account for less than 7 percent of forecasted surveys, a revised cost estimate would not greatly affect the total estimated costs associated with the alternatives.

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
The analysis estimates impacts of survey shutdowns based on a 500-meter exclusion zone for shallow penetration airgun surveys and non-airgun HRG surveys although the Proposed Rule specifies a 200-meter exclusion zone for both.	**Overestimate.** Analysis leads to a higher than expected cost estimate for this mitigation measure.	**Likely Minor.** We were not able to identify data on the frequency of marine mammal observations within a 200-meter exclusion zone. Absent these data, this analysis relied on marine mammal observation data within a 500-meter exclusion zone. We expect the implications of this uncertainty are likely to be minor with respect to the total estimated compliance costs because non-airgun HRG surveys account for less than 0.5 percent of total direct compliance costs, and shallow penetration airgun surveys account for approximately 3 percent of total high-end compliance costs.
The analysis assumes costs for several administrative and operational rule requirements are minor and they are not quantified in this analysis. In particular, the analysis does not include costs of experience requirements for PSOs and PAM operators.	**Underestimate.** Analysis leads to a lower than expected cost estimate for this mitigation measure.	**Likely Minor.** The analysis does not quantify costs associated with the requirement that vessels provide pedestal-mounted "bigeye" binoculars, the requirement that PSOs and PAM operators must be third party and have prior experience, or the requirement that surveys submit reports 90 days after the conclusion of a survey regarding observations of marine mammals and mitigation implementation. BOEM and NMFS indicated that these requirements are in line with standard industry practice, and thus we do not anticipate that these requirements increase the costs of the proposed rule.
POTENTIAL INDIRECT COSTS		
The demand for and timing of oil and gas production in the GOM over the next five years is uncertain.	**Not quantified.**	**Moderate.** The impacts of the seasonal restrictions and year-round area closures are highly dependent on volatile oil and gas market conditions over the next five years, which dictate the demand for activities in the GOM. The greater the demand for oil and gas, the greater the expected impacts of the regulatory alternatives. Given the five-year timeframe of the rule overlaps the GOMESA moratorium that covers the Proposed Rule area closures, however, we expect a low likelihood of significant oil and gas production effects, as described in Section 4.3.2. While extending the area closures beyond the five-year timeframe of the analysis would increase the likelihood and magnitude of potential social welfare effects associated with reduced or delayed production, the timeframe of this rule is limited to five years. Thus, this analysis does not speculate regarding longer timeframes for closures. Any additional closures would need to be proposed as part of a separate rulemaking and evaluated in the associated economic analysis. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, however, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.
The extent to which future G&G surveys can incorporate avoidance of seasonal restriction areas in planning stages is uncertain.	**Not quantified.**	**Moderate.** Seasonal restrictions require surveys to avoid specified areas during specified times. We expect that many G&G surveys may incorporate these restrictions as part of survey planning without measurably affecting the cost or effectiveness of the survey. However, this is likely to be more complicated for longer-term surveys that cover a larger area overlapping the restricted areas.

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
The suitability of existing G&G data to direct oil and gas production in the closure areas is unknown.	**Not quantified.**	**Moderate.** The extent to which oil and gas production is delayed because of the need for newer, better G&G data is a key source of uncertainty for this analysis. We expect some sites may be able to employ existing data from recent surveys. While demand for new G&G data in the Proposed Rule closure areas is likely to increase over the timeframe of this rule due to the potential expiration of the GOMESA moratorium, no new leasing will be permitted in these areas over the timeframe of the rule. Thus, we expect these area closures will have minor to moderate effects on oil and gas production over the next five to ten years. If the Proposed Rule closure areas are closed to G&G activity for longer than a five year period, we would anticipate more significant economic implications. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, however, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.
The most likely substitute sites for oil and gas production are uncertain.	**Not quantified.**	**Likely Minor.** As no oil and gas production is expected from the Proposed Rule closure areas over the timeframe of this analysis in the baseline (due to the GOMESA moratorium), the effect of this uncertainty on our findings related to indirect impacts is likely minor. We expect it is unlikely that the area closures in the Eastern Planning area over the next five years will influence the likelihood that oil and gas production levels move out of the GOM and into other substitute markets in the near term. With respect to the More Stringent Alternative, some fraction of reductions in production from the closure areas may be made up for with production in other areas in the GOM, mitigating potential regional economic impacts. To the extent that substitute areas are outside of the GOM but within the U.S., national-level impacts of the closure areas will likely be limited. However, to the extent that industry moves displaced activities outside of the U.S., national-level impacts associated with industry income and employment may be substantial. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.

CHAPTER 1 INTRODUCTION

1.1 INTRODUCTION

This draft regulatory impact analysis (RIA) evaluates the potential costs and benefits of incidental take regulations (ITR) proposed pursuant to the Marine Mammal Protection Act (MMPA). The proposed ITR addresses take of marine mammals incidental to geological and geophysical (G&G) activities conducted by the oil and gas industry in the Gulf of Mexico (GOM). The Bureau of Ocean Energy Management (BOEM), which has petitioned The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) for the issuance of the ITR on behalf of industry, manages the exploration and development of the Nation's offshore resources—including oil and gas, renewable energy, and marine minerals—in Federal waters. In accordance with Section 11 of the Outer Continental Shelf Lands Act (OCSLA) and supporting regulations, BOEM issues G&G permits for collection of data regarding the potential location, extent, and properties of energy and mineral resources as well as geotechnical and geologic properties and hazards. Under the OCSLA, BOEM ensures that G&G activities not cause undue harm to aquatic life, property, or the marine, coastal, or human environments.

NMFS is responsible for the stewardship of the Nation's ocean resources and their habitat. For example, under Section 101(a)(5) of the MMPA, the Secretary of Commerce[8] shall allow the incidental, but not intentional, take of marine mammals associated with a specified activity and geographical region if NMFS finds that the total taking will have a negligible impact on the species or stocks and will not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses (where relevant). In this capacity and if appropriate, NMFS must issue MMPA incidental take regulations prescribing: a) the permissible methods of taking; b) other means of effecting the least practicable adverse impact on the species or stocks and their habitat;[9] and c) monitoring and reporting requirements.

BOEM and NMFS have been working cooperatively to develop regulations governing how G&G surveys should be carried out on the Outer Continental Shelf (OCS) in the GOM to ensure that these activities will have a negligible impact on marine mammal species or stocks, and the appropriate mitigation, monitoring, and reporting

[8] Relevant to NMFS's trust species. Certain species of marine mammal are under the jurisdiction of the U.S. Fish and Wildlife Service and, for these species, incidental take authorizations are allowed by the Secretary of the Interior.

[9] NMFS routinely refers to this requirement as "mitigation" for shorthand.

requirements.[10] On December 20, 2002, the Minerals Management Service (MMS), a predecessor agency to BOEM, petitioned NMFS for rulemaking under Section 101(a)(5)(A) of the MMPA to authorize any potential take of sperm whales (*Physeter macrocephalus*) incidental to conducting seismic surveys during oil and gas exploration activities in the GOM. In response to feedback from NMFS and the public, MMS revised the petition in 2004 to include all species of marine mammals; the petition was again revised to integrate updated information in 2011. Following the 2004 petition, NMFS began working to develop a National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS), with BOEM participating as a Cooperating Agency until 2008 and then as Co-Lead Agency afterward. In 2015, BOEM became the lead agency for the EIS, with NOAA acting as a Cooperating Agency. Following the 2010 *Deepwater Horizon* oil spill, the Natural Resources Defense Council and other non-governmental organizations filed suit against the Department of the Interior alleging that BOEM violated NEPA when issuing G&G permits in the Gulf of Mexico before completing the PEIS. Following a 2013 litigation stay agreement (henceforth, "stay agreement") to stay the litigation (*NRDC v. Jewell*, No. 2:10-CV-01882 (E.D. La.), BOEM re-submitted a final, revised petition for the ITR in October 2016. Therefore, NMFS is developing the requested rulemaking, which is the subject of this draft RIA. The Final PEIS was published in August 2017.

1.2 STATEMENT OF NEED FOR REGULATORY ACTION

The MMPA (16 U.S.C. 1371; 50 CFR Subpart 216) generally prohibits the taking of marine mammals, but also contains a number of exemptions and exceptions, including Section 101(a)(5)(A). On behalf of the oil and gas industry, BOEM has submitted a petition for regulations under Section 101(a)(5)(A) of the MMPA so that industry operators may conduct G&G activities in compliance with the MMPA. Ultimately the final MMPA rule would establish a framework for issuing letters of authorization for the take of marine mammals incidental to G&G activities related to oil and gas activities in GOM waters.

1.3 ANALYTIC REQUIREMENTS MET BY THIS RIA

Executive Order (E.O.) 12866, as amended by E.O. 13563, directs Federal agencies to consider the costs and benefits of available regulatory alternatives and to select approaches that maximize net benefits, unless a statute requires another regulatory approach. In addition, the Office of Management and Budget (OMB) provides direction to Federal agencies on the characteristics of a methodologically sound regulatory analysis in *Circular A-4*. This RIA provides the public with the information required for evaluating the NMFS regulatory proposal as defined by these Executive Orders in a manner consistent with OMB guidance.

In addition, this analysis evaluates the distributional effects of the regulatory alternatives, providing information on how particular economic sectors or groups of people will be

[10] "Negligible impact" is described in 50 CFR 216.103 as, "An impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

affected. The distributional analyses included in Appendix B and C of this RIA address the requirements of multiple statutes and Executive Orders, including:

- **Regulatory Flexibility Act (RFA) of 1980, as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996.** The RFA (codified at 5 USC 601-612), as amended by SBREFA (Pub. L. 104-121), requires Federal agencies to prepare a regulatory flexibility analysis and take other steps to assist small entities -- unless the agency certifies that a rule will not have a "significant economic impact on a substantial number of small entities."
- **The Paperwork Reduction Act (PRA) of 1995** (44 U.S.C. 3501 et seq.) requires that Federal agencies assess the administrative burdens imposed by a rule's requirements on industry and the government.
- **Unfunded Mandates Reform Act (UMRA) of 1995.** UMRA (2 USC 1501 et seq.) requires Federal agencies to assess the effects of its regulatory actions on State, local, and Tribal governments and the private sector. Agencies must prepare a statement, including a cost-benefit analysis, for rules that may result in the expenditure by governments in the aggregate, or by the private sector, of $100 million or more in any one year.
- **E.O. 13211 – Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use**. E.O. 13211 directs Federal agencies to "weigh and consider the effects of the Federal Government's regulations on the supply, distribution, and use of energy." Agencies must prepare a Statement of Energy Effects for regulations meeting the definition of a "significant energy action." Specific thresholds included in the OMB guidance that are potentially relevant to the MMPA Rule include the following: reductions in crude oil supply in excess of 10,000 barrels (bbls) per day; reductions in fuel production in excess of 4,000 barrels per day; reductions in natural gas production in excess of 25 million mcf per year; and increases in the cost of energy production in excess of one percent.[11]

The results of these analyses are presented in Appendices B (IRFA) and C (Other Supplemental Analyses) of this RIA.

1.4 REGULATORY BASELINE FOR ANALYSIS

Circular A-4 directs Federal agencies to measure the costs and benefits of a proposed regulatory action against a baseline, which it defines as the "best assessment of the way the world would look absent the proposed action."[12] In other words, the baseline reflects the existing regulatory and socio-economic burden imposed on regulated entities potentially affected by a new rulemaking. Impacts that are incremental to that baseline (i.e., occurring over and above existing constraints or conditions) are considered to be attributable to the proposed rule.

[11] OMB, Memorandum 01-27: Guidance for Implementing E.O. 13211. July 13, 2001.

[12] OMB, Circular A-4, September 17, 2003.

This analysis evaluates the impacts of the proposed rule relative to two different baselines. The first baseline for this analysis corresponds with the management of G&G activities in the GOM prior to the 2013 stay agreement, which is set to expire in November 2018. Given the current industry practice of implementing the stay agreement-related mitigation measures over the past several years, however, it is possible that industry would continue to implement some of the measures included in the stay agreement following its expiration. Therefore, we additionally evaluate the costs and benefits of the ITR relative to an alternative baseline that reflects the stay agreement-related mitigation measures for G&G activities in the GOM. The costs and benefits of the proposed regulatory alternatives described in the main text of this RIA (Chapters 4 and 5) are presented as the incremental impacts of the proposed MMPA rule as compared to pre-stay agreement regulatory conditions for G&G activities in the GOM. The analysis of costs and benefits compared to the "stay agreement baseline" is included as Appendix A to the RIA.

1.4.1 PRE-STAY AGREEMENT BASELINE

The first baseline for the analysis is the pre-stay agreement baseline. This baseline includes regulations and other existing or ongoing practices that governed G&G activity in the GOM, including mitigation measures benefitting marine mammals, prior to the stay agreement (as amended in a 2016 Stipulation to Amend the Settlement Agreement and in a 2017 Second Stipulated Amendment of the Settlement Agreement). These include protections under the Endangered Species Act (ESA) that would require avoiding adverse effects on listed marine mammals absent the MMPA rule.

Also included in the baseline are existing BOEM-issued restrictions that pertain to G&G activities. In particular, BOEM issues notices to lessees and operators (NTLs) that guide how OCS activities should be carried out. Some of these NTLs include provisions protective of marine mammals. For example, NTL 2016-G02 (effective on September 30, 2016) is focused on the implementation of seismic survey mitigation measures and the protected species observer program. Measures such as ramp-up procedures (i.e., gradual increase in sound from an airgun array), use of a minimum sound source, airgun testing, and protected species observation and reporting, that are regularly implemented because of the NTLs are part of the analytic baseline.

Exhibit 1-1 describes mitigation and monitoring measures that were in place prior to the stay agreement. Exhibit 1-2 highlights those measures that were in place prior to the stay agreement specifically for seismic airgun surveys. While the measures described in Exhibit 1-1 are relevant to all seismic surveys, including airgun surveys, measures described in Exhibit 1-2 are only required of airgun surveys. Mitigation measures that may be required by the proposed MMPA rule that are not included in Exhibits 1-1 and 1-2 are incremental effects of the rule.

1.4.2 ALTERNATIVE STAY AGREEMENT BASELINE

In addition to the pre-stay agreement mitigation measures outlined in in Exhibits 1-1 and 1-2, in recent years the G&G industry has been implementing mitigation measures described in the 2013 stay agreement, finalized June 24, 2013, as amended on February

10, 2016, and on September 26, 2017. Impacts of the proposed rule over and above an alternative stay agreement baseline are described in Appendix A.

The stay agreement requirements include the following mitigation measures for seismic airgun surveys above and beyond those measures described for the pre-stay agreement baseline:

- **Shutdowns for protected species observer (PSO) observations of manatees within the exclusion zone and for whale observations at all depths.** This requires that seismic airgun surveys in water depths less than 200 meters (m) in the Western and Central Planning Areas implement shutdowns for observations of whales. Prior to the stay agreement the shutdown requirements pertained only to airgun surveys in water greater than 200 m depth. In addition, the stay agreement requires that seismic operations must shut down if a manatee is observed within the exclusion zone; this was not required prior to the stay agreement.
- **Use of Passive Acoustic Monitoring (PAM) required during periods of reduced visibility for surveys in waters deeper than 100m.** Under the stay agreement baseline, PAM is required during reduced visibility conditions in waters greater than 100 meters in depth for all seismic airgun surveys (shallow and deep penetration). Prior to the stay agreement, PAM was strongly encouraged but only required in the case that operators wanted to ramp up and resume survey activity during times of reduced visibility. This resulted in an industry practice of installing PAM equipment on some vessels even prior to the stay agreement, as discussed in Section 4.2.2 of this report. We assume these stay agreement requirements result in all surveys in waters deeper than 100m employing PAM for 12 hours per day (the estimated period of low visibility on average) and shutting down in response to PAM detections of whales.
- **Minimum separation distance of 40 kilometers (km) between simultaneous surveys in Areas of Concern (including a 5-km buffer zone in the Eastern Planning Area), as well as a minimum separation distance of 30 km between simultaneous surveys outside of the Areas of Concern.** Based on a review of historical G&G permits, BOEM estimates that 65 percent of all deep penetration seismic surveys are affected by the stay agreement requirements for minimum separation distances.[13]

[13] Email communication from BOEM to IEc on September 12, 2017.

EXHIBIT 1-1. BASELINE MITIGATION MEASURES FOR MARINE MAMMALS (PRE-STAY AGREEMENT)

CONSERVATION MEASURE	DESCRIPTION
Vessel Strike Avoidance (NTL 2016-BOEM-G01)	All authorizations for shipboard surveys, regardless of vessel size, would include guidance for vessel strike avoidance while a vessel is in transit. The guidance would address protected species identification, vessel strike avoidance, and injured/dead protected species reporting in accordance with the Vessel Strike Avoidance Measures and Reporting Measures for Mariners.
Marine Debris Awareness (NTL 2015-BSEE-G03)	All authorizations for shipboard surveys would include guidance for marine debris awareness, highlighting the environmental and socioeconomic impacts of marine trash and debris as well as operator responsibilities for ensuring that trash and debris are not discharged into the marine environment.
Avoidance of Biologically Sensitive Underwater Features and Areas (NTL 2009-BOEM-G39) and Deepwater (Sensitive) Benthic Communities (NTL 2009-BOEM-G40)	All authorizations for seafloor-disturbing activities would be subject to restrictions to protect sensitive benthic communities (e.g., topographic features, hard/live bottom areas, deepwater coral communities, and chemosynthetic communities). In areas where these communities are known or suspected, authorizations may include requirements for mapping and avoidance as well as pre-deployment photographic surveys where bottom-founded equipment is to be deployed.
Activities In or Near National Marine Sanctuaries (15 CFR part 922)	BOEM would not authorize seafloor-disturbing activities within a National Marine Sanctuary (NMS), and seafloor-disturbing activities proposed near the boundaries of an NMS would be assigned a setback distance by BOEM in consultation with the Sanctuary Manager.
Archaeological Resources (NTLs 2005-BOEM-G07, 2005-A03, 2008-G20, and 2011-JOINT-G01)	Authorizations for seafloor-disturbing activities would include requirements for operators to report suspected historic and prehistoric archaeological resources to BOEM and to take precautions to protect the resource. Reporting and avoidance requirements for any previously undiscovered or suspected archaeological resource.
Shallow Hazards Program (NTLs 2008-BOEM-G05 and 2014-G03)	All seafloor-disturbing activities associated with exploration, development, production, and transportation operations must be preceded by a shallow hazards assessment.
Military Coordination (NTL 2014-BOEM-G04)	To ensure personnel safety and reduce the likelihood of conflicts between military and OCS operations, all authorizations will include requirements in which the lessee or designated operator must enter into an agreement with the appropriate individual military command headquarters concerning the control of electromagnetic emissions and use of boats and aircraft in the applicable warning area or water test area before commencing such traffic.
Note: These baseline protections apply to all G&G survey types inclusive of seismic airgun surveys as well as non-airgun high-resolution geophysical (HRG) surveys and other G&G surveys.	

EXHIBIT 1-2. BASELINE MITIGATION MEASURES FOR MARINE MAMMALS-SEISMIC AIRGUN SURVEYS ONLY (PRE-STAY AGREEMENT)

CONSERVATION MEASURE	DESCRIPTION
Guidance for Ancillary Activities (NTL 2009-G34)	All approvals for ancillary G&G exploration or development activities require notification 15 or 30 days prior to commencement of operations, depending on the type of survey, equipment, location, and water depth.
Implementation of Seismic Survey Mitigation Measures and Protected Species Observer (PSO) Program (NTL 2016-JOINT-G02)	All approvals for seismic airgun surveys in water depths greater than 200 m (656 feet) in the Western and Central Planning Areas and in all water depths in the Eastern Planning Area would include ramp-up, protected species observers with specified training, visual and passive acoustic monitoring, exclusion zones, and reporting protocols for protected species. This protocol requires that G&G operations shut down if a whale is spotted in the 500-meter exclusion zone. In particular, Passive Acoustic Monitoring (PAM) for whales is strongly encouraged. PAM will allow ramp-up and the subsequent start of a seismic survey during times of reduced visibility when such ramp-up otherwise would not be permitted. An assessment of the use of PAM, a description of the PAM system, the software used, and the monitoring plan should be reported to BOEM at the beginning of PAM use.
Note: These baseline mitigation measures are relevant only to seismic airgun surveys, defined as G&G surveys that use airguns in the acquisition of data. Airgun HRG, 2D, 3D, and Vertical Seismic Profile (VSP) surveys are common types of seismic airgun surveys.	

- **Seasonal restrictions for surveys from Federal coastal waters shoreward of the 20m isobaths (and within a 5-km buffer zone in the Eastern Planning Area) between January 1st and April 30th:** On February 10, 2016, the stipulation to amend the settlement agreement went into effect, expanding these seasonal restrictions.
- **Closure of Areas of Concern and a 5-km buffer zone around them in the Eastern Planning Area to all deep-penetration seismic airgun surveys:** These closures include exceptions for currently leased blocks, any portion of the area encompassed by Lease Sale 224, or neighboring blocks adjacent to permitted survey areas but within an otherwise off-limits area.

1.5 DESCRIPTION OF THE PROPOSED RULE AND MORE STRINGENT ALTERNATIVE

The main body of this RIA evaluates the incremental impacts of the Proposed Rule and a More Stringent Alternative against the pre-stay agreement baseline. The ITR will pertain specifically to G&G surveys associated with oil and gas exploration and development activities; G&G surveys related to BOEM's marine minerals and renewable energy programs, or scientific research, will not be subject to the requirements of the rulemaking.

1.5.1 PROPOSED RULE

The Proposed Rule would require additional mitigation measures for both seismic airgun surveys as well as non-airgun high-resolution geophysical (HRG) surveys with frequencies less than 200 kilohertz (kHz) over and above baseline requirements, as follows:

1. **Mitigation Requirements for PSO Dolphin Observations:** The Proposed Rule requires seismic airgun survey power downs for small dolphins and shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys.
2. **PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Waters and Associated Mitigation for Whale Observations:** The Proposed Rule requires that seismic airgun surveys in water depths less than 200 meters in the Western and Central Planning Areas include PSOs and implement shutdowns for observations of whales in the exclusion zone. Prior to the stay agreement these requirements pertained only to seismic airgun surveys in waters greater than 200 meters in depth.
3. **Additional Mitigation Requirements for PSO Whale Observations:** The Proposed Rule requires deep penetration seismic airgun survey shutdowns due to PSO sightings of Bryde's whale, Kogia species, and beaked whales outside of the 500-meter exclusion zone.
4. **PAM Implementation Requirements and Associated Mitigation for Whale Detections:** The Proposed Rule requires implementation of PAM 24 hours/day for deep penetration airgun surveys in water depths greater than 100 meters. PAM detections of any whales except sperm whales require shutdown of deep penetration seismic airgun surveys.

5. **PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations:** The Proposed Rule requires that non-airgun HRG surveys in deep water (greater than 200 meters depth) include PSO observers. In addition, the Proposed Rule requires shutdowns for observations of any whales and of large dolphins within a 200-meter exclusion zone.
6. **PSO Equipment Requirements:** The Proposed Rule requires vessels to provide pedestal-mounted "bigeye" binoculars for PSOs.
7. **PSO Training and Experience Requirements:** The Proposed Rule requires that all observers (PSOs): a) must have appropriate training and must be third-party (i.e., not crew members); b) at least one visual PSO must have a minimum 90 days relevant experience, completed not less than 18 months prior; and c) at least two acoustic PSOs must have a minimum 90 days relevant experience, completed not less than 18 months prior. For PAM use in shallow penetration airgun surveys and non-airgun HRG surveys in shallow water, the PAM operator may be a crew member. Base on NMFS'and BOEM's experience with G&G surveys in the GOM, this analysis expects that the industry generally relies on experienced third-party PSOs. Accordingly, we do not anticipate that including this specification increases the costs of the Proposed Rule.
8. **Reporting Requirements:** The Proposed Rule specifies that all surveys (with exception of non-airgun HRG using sources > 200kHz) must submit reports within 90 days of the conclusion of the survey concerning the activity conducted, observations of marine mammals, and details of mitigation implementation, as applicable.
9. **Seasonal Area Closures:** The Proposed Rule specifies seasonal restrictions on seismic airgun surveys between February 1st and May 31st in the Coastal Waters Closure Area, as identified in Exhibit 1-3. The Coastal Waters Closure Area includes coastal waters shallower than 20 meters depth.
10. **Year-Round Area Closures:** The Proposed Rule includes complete closure (year-round) to seismic airgun surveys in the Eastern Planning Closure Area and the Dry Tortugas Closure Area. Both closure areas fall within BOEM's GOM Eastern Planning Area, with the exception of a small fraction of the Eastern Planning Closure Area, as identified in Exhibit 1-4.

EXHIBIT 1-3. MAP OF SEASONAL COASTAL WATERS CLOSURE AREA

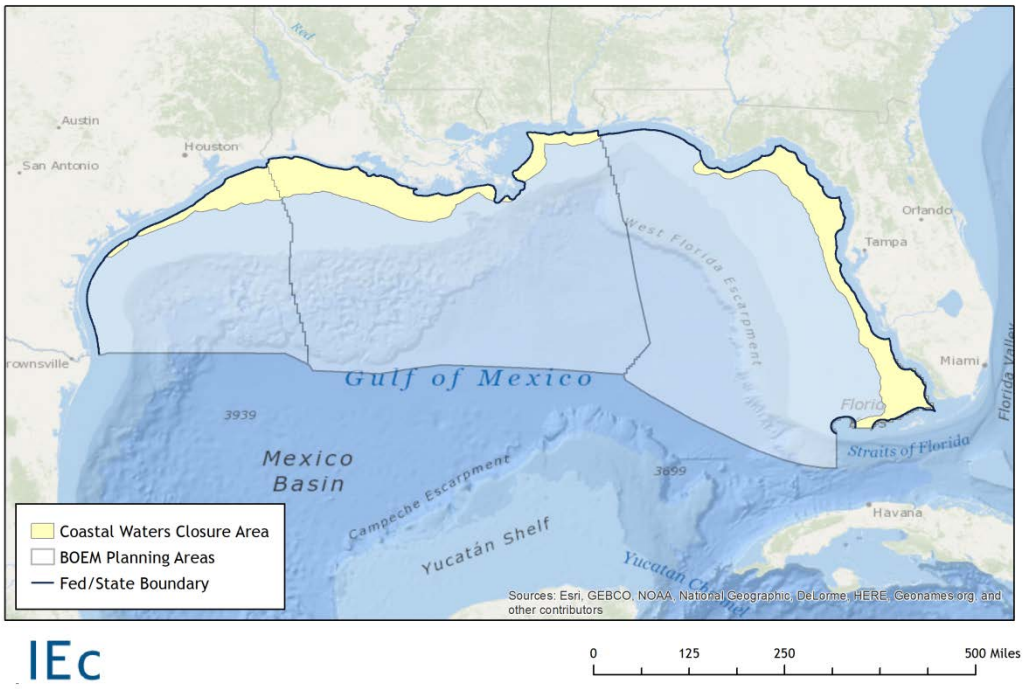
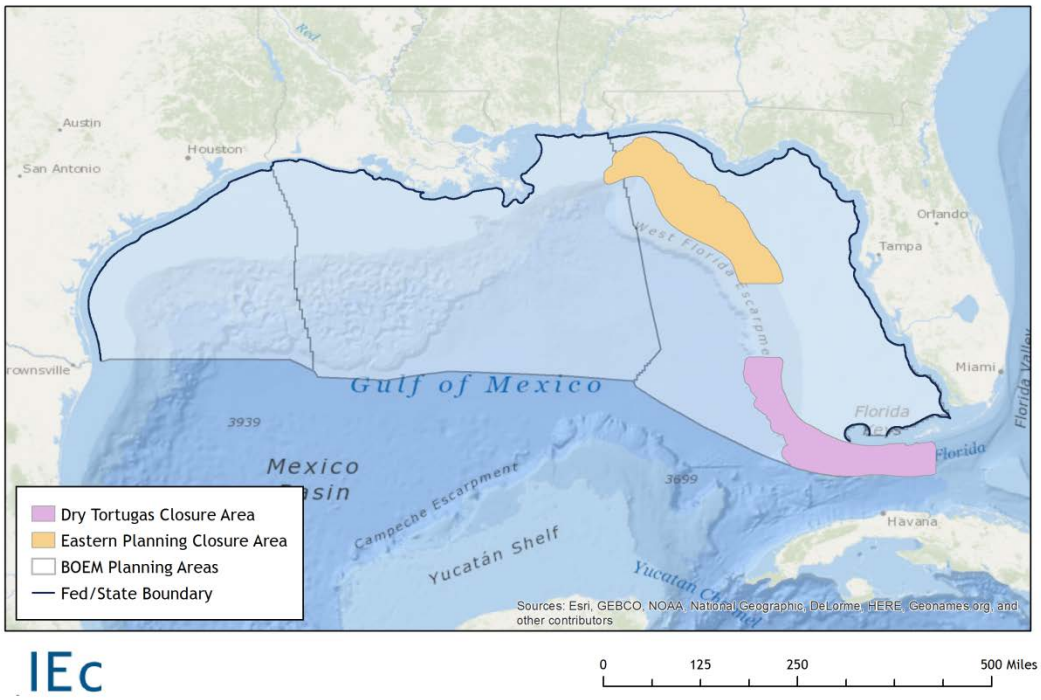


EXHIBIT 1-4. PROPOSED RULE YEAR-ROUND CLOSURE AREAS



1.5.2 MORE STRINGENT ALTERNATIVE

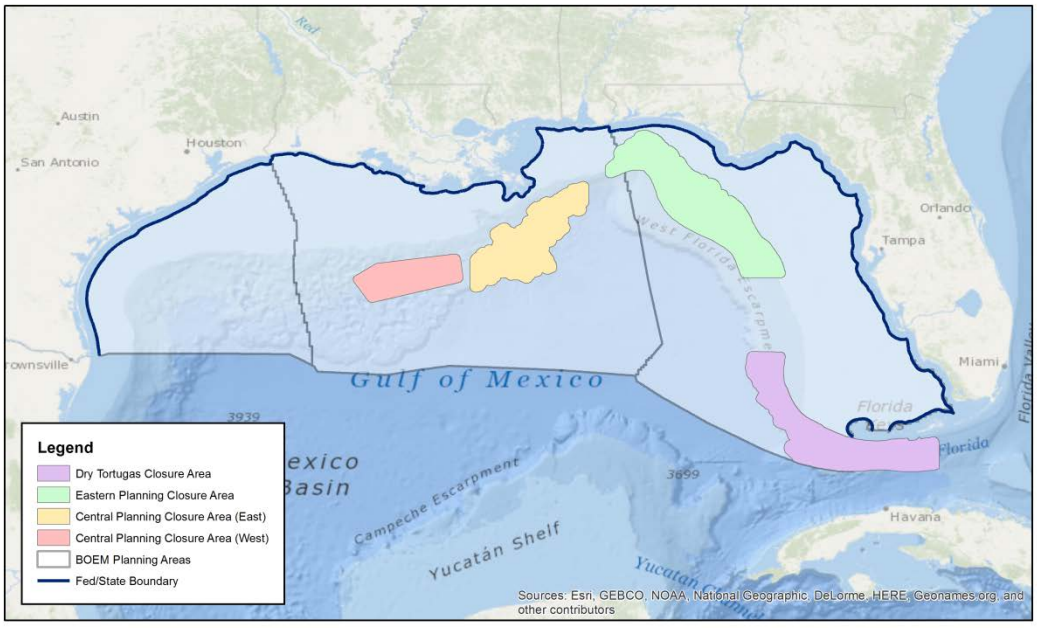
The More Stringent Alternative includes the same requirements as the Proposed Rule for: use of PAM and associated mitigation for whale detections; PSO implementation for non-airgun surveys and associated shutdown requirements for whale and dolphin

observations; PSO equipment requirements; PSO training and experience requirements; reporting requirements; and seasonal area closures.

The More Stringent Alternative includes additional requirements, however, as follows:

1. **Mitigation Requirements for PSO Dolphin Observations:** In line with the Proposed Rule, the More Stringent Alternative requires seismic airgun survey shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys. The Proposed Rule and More Stringent Alternative differ in terms of mitigation for small dolphins. The Proposed Rule requires power downs for all observations of small dolphins within the exclusion zone whereas the More Stringent Alternative requires shutdowns for observations of non-bow-riding dolphins but does not require shutdown or power down for bow-riding small dolphins.
2. **Additional Mitigation Requirements for PSO Whale Observations:** While the Proposed Rule only requires shutdowns for observations of Bryde's whale, Kogia species, and beaked whales outside the exclusion zone, the More Stringent Alternative also requires shutdowns for sperm whales outside the exclusion zone.
3. **Year-Round Area Closures:** The More Stringent Alternative includes complete closure (year-round) to seismic airgun surveys of the Eastern Planning Closure Area and the Dry Tortugas Closure Area (consistent with the Proposed Rule), as well as the additional Central Planning Closure Area (East and West portions), as identified in Exhibit 1-5.

EXHIBIT 1-5. MORE STRINGENT ALTERNATIVE CLOSURE AREAS



1.5.3 COMPARISON OF PSO AND PAM SHUTDOWN REQUIREMENTS

Requirements related to survey shutdowns due to marine mammal detections are the key driver of economic impacts in this analysis. Thus, to facilitate comparison of PSO- and PAM-related shut down requirements we summarize the differences across the two baseline scenarios, and the Proposed Rule and More Stringent Alternative. Exhibits 1-6, 1-7, and 1-8 summarize shutdown requirements for deep penetration airgun surveys, shallow penetration airgun surveys, and non-airgun surveys, respectively.

EXHIBIT 1-6. PSO AND PAM SHUTDOWN ASSUMPTIONS FOR DEEP PENETRATION AIRGUN SURVEYS (500 METER EXCLUSION ZONE (EZ))

DETECTION METHOD	SPECIES GROUP	DETECTION LOCATION	PRE-STAY AGREEMENT BASELINE	STAY AGREEMENT BASELINE	PROPOSED RULE	MORE STRINGENT ALTERNATIVE
PSO	Whales	Within EZ	Shutdown	Shutdown	Shutdown	Shutdown
		Outside EZ			Shutdown (Bryde's/beaked/ Kogia)	Shutdown (all)
	Small Dolphins	Within EZ			Power down	Shutdown (unless bow-riding)
		Outside EZ				
	Other Dolphins	Within EZ			Shutdown	Shutdown
		Outside EZ				
PAM**	Whales	Within EZ		Shutdown*	Shutdown	Shutdown
		Outside EZ		Shutdown*	Shutdown	Shutdown
	Small Dolphins	Within EZ				
		Outside EZ				
	Other Dolphins	Within EZ				
		Outside EZ				

Notes:
* While the stay agreement does not explicitly require shutdowns with the use of PAM during periods of low visibility, we understand that this is generally industry practice for PAM detections of whales due to the stay agreement.
** The pre-stay agreement baseline does not require PAM except for pre-clearance purposes in order to ramp up during periods of low visibility.

EXHIBIT 1-7. PSO AND PAM SHUTDOWN ASSUMPTIONS FOR SHALLOW PENETRATION AIRGUN SURVEYS

DETECTION METHOD	SPECIES GROUP	DETECTION LOCATION	PRE-STAY AGREEMENT BASELINE (500-M EZ)	STAY AGREEMENT BASELINE (500-M EZ)	PROPOSED RULE (200-M EZ)	MORE STRINGENT ALTERNATIVE (200-M EZ)
PSO	Whales	Within EZ	Shutdown	Shutdown	Shutdown	Shutdown
		Outside EZ				
	Small Dolphins	Within EZ			Power down	Shutdown (unless bow-riding)
		Outside EZ				
	Other Dolphins	Within EZ			Shutdown	Shutdown
		Outside EZ				
PAM*	Whales	Within EZ				
		Outside EZ				
	Small Dolphins	Within EZ				
		Outside EZ				
	Other Dolphins	Within EZ				
		Outside EZ				

Notes:
* PAM is not required for shallow penetration airgun surveys.

EXHIBIT 1-8. PSO* SHUTDOWN ASSUMPTIONS FOR NON-AIRGUN SURVEYS (200-M EZ)

DETECTION METHOD	SPECIES GROUP	DETECTION LOCATION	PRE-STAY AGREEMENT BASELINE	STAY AGREEMENT BASELINE	PROPOSED RULE	MORE STRINGENT ALTERNATIVE
Shallow water (<200m)	Whales	Within EZ				
		Outside EZ				
	Small Dolphins	Within EZ				
		Outside EZ				
	Other Dolphins	Within EZ				
		Outside EZ				
Deep water	Whales	Within EZ			Shutdown	Shutdown
		Outside EZ				
	Small Dolphins	Within EZ				
		Outside EZ				
	Other Dolphins	Within EZ			Shutdown	Shutdown
		Outside EZ				

Notes:
* PAM is not required for non-airgun surveys.

1.6 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- **Chapter 2 - Profile of Affected Industries and Communities:** This chapter describes the nature of the G&G activities that will be regulated by this rulemaking, economic information on the G&G industry and the oil and gas industry in the GOM. We also provide a socioeconomic profile of the GOM region, highlighting the relative importance of the potentially affected industries.
- **Chapter 3 – Framework for the Analysis:** This chapter characterizes the scope of the RIA, including the geographic area, the timeframe of the analysis and the types of economic costs and benefits evaluated.
- **Chapter 4 – Industry Compliance and Economic Cost Analysis:** This chapter describes the quantified costs of the Proposed Rule and More Stringent Alternative, as well as a qualitative discussion of potential unquantified costs. We also provide discussion of the key uncertainties and limitations associated with the cost analysis.
- **Chapter 5 – Economic Benefits Analysis:** Chapter 5 characterizes the types of benefits resulting from the protection of marine mammals in the GOM and summarizes the uncertainties that preclude a reliable monetized estimate of these benefits.
- **Appendix A – Alternative Baseline Analysis:** Appendix A evaluates impacts of the regulatory alternatives relative to the alternative post-stay agreement baseline described above.
- **Appendix B – Initial Regulatory Flexibility Analysis:** The IRFA evaluates the extent to which the regulatory alternatives may result in a significant impact on a substantial number of small businesses.
- **Appendix C – Other Statutory and Executive Order Analyses:** Appendix C provides analyses of the MMPA rule in compliance with multiple statutes and orders, including the Paperwork Reduction Act, Unfunded Mandates Reform Act, and Energy Impacts Analysis (E.O. 13211).
- **Appendix D – Alternative Discount Rate:** Appendix D evaluates the implications of alternative discount rate assumptions on the results of the analysis. While the main body of the RIA text applies a seven percent discount rate, Appendix D calculates present value and annualized impacts applying a three percent discount rate.

CHAPTER 2 | PROFILE OF AFFECTED INDUSTRIES AND COMMUNITIES

2.0 INTRODUCTION

The information in this chapter provides context for the analysis of the rule's costs and benefits, as presented in subsequent chapters of this document. First, this chapter provides an overview of the oil and gas industry in the GOM, and the particular role of G&G surveys within the industry. Second, it describes characteristics of the G&G industry that currently operates in the GOM. Finally, this chapter provides an overview of population demographics for the region potentially impacted by the rule.

2.1 OVERVIEW OF THE OIL AND GAS INDUSTRY IN THE GULF OF MEXICO

The oil and gas industry has been active in the GOM since the 1930's. The 1953 passage of the Outer Continental Shelf Lands Act (OCSLA) exerted federal control over the Outer Continental Shelf (OCS), defined as all submerged lands lying seaward of state coastal waters (3 or 9 nautical miles offshore). The GOM currently accounts for 98 percent of all OCS oil and gas production[14], as the vast majority of leases[15] and estimated reserves[16] on the OCS are located in the GOM.[17] An estimated 15 percent of total US crude oil reserves are located beneath Federal GOM waters. In addition, GOM oil and gas production comprises 18 percent of total US crude oil production and four percent of US natural gas production.[18]

2.1.1 OIL AND NATURAL GAS DEVELOPMENT PROCESS

The development of oil and gas resources has four general phases: assessment, exploration and appraisal; development; production; and decommissioning. G&G survey activities evaluate and refine possible areas for development and production in all stages of the development process. Our analysis considers the potential impacts of the proposed rule and more stringent alternative on surveys conducted during any of these phases.

---

[14] BSEE. Outer Continental Shelf Oil and Gas Production. Accessed at https://www.data.bsee.gov/Production/OCSProduction/Default.aspx on September 8, 2017.

[15] BOEM, 2017. "Combined Leasing Report as of March 1,2017." Accessed at https://www.boem.gov/2017-03-Lease-Status-Report/ on March 8, 2017.

[16] BOEM. "Assessment of Undiscovered Oil and Gas Resources of the Nation's Outer Continental Shelf, 2016." Accessed at https://www.boem.gov/2016-National-Assessment-Fact-Sheet/ on March 1, 2017.

[17] BOEM. "Gulf of Mexico OCS Region." Accessed at https://www.boem.gov/Gulf-of-Mexico-Region/ on March 1, 2017.

[18] BOEM Oil & Gas Energy Program. Accessed at https://www.boem.gov/Oil-and-Gas-Energy-Program/ on September 19, 2017.

Assessment

During the initial phase, geophysical and geological surveys are conducted to provide an overview of the geological structure of an area. Initial surveys cover large areas and provide data on possible areas for oil and gas development. BOEM issues permits for these surveys to seismic surveyors, who may or may not be affiliated with particular oil and gas companies. Non-exclusive (multi-client) survey data are collected over large, multi-lease block areas, and are licensed for use to as many clients as possible. Oil and gas companies use these data to inform the bid values for prospective leases as well as decisions regarding exploration on existing leases.

Exploration and Appraisal

Exploration and appraisal occurs after an oil/gas company has leased a particular OCS tract. Oil and gas companies use the seismic survey data collected during the assessment phase to refine prospective hydrocarbon targets. Additional G&G surveys may be commissioned during the exploration and appraisal phase to gain a more detailed understanding of an area. These surveys, referred to as targeted surveys, cover the areas over and adjacent to potential well sites, and provide detailed information to oil and gas companies about optimal drilling locations. Companies drill exploratory wells on the most promising prospects. Therefore, while G&G firms perform targeted surveys on behalf of an oil or gas company, the oil/gas company itself owns the data and has exclusive use of it. The targeted surveys, which usually cover only a few OCS lease blocks, provide technical information to determine the best approach for exploration, appraisal and potential development of the hydrocarbon resource.

Development

The development phase includes drilling development wells and installing the necessary infrastructure for production[19]. During this phase, the oil/gas company and BOEM/BSEE continue to assesses potential risks as well as environmental and social impacts through laws and regulations such as NEPA and CZMA.[20,21]

Production

Oil and gas are produced during the production phase. Production will last as long as economically viable hydrocarbons can be produced, which may be decades. This phase includes both the extraction of resources as well as the separation of fluids and gases

---

[19] Kark *et al*. 2015. "Emerging conservation challenges and prospects in an era of offshore hydrocarbon exploration and exploitation." Accessed at https://www.researchgate.net/figure/280588858_fig2_Figure-1-An-overview-of-marine-oil-and-gas-exploitation-stages-from-exploration-to on March 7, 2017.

[20] BOEM. "OCS Oil and Gas Leasing, Exploration, and Development Process." Accessed at https://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Five-Year-Program/BOEM-OCS-Oil-and-Gas-Leasing-Process-Diagram.aspx on September 12, 2017.

[21] BOEM. "Oil and Gas Leasing on the Outer Continental Shelf." Accessed at https://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/5BOEMRE_Leasing101.pdf on March 20, 2017.

using gravity and difference in density.[22] After all economically viable resources have been extracted, the oil/gas company decommissions surface and subsurface structures.[23]

G&G activities as a share of total development costs

While G&G survey activities are important sources of data to inform exploration, appraisal, development, and production, survey activities comprise only a small share of the total costs associated with oil and gas exploration and development. Quest Offshore (2014) estimates that G&G activities would account for only three percent of total spending on oil and gas activities in the Eastern Gulf over a 19-year timeframe.[24]

2.1.2 OIL AND GAS LEASING PROGRAM IN THE GULF OF MEXICO

BOEM is responsible for oil and gas leasing activities in Federal waters of the GOM. BOEM develops oil and gas leasing schedules, which it publishes in five-year increments by OCS planning area. Exhibit 2-1 displays the BOEM Planning Areas in the GOM. Planning areas open to leasing have at least one lease sale scheduled in the Five-Year Program. Prior to each lease sale, BOEM conducts an environmental review under NEPA. Thirty days after BOEM publishes a final notice of sale, the Bureau holds a sealed bid auction for available tracts. BOEM evaluates a tract's high bid for consistency with antitrust laws and receipt of fair market value for the right to explore, develop and produce potential hydrocarbons. If the bid meets the fair market value and antitrust requirements, BOEM issues a lease to the company with the successful bid.[25]

Due to the Gulf of Mexico Energy Security Act (GOMESA) of 2006, leasing, preleasing or any related activity is restricted in most of the Eastern Planning Area and some parts of the Central Planning Area until 2022. The current Five-Year Program for 2017 to 2022 proposes ten more sales for the areas not under the GOMESA moratorium in the Gulf of Mexico.

---

[22] Abdel-Aal, Hussein, *et al*., 2003. "Petroleum and Gas Field Processing." Page 113-114.

[23] Department of Energy & Climate Change, 2014. "Stages of shale gas and oil." Accessed at http://www.thegwpf.com/four-stages-of-uk-shale-gas-and-oil-exploration-development/ on March 7, 2017.

[24] Quest Offshore. (2014). "The Economic Benefits of Increasing U.S. Access to Offshore Oil and Natural Gas Resources in the Eastern Gulf of Mexico." Prepared for the American Petroleum Institute (API) and the National Ocean Industries Association (NOIA).

[25] BOEM. "Oil and Gas Leasing on the Outer Continental Shelf." Accessed at https://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/5BOEMRE_Leasing101.pdf on March 20, 2017.

EXHIBIT 2-1 BOEM PLANNING AREAS IN THE GOM

Oil and gas production fluctuates depending on the current and expected price of oil/gas and development of recent OCS hydrocarbon discoveries. The EIA 2017 Annual Energy Outlook predicts production from the offshore areas of the GOM will continue to increase until 2020, with a decline afterwards until 2034.[26] After 2034, the rate of decline will slow through 2040. Exhibit 2-2 depicts the 2017 EIA forecast of U.S. oil production from 2016 to 2050.

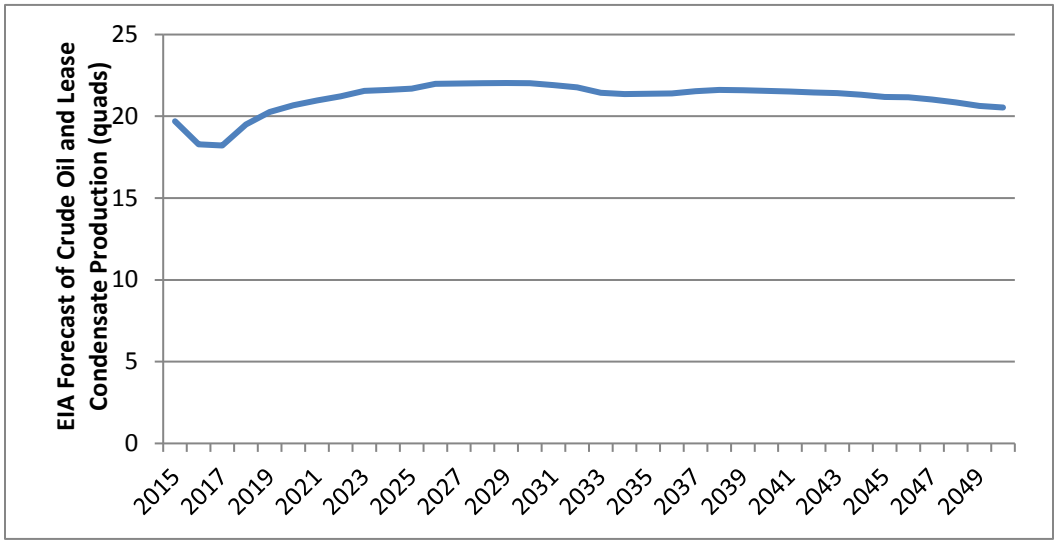
Oil and gas production from the GOM is a major contributor to U.S economy. BOEM estimates that in FY 2015, OCS-oil and gas activity contributed $86 billion in total U.S output and sustained 492,000 domestic jobs.[27] In FY 2014, the OCS contributed $113 billion in total U.S output and sustained 651,000 domestic jobs.[28]

[26] DOE/EIA, 2015. "Annual Energy Outlook 2015 with projections to 2040." Pg 19. http://www.eia.gov/outlooks/archive/aeo15/pdf/0383(2015).pdf

[27] USDOI, 2016. "U.S. Department of the Interior Economic Report FY2015." Pg 40-41. Accessed at https://www.doi.gov/sites/doi.gov/files/uploads/fy2015_doi_econ_report_2016-06-17.pdf on March 2, 2017.

[28] USDOI, 2015. "U.S. Department of the Interior Economic Report FY2014." Pg 38-40. Accessed at https://www.doi.gov/sites/doi.gov/files/uploads/FY2014%20Econ%20Report%20_06_23_2015%20(1).pdf on March 2, 2017. The increased economic and job contributions in FY2014 are due to the higher oil and gas prices in 2014 than 2015.

EXHIBIT 2-2 EIA 2017 ENERGY OUTLOOK FORECAST FOR U.S. OIL PRODUCTION (CRUDE OIL AND LEASE CONDENSATE PRODUCTION)



Source: EIA Energy Outlook 2017. Accessed at http://www.eia.gov/outlooks/aeo/data/browser/#/?id=1-AEO2017&sourcekey=0 on September 8, 2017.

2.2 GEOLOGICAL AND GEOPHYSICAL SURVEY ACTIVITIES IN THE GULF OF MEXICO

As described above, G&G data and information are required to support leasing, resource assessment, and exploration/development decisions for OCS acreage. Certain G&G activities are necessary to determine the oil and gas prospectively of acreage in a specific area (speculative surveys), while post-lease G&G data are required for lessees to more accurately assess the risk of exploration and development decisions (targeted surveys). G&G survey data provide information including, but not limited to:

1. Potential locations and extent of oil and gas reserves;
2. Locations for placement of oil and gas structures;
3. Locations of marine archaeological resources as to assure compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA); and

In addition to the needs of private industry, G&G surveys provide important information for government decisions. Deep 2D and 3D seismic data are used for resource estimation and bid evaluation to ensure that the government receives a fair market value for OCS lease blocks that have received bids in OCS lease sales. G&G data are also used to assist government agencies in evaluating discovered/undiscovered oil and gas resources, to evaluate worst-case discharge scenarios for potential oil-spill analysis, and to evaluate sites for potential hazards prior to drilling.

2.2.1 G&G SURVEY PERMITTING PROCESS

The BOEM Data Acquisition and Special Projects Unit (DASPU) evaluates G&G permits applications. Each permit application goes through three process components: application completeness and acceptance, permit processing, and operations (Exhibit 2-3). In total,

this process timeline is estimated to take 50-70 days depending on the type and complexity of the survey.

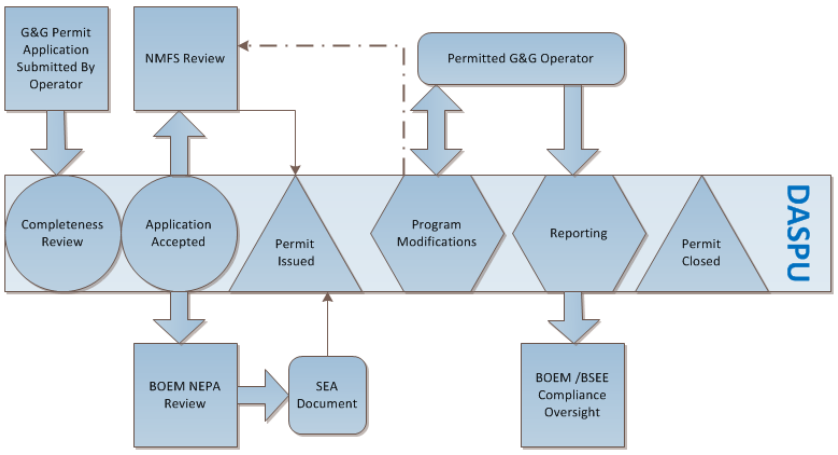
The following information is required for each permit application:

1. Service company name and purchaser of the data
2. Expected commencing and completion date
3. Names, registries, type of vessel, call signs and owners of all vessels to be used in the operation (support vessels do not need to be listed by name)
4. Description of survey activities including a description of potential environmental effects and mitigation measures that will be implemented
5. Location of survey, track lines, coring, and other spatial details
6. All energy sources to be used in the survey (includes airgun and non-airgun)
7. Configuration of the survey including vessel, sources, nodes or streamer configurations
8. Physical characterization of source array
9. Technical specifications of each energy source (airgun and non-airgun)
10. Propagation model of all sources
11. Estimated time when survey data will be available
12. A non-duplicative survey statement indicating that existing data are not available to meet the data needs identified for the applicant's survey
13. A sound source verification letter that indicates that the operations are using the minimal source array size/power necessary to meet the survey goals and that the array is tuned to maximize radiation of the emitted energy toward the seafloor.

Once a permit application is received, it is reviewed for completeness of the information provided, including information on proposed operations. Applications deemed complete are accepted and are submitted to NMFS for ESA review of consistency with the existing biological opinion and move into the BOEM NEPA review process, which concludes in the issuance of a Site Specific Environmental Assessment (SEA). Applications deemed incomplete are returned to the applicant. After an application has been designated as complete, there should be little or no changes made to operations without consultation between BOEM and applicant. Any deviation is considered a Permit Modification and may require re-review by NMFS and BOEM.

After the permit is issued, the operator will typically finalize all supplemental activities including hiring the support vessels and mitigation personnel. In the operations phase, the operator is required to provide BOEM with bi-weekly reports that include navigational data, operational data (number of acquisition hours), exceedances of expected energy output, protected species monitoring and mitigation data, and confirmation of compliance with buffer distances and Section V of the Settlement Agreement. BOEM and BSEE monitor the reporting and operations for compliance with the permit.

EXHIBIT 2-3 DASPU G&G PERMIT PROCESS



Source: To be provided from CSA

2.2.2 G&G SURVEY TYPES

Marine seismic surveys using airgun sources are capable of imaging geological structures to depths of several kilometers and have become an essential tool for geoscientists studying the Earth's uppermost crust. Deep-penetration seismic surveys are conducted to obtain data on geological formations several thousand meters beneath the seafloor. To conduct these surveys, a survey vessel tows an airgun array that emits acoustic energy pulses that propagate through water then pass into the seafloor. As the acoustic signals reflect off subsurface layers, they are detected by sensors towed in streamer cables behind the vessel or incorporated into cables or autonomous nodes placed on the seafloor or in boreholes. Data from these surveys can be used to assess potential hydrocarbon structural and stratigraphic traps and reservoirs, and also to help site exploration, development, and production wells to optimize extraction and production from a reservoir.

Seismic data acquisition, processing, and analysis technologies are continuously evolving to provide more information about the subsurface. Consequently, regions already surveyed may be resurveyed using a new technology to obtain improved imaging of subsurface geology, which may lead to increased success in the discovery and production of oil and gas resources. Geophysical surveyors and customers often have proprietary methods for data acquisition/processing depending on the survey target and their data-processing capabilities. Such differences can make each survey dataset for the same area unique, and may prevent survey operators from combining one survey dataset for an area with that of another survey for the same area.

2D surveys provide a cross-sectional image of the Earth's structure while 3D surveys provide a volumetric image of underlying geological structures. Repeated 3D surveys result in time-lapse, or 4D, that assess the depletion of a reservoir over time. Vertical Seismic Profile (VSP) surveys provide information about geologic structure, lithology, and fluids. High-resolution geophysical (HRG) surveys are used to detect shallow geohazards, archaeological resources, and certain types of benthic communities. A brief

description of key survey types is provided below. Additional detail about survey methods is provided in the Programmatic EIS.[29]

- **2D (Towed-Streamer) Seismic Surveys:** Two-dimensional (2D) surveys provide a cross-sectional image of subsurface geology. A single vessel towing an airgun array and a single streamer cable usually conduct 2D seismic surveys. In the GOM, 2D surveys are primarily used to describe structural and stratigraphic geology, to link known productive areas over large geographic areas, and to determine if a three-dimensional (3D) survey is warranted in an area of interest. 2D surveys usually cover a larger area in the same time as 3D surveys at much lower cost but with lower spatial resolution. The industry conducts fewer 2D surveys than 3D surveys.
- **3D (Towed-Streamer) Seismic Surveys:** 3D seismic surveys provide data that image the subsurface geology with much greater clarity and higher resolution than is possible with 2D surveys. The data density for any subsurface point will be 15 to 30 times greater in the cross-track direction for 3D surveys than for 2D surveys. 3D survey data can be used to distinguish hydrocarbon-bearing zones from water-bearing zones below the seafloor. Conventional, single-vessel 3D surveys are referred to as narrow azimuth (NAZ) 3D surveys. Ships used for 3D surveys are purpose-built vessels with much greater towing capability than vessels used for 2D surveys. The seismic ships typically tow two parallel airgun arrays behind them. Streamers containing hydrophones and other sensors are towed behind the airgun arrays.
- **Ocean-Bottom Seismic (OBS) Surveys:** OBS surveys can be conducted using ocean-bottom cables (OBCs) and/or ocean-bottom nodes (OBNs). OBS surveys are most useful to acquire data in shallow water and obstructed areas and to develop four-component (4C) survey data, which consists of pressure and 3D linear acceleration. 4C data can provide more information than 2D data about subsurface fluids and rock characteristics. To conduct these surveys, surveyors lay seismic cables on the seafloor using special equipment off the back of a vessel that may be designed specifically for that purpose. After OBNs or OBCs are deployed, a vessel towing an airgun array (source vessel) passes along the line of OBN/OBC and readings from the OBN/OBC are transmitted to a recording vessel. When data acquisition using sets of OBCs or OBNs is complete, the nodes or cable are retrieved and moved to their next position. A particular set of nodes or cable may remain in place for a couple of days to several weeks, and in some cases, nodes or cables may be left on the seafloor for future 4D (time-lapse) surveys.
    - 2D-OBS: 2D-OBS surveys create a cross-sectional image of subsurface geology, similar to 2D towed-streamer surveys. Most 2D OBS surveys use OBCs.

[29] BOEM, September 2016. Gulf of Mexico OCS Proposed Geological and Geophysical Activities, Programmatic Environmental Impact Statement. BOEM 2016-049.

  - 3D-OBS: 3D-OBS surveys create a more detailed image of the subsurface geology, similar to 3D towed-streamer surveys. Newer technology 4C receiving sensors, rather than older 2D sensors, are used for most ocean bottom receiver 3D surveys. Most 3D ocean-bottom receiver surveys are rich-azimuth (RAZ) or in areas where there are structural obstructions on the sea surface or seafloor. A nominally rectangular grid of sensors is laid on the seafloor for 3D OBC or OBN surveys.

- **Wide Azimuth (WAZ) and Related Multi-Vessel Surveys**: In conventional 3D seismic surveys involving a single source vessel, only a subset of the reflected wave field can be obtained because of the narrow range of source-receiver azimuths, and thus are called narrow azimuth (NAZ) surveys. New techniques such as wide azimuth (WAZ), multi-azimuth (MAZ), rich-azimuth (RAZ), and full azimuth (FAZ) towed streamer acquisition as well as associated data processing have emerged to provide better data quality than achievable using traditional NAZ seismic surveys. The various azimuth surveys have been particularly helpful in deepwater locations of the GOM and other areas, where breakthroughs have been achieved in imaging subsurface areas containing complex geologic structures, particularly those beneath salt bodies with highly irregular geometries. Better azimuthal coverage is more costly than NAZ surveys because some combination of more vessels or more vessel passes over the survey area are typically required.
- **Vertical Seismic Profile (VSP) Surveys**: VSP surveying is conducted by placing seismic receivers, usually three-component geophones, at many depths in a wellbore, and recording both direct-arriving and reflection energy from an acoustic source. Borehole seismic surveys include (1) 2D VSPs, (2) 3D VSPs, and (3) seismic while drilling (SWD). The seismic source usually is a single airgun or small airgun array hung from a platform or deployed from a source vessel. Less sound energy is required for VSP surveys because the seismic sensors are in a borehole, which is a much quieter environment than the water column, and because VSP sensors are located nearer to the targeted reflecting horizons. VSP surveys provide information about geologic structure, lithology, and fluids that is intermediate between that obtained from sea surface seismic surveys and the well-log scale of information.
  - **Seismic While Drilling (SWD)**: The acquisition of seismic while drilling refers to the acquisition of borehole data while there is downtime from the actual drilling. This survey is run intermittently for weeks and sometimes up to a month to the well completion depth.
- **High-Resolution Geophysical (HRG) Surveys**: HRG surveys are conducted using several techniques involving airguns as well as electromechanical sources. Before any operation takes place on the seafloor, there is a need to characterize the nature of the seafloor and the geologic layers immediately beneath it. In most

cases, conventional 2D and 3D deep-penetration seismic surveys do not have the resolution necessary to provide the required information. HRG surveys are used to investigate the shallow subsurface for geohazards and soil conditions over specific locations in one or more OCS lease blocks. Survey data are used for initial site evaluation, drilling rig emplacement, and platform or pipeline design and emplacement.

- **Airgun HRG Surveys:** Because the intent of high-resolution, shallow-penetration airgun seismic surveys is to image shallow depths and to produce high-resolution images, the airgun sources used (typically one or two airguns) are smaller, the streamers are shorter and towed shallower, the streamer-separation distances are smaller, and the firing times between airgun shotpoints are shorter than for conventional 2D and 3D airgun seismic surveys.
- **Non-Airgun Acoustic HRG Surveys**: Non-airgun acoustic HRG surveys are the most common type of survey conducted in the GOM. Non-airgun acoustic surveys are often from the seismic vessel, but sometimes from a vessel dedicated to such surveys. Typical non-airgun HRG surveys may involve one or more types of high-frequency acoustic sources such as the following: sub-bottom/sediment profilers; pingers; sparkers; boomers; compressed high-intensity radar pulse (CHIRP) sub-bottom profilers; side-scan sonar; single-beam echosounders; and multibeam echosounders. In general, any combination of these techniques, which are employed for both hazard and archaeological surveys, may be conducted during a single deployment from the same vessel.

2.2.3 RECENT TRENDS IN G&G SURVEY ACTIVITY

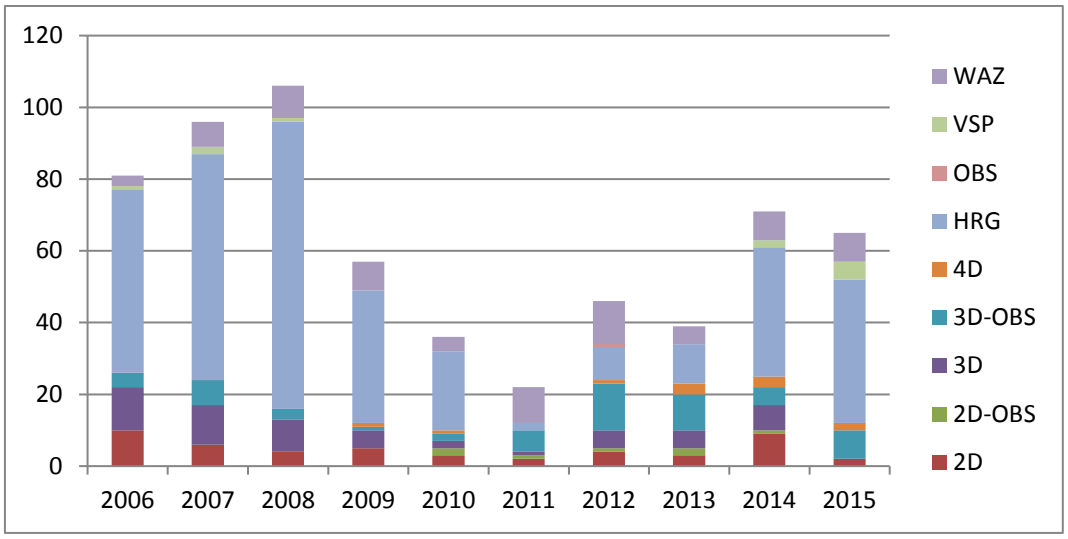
As context for the analysis of the rule's impact on different types of G&G surveys, Exhibit 2-4 presents the number of acoustic G&G surveys conducted for oil and gas activities in the GOM between 2006 and 2015. To generate the data shown in the exhibit, we reviewed the full record of G&G permit data for this period, which included 879 applications to BOEM for G&G permits in the Gulf of Mexico.[30] We then removed applications for 265 survey permits not anticipated to be affected by the rule from the dataset.[31] After this process, 614 surveys were deemed relevant to this analysis between 2006 and 2015.

[30] BSEE Public Information Query for G&G. Accessed at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5 on March 2017.

[31] Thirty-three permit applications pertained to the Atlantic OCS; 21 surveys were not related to exploration of oil, gas or Sulphur; 37 permits for surveys were later cancelled; four surveys were conducted by ultimate parent companies that are bankrupt and no longer operate; 29 surveys were conducted for the purpose of scientific research; and 141 surveys were non-acoustic surveys.

As illustrated in Exhibit 2-4, the annual number of surveys has declined since 2008, when the annual number of surveys peaked at 106. The data for more recent years suggest a rebound from the dip in 2011 and 2012. The data in Exhibit 2-4 also show that HRG surveys are consistently the most common type of survey, accounting for 28 to 75 percent of all surveys in any year. This likely reflects the relatively low cost of HRG surveys. The prevalence of WAZ surveys in 2011 and 3D-OBS surveys in 2012 coincided with a large reduction in the prevalence of HRG surveys in those years. These years immediately followed the *Deepwater Horizon* incident in 2010 and ensuing suspension of certain offshore drilling activities from July 12, 2010 to October 12, 2010.[32]

EXHIBIT 2-4 ANNUAL NUMBER OF ACOUSTIC G&G SURVEYS IN THE GOM, 2006-2015



WAZ: Wide Azimuth Survey; VSP: Vertical Seismic Profile*; OBS: Ocean Bottom Survey; HRG: High-Resolution Geophysical. *Not all VSP surveys are individually permitted, so the graph most likely presents an underrepresentation of the number of VSP surveys conducted.

2.2.4 G&G SURVEY COMPANIES OPERATING IN THE GOM THAT MAY BE AFFECTED BY THE MMPA RULE

This section provides an overview of businesses that conduct G&G surveys for oil and gas in the Gulf of Mexico and are therefore likely to be affected by the rule. As an initial step in characterizing the industry, we first estimated the number of business entities engaged in G&G activity in the GOM. For the 614 acoustic G&G survey permit applications for oil and gas activities between 2006 and 2015 in the GOM, we used public merger and bankruptcy records, Bloomberg's information on acquisitions, and Hoover's family tree mapping to identify the ultimate parent companies for each permittee.[33] Our findings included the following:

[32] Secretary Ken Salazar, 2010. "Termination of the suspension of certain offshore permitting and drilling activities on the Outer Continental Shelf."

[33] Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

- 82 independently owned companies had applied for 614 acoustic G&G permits between 2006 and 2015. This included:
    - 62 U.S. based-companies that applied for 284 acoustic G&G survey permits.
    - 20 companies headquartered outside of the U.S that applied for 330 acoustic G&G survey permits. As such, foreign applications represented more than half (54 percent) of the acoustic G&G survey applications.

EXHIBIT 2-5 COUNTRY OF BUSINESSES THAT APPLIED FOR GULF OF MEXICO G&G PERMITS, 2006-2015

COUNTRY OF COMPANY HEADQUARTERS	NUMBER OF BUSINESSES
United States	62
Non-US	
Australia	2
Bermuda	1
Brazil	1
British Virgin Islands	1
Canada	1
Curaçao	1
Cyprus	1
United Kingdom	2
France	1
Italy	1
Japan	2
Norway	4
Netherlands	2
Total Non-US Businesses	20
Total	82

Profile of Affected G&G Companies

The 82 companies that applied for acoustic G&G survey permits in the Gulf of Mexico between 2006 and 2015 varied widely in terms of industry, revenues, and employment. The companies conducted business across 21 North American Industry Classification System (NAICS) codes. As shown in Exhibit 2-6, the average 2015 revenues across all companies was $16 billion, but average company revenues per industry ranged from $0.3 million (541990: All Other Professional, Scientific and Technical Services) to $230 billion (447190: Other Gasoline Stations). The average number of employees for affected companies was 8,700 employees, but ranged from less than 10 (541990: All

Other Professional, Scientific and Technical Services) to 80,000 (447190: Other Gasoline Stations). [34]

Domestic companies that applied for permits were slightly smaller than the average across the broader population of companies that applied for permits, as shown in Exhibit 2-7. The average revenue across domestic companies was $8 billion, with a range from $0.3 million (541990: All Other Professional, Scientific and Technical Services) to $200 billion (324110: Petroleum Refineries). The average number of employees for domestic companies across NAICS codes was 4,000 employees, with a range from less than 10 (541990: All Other Professional, Scientific and Technical Services) to 68,000 (324110: Petroleum Refineries).

As discussed more fully in the IRFA included in Appendix B, we used the SBA thresholds for small businesses by NAICS code to identify the number of companies in the sample that are small. We identified two of the 20 foreign companies in the population as small, and 34 of the 62 domestic companies as small. Small companies are responsible for a smaller share of surveys than share of companies (i.e. they account for 12 percent of surveys and 54 percent of companies). Of the 633 surveys that were permitted in 2006-2015, approximately 12 percent had applicants classified as small businesses. Small businesses applied for between 1 (median) and 2.1 (mean) surveys per year over the ten years, whereas the typical large company applied for between 4 (median) and 1.7 (mean) surveys per year over the same period. Companies in Support Activities for Oil and Gas Operations (NAICS 213112) applied for the most surveys in the ten years for all companies (210 surveys) and for domestic companies (125 surveys).

The large companies in our sample tended to be organizationally complex, and often the permittee was a subsidiary of the larger companies profiled above. Subsidiaries applied for 68 percent of surveys. The industries involved in this work have also undergone consolidation in the last eleven years; approximately 12 percent of the permittees in the sample were companies that have since been acquired by others. Parent companies directly applied for the remaining 20 percent of the permits.

[34] Hoover's and Manta data for the companies in the universe, Accessed at http://www.hoovers.com/ and http://www.manta.com/ in September 2016.

EXHIBIT 2-6 AVERAGE REVENUES AND EMPLOYEES FOR G&G COMPANIES BY NAICS CODE

PRIMARY NAICS CODE	NAICS CODE DESCRIPTION	NUMBER OF COMPANIES (TOTAL=82)	2015 AVERAGE REVENUE (MILLIONS USD)	2015 AVERAGE EMPLOYEES	NUMBER OF SURVEY PERMITS FROM 2006-2015
211111	Crude Petroleum and Natural Gas Extraction	25	$2,700	1,500	95
213112	Support Activities for Oil and Gas Operations	24	$620	4900	210
551112	Offices of Other Holding Companies	7	$76,000	31,000	78
541330	Engineering Services	3	$580	970	53
237120	Oil and Gas Pipeline and Related Structures Construction	2	$42	93	5
324110	Petroleum Refineries	2	$200,000	68,000	10
523991	Trust, Fiduciary and Custody Activities	2	$7,300	27,000	81
541370	Surveying and Mapping (except Geophysical) Services	2	$210	1100	2
541620	Environmental Consulting Services	2	$7.8	34	4
541990	All Other Professional, Scientific and Technical Services	2	$0.27	3	2
213111	Drilling Oil and Gas Wells	1	$2.6	5	2
212234	Copper Ore and Nickel Ore Mining	1	$16,000	35,000	1
221118	Other Electric Power Generation	1	$12,000	15,000	1
221210	Natural Gas Distribution	1	$1,800	2,100	3
331313	Alumina Refining and Primary Aluminum Production	1	$10,000	270	1
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)	1	$100	20	1
447190	Other Gasoline Stations	1	$230,000	80,000	26
511210	Software Publishers	1	$220	560	12
525990	Other Financial Vehicles	1	$160	540	2
561110	Office Administrative Services	1	$200	400	22
921130	Public Administration	1	N/A	33,000	3

EXHIBIT 2-7 AVERAGE REVENUES AND EMPLOYEES FOR G&G COMPANIES HEADQUARTERED IN THE US BY NAICS CODE*

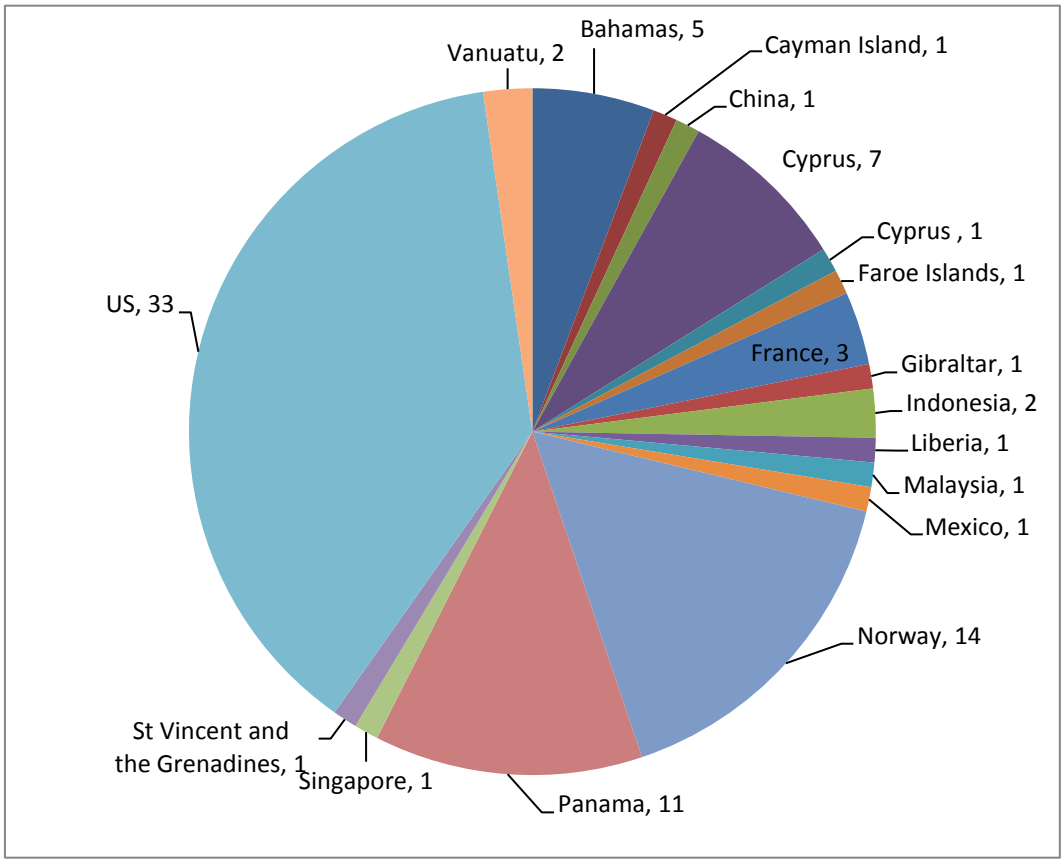
PRIMARY NAICS CODE	NAICS CODE DESCRIPTION	NUMBER OF U.S. COMPANIES (TOTAL=62)	2015 AVERAGE REVENUE (MILLIONS USD)	2015 AVERAGE EMPLOYEES	NUMBER OF SURVEYS
211111	Crude Petroleum and Natural Gas Extraction	25	$2,700	1,500	95
213112	Support Activities for Oil and Gas Operations	21	$680	1,000	125
237120	Oil and Gas Pipeline and Related Structures Construction	2	$42	93	5
324110	Petroleum Refineries	2	$200,000	68,000	10
541620	Environmental Consulting Services	2	$7.8	34	4
541990	All Other Professional, Scientific and Technical Services	2	$0.27	3	2
212234	Copper Ore and Nickel Ore Mining	1	$16,000	35,000	1
213111	Drilling Oil and Gas Wells	1	$2.6	5	2
221118	Other Electric Power Generation	1	$12,000	15,000	1
221210	Natural Gas Distribution	1	$1,800	2,100	3
424720	Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals)	1	$100	20	1
511210	Software Publishers	1	$220	560	12
541370	Surveying and Mapping (except Geophysical) Services	1	$18	130	1
561110	Office Administrative Services	1	$200	400	22

*RFA/SBREFA only applies to U.S.-based companies.

Vessels

When conducting G&G surveys, oil and gas and G&G survey companies use their own boats as well as boats hired under contract. Of 87 vessels engaged in G&G permit activity in the Gulf of Mexico between 2012 and 2014, 54 vessels operate under non-U.S. flags, as summarized in Exhibit 2-8.[35] Ownership information was available for 25 of the 33 vessels that operate under US flags. Based on this information, we identified 14 parent companies that own at least one of the 25 vessels. Seven of these companies are permitted for G&G activity, and therefore we assume that they are in the vessel dataset because they use boats they own for G&G activity. The other seven companies have not applied for a G&G permit, and therefore we assume they contract with vessel companies. All contract vessel operators are headquartered in either Louisiana or Texas. With $8 million in average annual revenues and 58 employees on average, these companies are much smaller than domestic G&G permittees, whose average revenue is $8 billion and average number of employees is 4,000.

EXHIBIT 2-8 VESSEL FLAGS OF BOATS ENGAGED IN G&G ACTIVITY IN THE GULF OF MEXICO



[35] Estimate developed by CSA, 2016.

2.3 DEMOGRAPHIC PROFILE OF COMMUNITIES POTENTIALLY AFFECTED BY THE MMPA RULE

If the overall volume and/or the timing of G&G survey activities change as a result of the rule, communities along the coast of the Gulf of Mexico may be affected. In particular, such changes in G&G activity could affect communities near the Port of Fourchon, Louisiana, and the Port of Galveston, Texas, which are the two primary ports for G&G vessels and G&G activities. In addition, many companies process the data collected from G&G surveys in regional headquarters, many of which are located in Houston or Dallas.

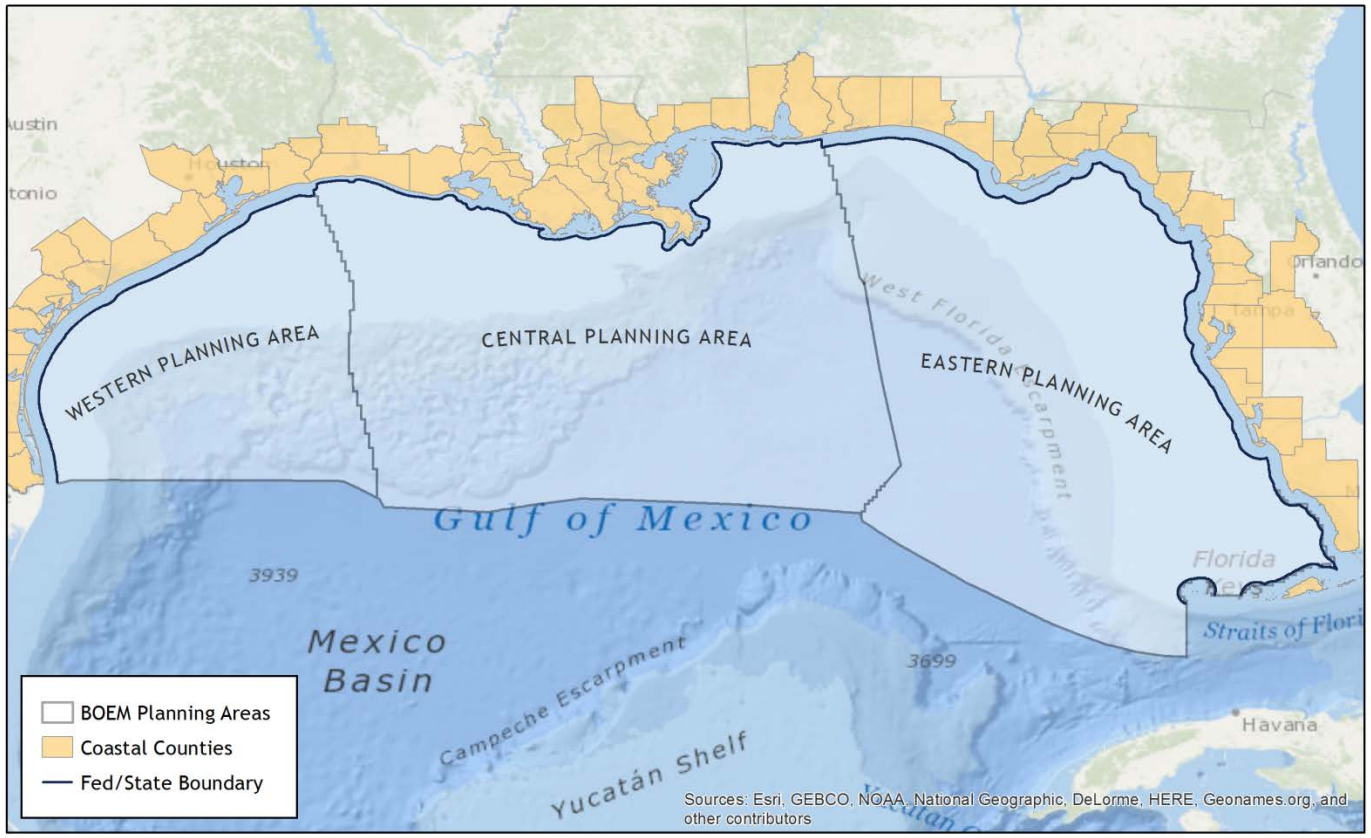
2.3.1 ECONOMIC PROFILE OF GOM COASTAL AREAS

The Gulf of Mexico's coastal economy, which encompasses the coastal counties shown in Exhibit 2-9, is dynamic and diversified across a variety of industries. As of 2015, over 17.4 million people live in the coastal counties shown in the exhibit,[36] 6.6 million of whom are employed by the 410,000 businesses in the region. Altogether, the coastal counties in the GOM had a combined GDP of $905 billion in 2015, which represented 0.05 percent of total U.S GDP and 0.3 percent of the GOM states' that year. Exhibit 2-10 shows the distribution of employment, wages, business establishments and GDP across the states that make up the Gulf of Mexico's coastal economy from 1997 to 2015. Over this period, Texas and Florida accounted for the largest share of the region's coastal economy. In addition, with the exception of Mississippi, every Gulf coastal economy has grown in the last 20 years.

Exhibit 2-11 and Exhibit 2-12 show the distribution of the GOM coastal economy's GDP and employment, respectively, by economic sector. As illustrated in the exhibits, the Financial, Information and Business Services sector accounts for the largest share of GDP (29percent) and the third largest share of employment (21 percent). Education, Health Services and Public Administration has the largest share of employment (25 percent), and the third largest share of GDP (16 percent).Trade, Transportation and Utilities sector accounts for both the second largest share of employment (22 percent),and the second largest share of GDP (19 percent). Oil and gas companies are part of the Natural Resources and Mining sector, which compromises 9 percent of the coastal economy's GDP and 3 percent of the coastal economy's employment. G&G survey companies that have applied for permits in the Gulf of Mexico in the last 10 years are spread across six sectors: (1) Natural Resources and Mining, (2) Trade, (3) Transportation and Utilities, (4) Construction, (5) Manufacturing, and (6) Information and Professional and Business Services.

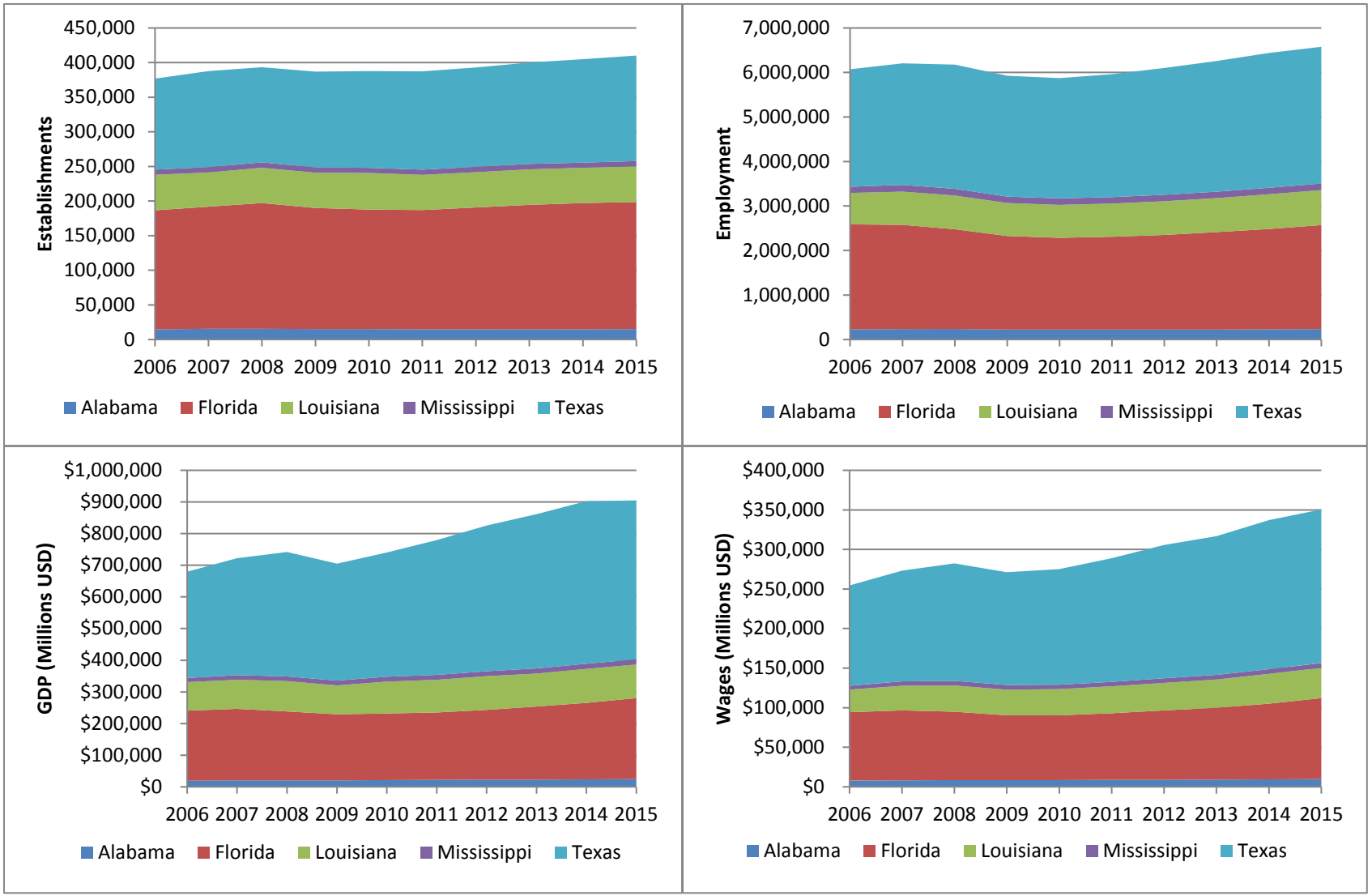
[36] National Ocean Economies Program, 2015. "Population and Housing Data."

EXHIBIT 2-9 NATIONAL OCEAN ECONOMICS PROGRAM (NOEP) COASTAL COUNTIES IN THE GULF OF MEXICO



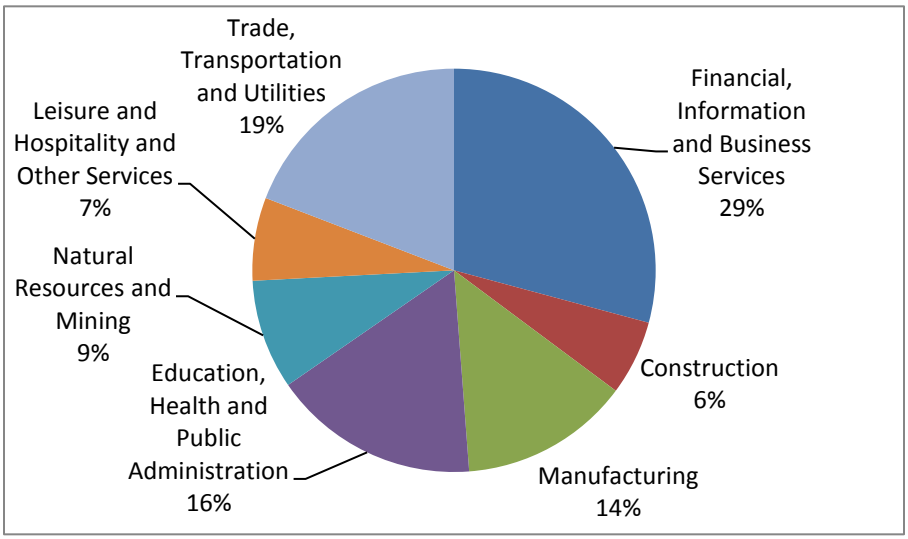
IEc

EXHIBIT 2-10 COASTAL ECONOMIES BASED IN THE GULF OF MEXICO



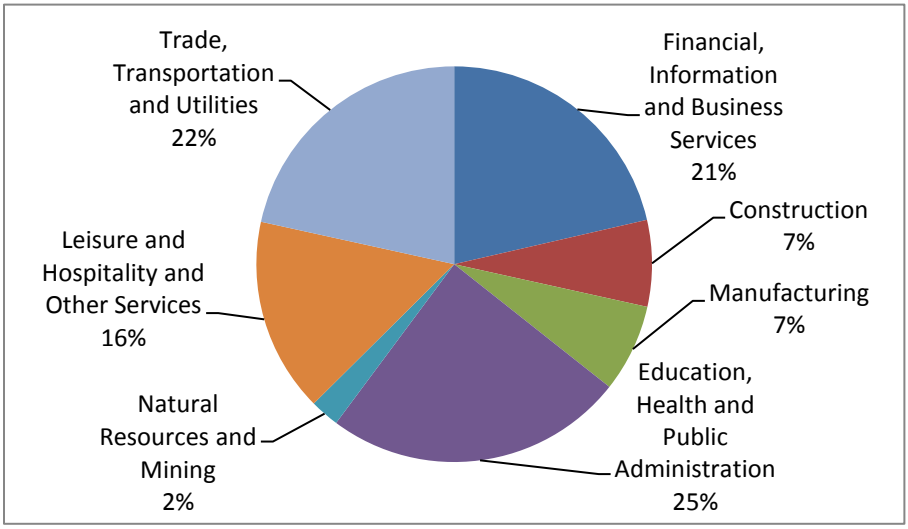
Source: National Ocean Economies Program, Coastal Economy Data

EXHIBIT 2-11 SHARE OF GDP BY SECTOR IN COASTAL ECONOMIES



Source: NOEP Coastal Economy Data for Gulf of Mexico Region, 2015

EXHIBIT 2-12 SHARE OF EMPLOYMENT BY SECTOR IN COASTAL ECONOMIES



Source: NOEP Coastal Economy Data for Gulf of Mexico Region, 2015

2.3.2 DEMOGRAPHICS OF AREAS SURROUNDING PRIMARY PORTS

To develop a demographic profile for the populations in areas that would be affected by the rule, we focus on populations near the two ports that are most commonly used for G&G activities: the Port of Fourchon and the Port of Galveston.[37] The Port of Fourchon is located in the Lafourche Parish in the Houma-Thibodaux Metro Area of Louisiana,

[37] Section 13.2 of Appendix E of the PEIS.

while the Port of Galveston is located near Galveston city in the Houston-The Woodlands- Sugar Lands Metro Area of Texas.

Exhibit 2-13 presents the total population and the share of racial minorities living in proximity to the two main ports. Lafourche Parish has approximately 97,000 residents, and the Houma Thibodaux MSA has approximately 210,000 residents. The number of individuals identifying as Black or African American in the Houma-Thibodaux MSA and Lafourche Parish is proportionally higher relative to the U.S. The proportion of the population characterized as Black or African American in these areas, however, is lower than the corresponding share for the state of Louisiana. The percentage of the population identified as American Indian or Alaskan Native in these areas is higher than for the U.S. or Louisiana.

Galveston City has a population of approximately 49,000 residents, while the Houston-The Woodlands-Sugar Land metro area is home to 6.3 million residents. In each of these two areas, the share of the population identified as Black or African American is higher than for the U.S. or for Texas. The Hispanic/Latino population in these areas is proportionally higher relative to the U.S. population but lower, in proportional terms, than for all of Texas.

Exhibit 2-14 presents the per capita income, median income and the percent of the population that is considered low income in these areas. The area around Port of Fourchon has slightly lower median and per capita income than the US, but, relative to Louisiana, slightly higher median income and comparable per capita income. The percent of low income residents in Lafourche Parish is lower than both the national and state share. In the Houma- Thibodaux Metro Area, low-income residents' share of the population is higher than for the US but lower than the share for Louisiana. In the direct vicinity of the Port of Galveston in Galveston City, median and per capita income are lower than the national average and percent of the population that poverty rate is higher than the national average. When the larger metro area of Houston- The Woodlands- Sugar Land is considered, the trend is reversed with higher median and per capita income relative to the U.S. as a whole and the state of Texas.

Exhibit 2-15 shows the seasonally adjusted unemployment rate for the areas surrounding the Port of Fourchon and Port of Galveston between 2006 and 2016. Until 2014, the areas around these two ports experienced lower unemployment rates than the national average. Starting in 2015, the Houma- Thibodaux MSA has had unemployment rates higher than national and Louisiana rates. The Houston- The Woodlands-Sugar Land Metro Area have had unemployment rates lower than the national average until the end of 2015 when the unemployment rate in the MSA climbed above the national and Texas rates.

EXHIBIT 2-13 DEMOGRAPHICS AROUND PORT OF FOURCHON AND PORT OF GALVESTON IN 2015

PORT / LOCATION	TOTAL POPULATION	PERCENT OF TOTAL POPULATION								
		WHITE	BLACK OR AFRICAN AMERICAN	AMERICAN INDIAN AND ALASKAN NATIVE	ASIAN	NATIVE HAWAIIAN AND OTHER PACIFIC ISLANDER	SOME OTHER RACE ALONE	TWO OR MORE RACES	TOTAL PERCENT RACIAL MINORITY	HISPANIC OR LATINO[1]
United States	**316,515,021**	**73.6%**	**12.6%**	**0.8%**	**5.1%**	**0.2%**	**4.7%**	**3.0%**	**26.4%**	**17.1%**
Louisiana	**4,625,253**	**62.8%**	**32.1%**	**0.6%**	**1.7%**	**0.0%**	**1.0%**	**1.8%**	**37.2%**	**4.7%**
Lafourche Parish, Louisiana	97,474	79.5%	13.4%	2.3%	0.8%	0.0%	1.6%	2.4%	20.5%	4.3%
Houma-Thibodaux, LA Metro Area	210,216	75.1%	16.1%	4.0%	0.9%	0.2%	1.2%	2.6%	24.9%	4.5%
Texas	**26,538,614**	**74.9%**	**11.9%**	**0.5%**	**4.2%**	**0.1%**	**6.0%**	**2.5%**	**25.1%**	**38.4%**
Galveston City, Texas	48,971	71.4%	20.6%	0.3%	4.1%	0.0%	1.4%	2.2%	28.6%	29.0%
Houston-The Woodlands-Sugar Land, TX Metro Area	6,346,653	65.7%	17.1%	0.4%	7.1%	0.1%	7.3%	2.3%	34.3%	36.1%

[1]Hispanic and Latino is considered ethnicity rather than race. Therefore the total of these columns is larger than 100 percent.

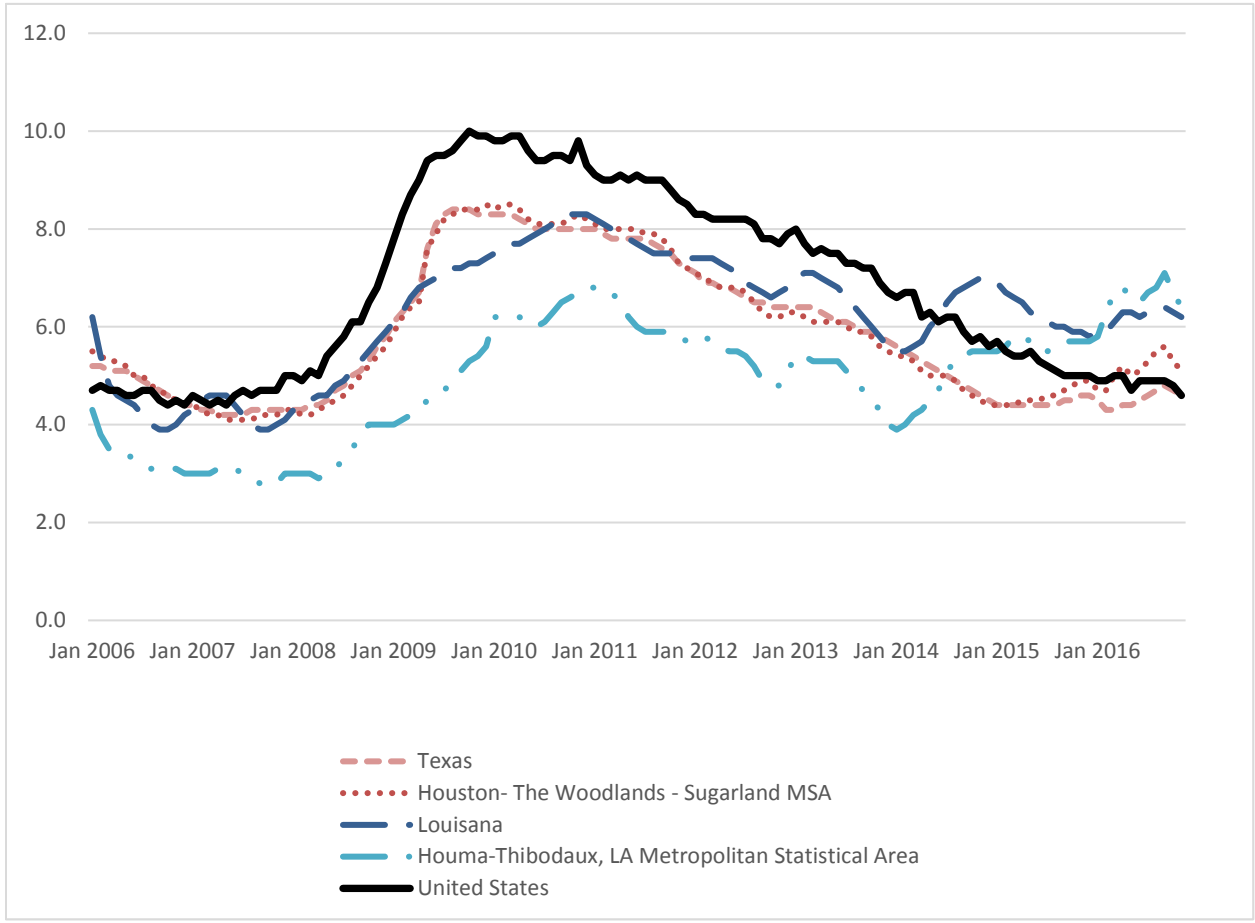
Source: American Communities Survey, Data for 2015

EXHIBIT 2-14 INCOME LEVELS AROUND PORT OF FOURCHON AND PORT OF GALVESTON IN 2015

PORT / LOCATION	MEDIAN INCOME	PER CAPITA INCOME	PERCENT LOW INCOME
United States	**$53,889**	**$28,930**	**15.5%**
Louisiana	**$45,047**	**$24,981**	**19.8%**
Lafourche Parish, Louisiana	$51,030	$25,303	14.8%
Houma-Thibodaux, LA Metro Area	$49,442	$24,403	17.3%
Texas	**$53,207**	**$26,999**	**17.3%**
Galveston City, Texas	$39,098	$26,665	24.6%
Houston-The Woodlands-Sugar Land, TX Metro Area	$59,649	$30,241	15.9%

Source: American Communities Survey, Data for 2015.

EXHIBIT 2-15 UNEMPLOYMENT RATES NEAR PORT OF FOURCHON AND PORT OF GALVESTON, 2006-2016



Source: BLS Seasonally Adjusted Local Area Unemployment Statistics

2.3.3 AREAS OUTSIDE OF THE GULF OF MEXICO POTENTIALLY AFFECTED

In addition to the populations that are involved in and which could be affected by the G&G surveys by proximity, the G&G survey companies also employ people involved in the management, sales and analysis of these surveys outside of these coastal regions. These functions are typically located in the headquarters or regional headquarters of these companies. The most common location for GOM regional headquarters is the Houston metro area, which is part of the coastal economy and near the Port of Galveston. In addition, Dallas is the regional headquarters for some of these companies.

CHAPTER 3 FRAMEWORK FOR THE ANALYSIS

The purpose of this analysis is to identify and analyze the potential economic costs and benefits associated with the proposed MMPA rule governing G&G activities associated with oil and gas exploration and development in the GOM. This chapter presents the framework applied to evaluate the potential economic impacts of the Proposed Rule and More Stringent Alternative, as described in Chapter 1.

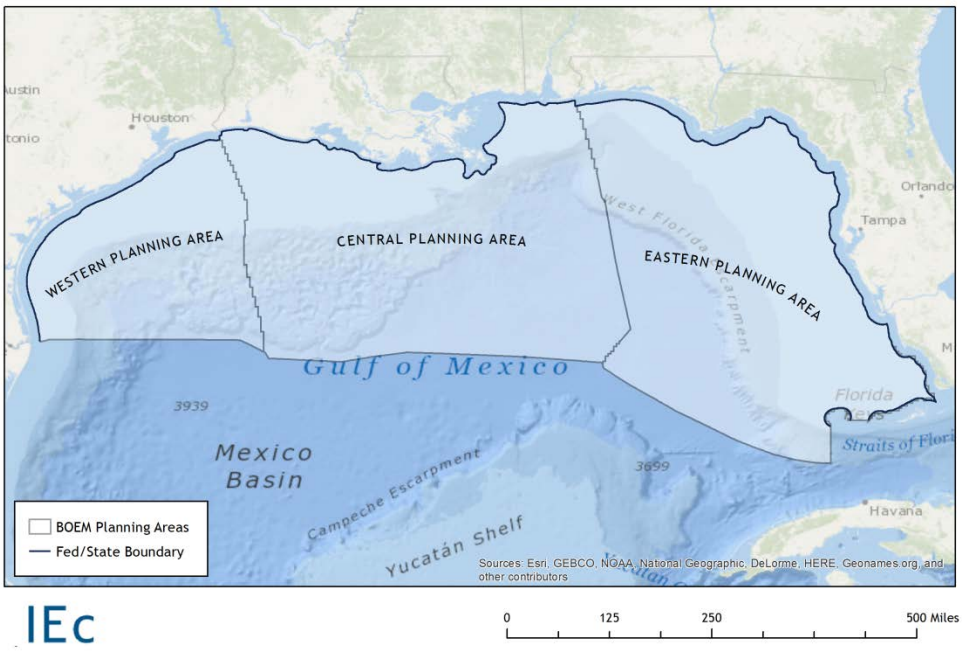
This analysis examines the impacts of implementing mitigation measures as part of future G&G activities in order to comply with the requirements of the proposed MMPA incidental take regulations governing take of marine mammals incidental to these activities. This analysis compares the costs of conducting these surveys against an analytic baseline that considers the state of the world absent the MMPA rule. As described in Chapter 1, the primary baseline for this analysis reflects the management of G&G surveys prior to the 2013 stay agreement (economic impacts of the MMPA rule compared against an alternative baseline reflecting the stay agreement are evaluated in Appendix A). The baseline considers marine mammal conservation and mitigation measures implemented as part of G&G surveys absent the MMPA rule; for example, due to the Endangered Species Act (ESA) status of certain marine mammal species, and other Federal, state, and local regulations. The focus of this analysis is on the incremental economic costs and benefits of mitigation measures, defined as those costs and benefits precipitated specifically by the proposed MMPA rule.

3.1 SCOPE OF THE ANALYSIS

This initial RIA forecasts regulatory costs and benefits associated with incidental take regulations for BOEM-permitted G&G activities. In contrast to the BOEM's Programmatic Environmental Impact Statement (PEIS) regarding the G&G program in the GOM, which also covers renewable energy and marine minerals programs, this RIA is limited to G&G survey activities related to oil and gas exploration and development, as described in BOEM's October 2016 MMPA incidental take application description of the specified activity[38] and subject to the requirements in the Notice of Proposed Rulemaking (NPRM). BOEM's jurisdiction for permitting G&G activities is limited to Federal waters as shown in Exhibit 3-1. The geographic scope of this RIA therefore encompasses the impacts related to G&G activities occurring in federal waters within the three BOEM planning areas in the GOM (Western, Eastern, and Central), as identified in Exhibit 3-1.

[38] Bureau of Ocean Energy Management, *Request to the National Oceanic and Atmospheric Administration for Incidental Take Regulations Governing Geophysical Surveys on the Outer Continental Shelf of the Gulf of Mexico*, October 14, 2016.

EXHIBIT 3-1. STUDY AREA FOR THE RIA



We quantify the impacts of the proposed MMPA rule implementation from 2018 through 2022. The five-year timeframe of this analysis reflects the statutory timeframe for the Incidental Take Regulations under the MMPA.[39] While implementation of the MMPA rule will occur between 2018 and 2022, we consider the potential for rule implementation to affect G&G and associated activities beyond this timeframe. For example, to the extent that area closures delay oil and gas development, the economic impacts associated with these restrictions may extend beyond the five-year timeframe of the rule.

3.2 ECONOMIC COSTS

A primary goal of regulatory analysis is to estimate the total societal costs, or the opportunity costs to society of compliance with a proposed regulation. These costs are typically measured as changes in producer and consumer surplus. Producer surplus is the difference between the market price of a good and the marginal cost of production, while consumer surplus is the difference between what consumers are willing to pay for the good and the market price.

[39] The U.S. Office of Management and Budget specifies that the timeframe of an RIA reflect the timeframe of the associated rule. OMB, February 7. 2011. "Regulatory Impact Analysis: Frequently Asked Questions (FAQs)." Accessed at https://www.whitehouse.gov/sites/default/files/omb/assets/OMB/circulars/a004/a-4_FAQ.pdf.

The analysis of economic costs presented in this RIA focuses on the compliance costs of the Proposed Rule and the More Stringent Alternative. For policies expected to result in little to no change in market prices, compliance costs provide a reasonable approximation of the change in societal surplus (i.e., producer surplus and consumer surplus combined). Compliance costs are comprised of administrative costs borne by private entities, costs associated with changes to operations and/or additional capital costs required to comply with the Proposed Rule (as borne by the G&G industry), and costs to state and federal governments associated with administering and implementing the rule. Compliance costs include the *direct costs* of purchasing and installing equipment or technology to comply with a regulation, as well as the value of time spent complying. Compliance costs may also include *indirect costs* associated with unintended delays, cancellation, or other changes to survey activities associated with rule compliance that may affect competitiveness, productivity, or innovation in affected industries.

This analysis also evaluates the potential impact that changes in the expected number of surveys and/or increases in compliance costs of G&G surveys may have on the oil and gas market in the U.S.

3.3 ECONOMIC BENEFITS

Under Executive Order 12866, OMB directs federal agencies to provide an assessment of both the social costs and benefits of proposed regulatory actions.[40] OMB's Circular A-4 distinguishes between two types of economic benefits: direct benefits and ancillary benefits. Ancillary benefits are defined as favorable impacts of a rulemaking that are typically unrelated, or secondary, to the statutory purpose of the rulemaking.[41]

The primary purpose of the MMPA rule (i.e., the direct benefit) is to verify that G&G activity will have a negligible impact on the affected species or stocks and minimize or avoid impacts to marine mammal species or stocks and their habitat from oil and gas-related G&G activities in the GOM. The MMPA requires that ITRs prescribe the "means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance…." and therefore requires a different standard for mitigation and related monitoring requirements than does the Outer Continental Shelf Lands Act.

As discussed in Chapter 5, the published economics literature has documented that social welfare benefits can result from the protection of marine mammal species. Ideally, a monetized value for this intended benefit would provide a practical means to compare against the monetized costs. However, we do not have a quantitative estimate of the expected reduction in take or harassment of marine mammals due to the Proposed Rule or the More Stringent Alternative. In addition, any reductions in harassment due to specified mitigation measures do not directly translate into the presence or absence of a given marine mammal population or into changes in population levels. Thus, we are not

[40] Executive Order 12866, Regulatory Planning and Review, September 30, 1993.

[41] U.S. Office of Management and Budget, "Circular A-4," September 17, 2003, available at http://www.whitehouse.gov/sites/default/files/omb/assets/omb/circulars/a004/a-4.pdf

able to quantify or monetize the targeted benefits of the Proposed Rule or the More Stringent Alternative in terms of the public's willingness-to-pay for the expected improvement to marine mammal species relative to the baseline.

In its guidance for implementing Executive Order 12866, OMB acknowledges that it may not be feasible to monetize, or even quantify, the benefits of environmental regulations due to either an absence of defensible, relevant studies or a lack of resources on the implementing agency's part to conduct new research.[42] This analysis therefore characterizes the potential values associated with the protected resources in the GOM (in this case, marine mammals) to provide perspective on their contribution to the public's well-being. More specifically, we summarize the economics literature focused on people's willingness to pay for conservation of marine mammal populations or habitats. We also describe the value (both social welfare and regional economic contribution) of affected activities and industries expected to benefit from the rulemaking. For example, we provide a description of ongoing recreational wildlife-viewing activities in the GOM for perspective on the economic and social importance of this resource.

Finally, consistent with OMB guidance for regulatory analysis, we also consider potential ancillary benefits of the rule including, for example, improved habitat conditions for co-existing species that may be commercially or recreationally valuable. This discussion reflects the best available information for comparison of the economic costs and benefits of the MMPA rule.

3.4 DISTRIBUTIONAL EFFECTS

Measurements of changes in economic efficiency (i.e., cost-benefit analysis) focus on the net impact of regulatory actions, without consideration of how certain economic sectors or segments of the population are affected. Thus, a discussion of efficiency effects alone may disregard important distributional considerations; for example, given current economic conditions, regulatory decision makers are deeply attuned to the impact of new regulatory actions on jobs. This analysis considers several types of distributional effects, including impacts on small entities; impacts on energy supply, distribution, and use; and regional economic impacts. Specifically, the analysis discusses the likelihood that the rule could lead to reductions in G&G activity (direct impact) or offshore energy production (indirect impact), and employment and other impacts that could be associated with those reductions. Several statutes and Executive Orders require agencies to consider the distributional impacts of their regulations, including EO 12866 (Regulatory Review), the Unfunded Mandates Reform Act (UMRA); the Regulatory Flexibility Act (RFA), as amended by the Small Business Regulatory Enforcement and Fairness Act (SBREFA); and EO 13211 (Energy Supply). The RIA includes an analysis associated with each of these requirements in Appendices B and C.

[42] Ibid.

3.5 CONSIDERING UNCERTAINTY

Recognizing the frequent infeasibility of developing precise estimates of costs and benefits, Circular A-4 advises Federal agencies to consider key sources of uncertainty at the earliest possible stages of an RIA. To account for uncertainties regarding costs and benefits, this RIA presents the estimated costs of the Proposed Rule and More Stringent Alternative as a range. This range reflects alternative values for key data inputs and assumptions for the analysis. In addition, to ensure that the analytic uncertainties in this RIA are fully transparent, the analysis of economic costs systematically identifies the major sources of uncertainty in the analysis, states the direction of potential bias associated with these uncertainties, and characterizes the likely significance of these uncertainties with respect to the conclusions of the analysis.

CHAPTER 4 | INDUSTRY COMPLIANCE AND ECONOMIC COST ANALYSIS

4.1 INTRODUCTION AND SUMMARY OF FINDINGS

This analysis evaluates the costs of compliance with the Proposed Rule and More Stringent Alternative, including: a) quantifying the increased cost of conducting G&G surveys due to the additional requirements of the rule (direct compliance costs); and b) qualitatively assessing the economic implications of potential reductions in the overall level of G&G survey activity in the GOM (indirect costs). In addition to historical BOEM G&G permit data, this analysis employs cost information provided to BOEM by the International Association of Geophysical Contractors (IAGC), follow-on communication with the IAGC and the American Petroleum Institute (API), and public comments submitted on the September 2016 Draft Programmatic Environmental Impact Statement (Draft PEIS) for G&G activities in the GOM.

Exhibit 4-1 summarizes the costs of the Proposed Rule and More Stringent Alternative over the five-year timeframe of the rule. These costs reflect additional expenditures (e.g., on marine mammal monitoring), as well as reductions in survey efficiency (e.g., increased time to acquire data), and are incremental to the pre-stay agreement baseline for this analysis, as described in Chapter 1. Costs of the Proposed Rule and More Stringent Alternative relative to the mitigation measures related to the stay agreement are summarized in Appendix A.

The annualized direct compliance costs of the Proposed Rule range from $49 million to $182 million over the rule's five-year timeframe (assuming a seven percent discount rate).[43] The direct costs reflect:

- Shutdowns for protected species observer (PSO) sightings of large dolphins within the exclusion zone (5 percent of high-end costs);
- Potential need to reshoot the airgun array following a power down due to PSO observations of small dolphins within the exclusion zone (22 percent of high-end costs);
- PSO requirements for seismic airgun surveys operating in water depths less than 200 meters in the Central and Western Planning Areas (in addition to the baseline PSO requirements for seismic airgun surveys in water 200 meters and deeper) and

[43] All monetized cost estimates in this chapter are presented in 2016 dollars. Present value and annualized costs are calculated assuming a seven percent real discount rate unless otherwise indicated. Appendix D provides information on present value and annualized costs assuming a three percent discount rate for comparison.

associated shutdowns for whale observations within the exclusion zone (1 percent of high-end costs)

- Shutdowns for PSO sightings of Bryde's whale, Kogia species, and beaked whales outside the exclusion zone (2 percent of high-end costs);
- Use of passive acoustic monitoring (PAM) at all times in waters greater than 100 meters in depth and associated shutdowns for detections of whales (70 percent of high-end costs); and
- PSO requirements for non-airgun HRG surveys and associated shutdowns for whale observations in the exclusion zone (0.2 percent of high-end costs).

The broad range in the direct compliance costs is driven in large part by uncertainty associated with how many G&G surveys will be conducted over the rule's five-year timeframe. While the difference in projected survey activity between the low- and high-ends varies by survey type, overall the high-end forecast of survey activity is approximately 65 percent higher than that of the low-end forecast. The high-end forecast reflects industry capacity in the GOM and historical survey frequency. The low-end forecast was developed in response to public comment on the draft PEIS, and incorporates a number of factors that could potentially reduce activity levels (e.g. marketplace changes and adjustment of schedules for closures). Additional information on the forecast G&G activity levels is provided in BOEM's final PEIS.[44]

The annualized compliance costs of the More Stringent Alternative range from $78 million to $218 million. In addition to the regulatory requirements and associated costs described for the Proposed Rule, the costs of the More Stringent Alternative reflect:

- Shutdowns for PSO sightings of small dolphins that are not bow-riding; and
- Shutdowns for PSO sightings of sperm whales outside the exclusion zone.

In addition to the quantified direct costs, the Proposed Rule and More Stringent Alternative include seasonal restrictions and area closures where G&G activities would be precluded over the timeframe of the rule. Specifically, the Proposed Rule includes a seasonal restriction on G&G activity in coastal waters and year-round restrictions on G&G activity in two areas in the GOM Eastern Planning Area (see Exhibit 4-22). The More Stringent Alternative includes the same closure areas as the Proposed Rule, as well as an additional year-round closure area in the GOM Central Planning Area (see Exhibit 4-29).

Closing areas to G&G surveys, whether seasonally or year-round, can have real implications on the value of the GOM for oil and gas development. While these closures do not increase the compliance cost for a given G&G survey, they may affect the overall levels of G&G activities that occur in the GOM over the five-year timeframe of the

[44] BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

analysis. In the case that the closures delay or reduce the ability of industry to collect the necessary data to identify and recover oil and gas resources, the overall level of oil and gas production in the GOM may be delayed or reduced. In addition to affecting the offshore oil and gas and G&G industries, reductions in exploration and development activities in the GOM would have consequences on regional economies that are tied to these industries.

Uncertainty exists regarding whether or how the Proposed Rule or More Stringent Alternative will delay or reduce oil and gas development in the GOM, as discussed in Section 4.3. Given these information limitations, quantifying the impacts of these closures would be speculative. This analysis does find, however, that two factors could limit the extent to which the Proposed Rule closures delay or reduce oil and gas production: 1) the ability for the G&G industry to plan surveys around seasonal closures; and 2) the year-round closures occurring only in the Eastern Planning Area, which is subject to a moratorium on oil and gas development for the timeframe of the rule.

On the other hand, the Central Planning Area Closure Area included in the More Stringent Alternative is relatively more likely to delay or reduce development of oil and gas resources due to the historically high levels of exploration and development activity in this area and because the closure is year-round as opposed to seasonal.

Overall, the quantified costs of the Proposed Rule are conservative in that they are more likely to overestimate than underestimate costs. In particular, the high-end costs reflect conservative assumptions regarding mitigation generated by the rule; for example, at the high end we assume that power downs for small dolphin observations all result in the need to reshoot in order to effectively gather the needed geophysical data. In reality, it is likely that some fraction of the power downs would be relatively short or otherwise not result in the need to reshoot. In addition, the Proposed Rule has the potential to generate some cost savings due to:

- Reduced administrative effort required to obtain a letter of authorization (LOA) from the National Marine Fisheries Service (NMFS) rather than an Incidental Harassment Authorization (IHA) for each survey; and
- Smaller exclusions zones for shallow penetration airgun surveys (200 meters as compared with 500 meters under the baseline).

The potential for these aspects of the Proposed Rule to result in cost savings would offset some of the additional compliance costs at both the low end and the high end. While data limitations precluded quantification of these potential cost savings, we include them as key uncertainties leading to a generally conservative estimate of the Proposed Rule costs.

EXHIBIT 4-1: ANNUALIZED COSTS BY ALTERNATIVE AND MITIGATION MEASURE, 2018-2022 (2016$, 7 PERCENT DISCOUNT RATE)

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS	MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS
QUANTIFIED DIRECT COMPLIANCE COSTS			
Mitigation Requirements for PSO Dolphin Observations: Shutdowns for large dolphins in the exclusion zone and power downs for small dolphins in the exclusion zone	$3.9 – $49.7	*Mitigation Requirements for PSO Dolphin Observations:* Shutdowns for large dolphins in the exclusion zone and for small dolphins that are not bow-riding in the exclusion zone	$15.2 - $40.2
PSO Implementation Requirements and Associated Mitigation for Whale Observations in Shallow Waters (in addition to baseline requirement for PSO implementation in deep waters): Shutdowns for all whale species in the exclusion zone for seismic airgun surveys in water depths less than 200m in the Central and Western Planning Areas	$0.02 - $2.1	*PSO Implementation Requirements and Associated Mitigation for Whale Observations in Shallow Waters (in addition to baseline requirement for PSO implementation in deep waters):* Shutdowns for all whale species in the exclusion zone for seismic airgun surveys in water depths less than 200m in the Central and Western Planning Areas	$0.02 - $2.1
Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone: Shutdowns for Bryde's/beaked/Kogia whales for deep penetration airgun surveys	$1.1 - $3.0	*Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone:* Shutdowns for Bryde's/beaked/Kogia and sperm whales for deep penetration airgun surveys	$18.4 - $48.8
PAM Implementation Requirements and Associated Mitigation for Whale Detections: Shutdowns for all whale detections for deep penetration airgun surveys	$43.9 - $127	*PAM Implementation Requirements and Associated Mitigation for Whale Detections:* Shutdowns for all whale detections for deep penetration airgun surveys	$43.9 - $127
PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations: Shutdowns for whale and large dolphin observations in the exclusion zone	$0. 12 - $0.39	*PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations*: Shutdowns for whale and large dolphin observations in the exclusion zone	$0.12 - $0.39
Proposed Rule Total Direct Compliance Costs	**$49 - $182**	**More Stringent Alternative Total Direct Compliance Costs**	**$78 - $218**
QUALITATIVE ASSESSMENT OF POTENTIAL INDIRECT COSTS*			
Seasonal Restrictions: Precludes use of airguns in coastal waters between February 1 and May 31	Some potential for impacts to oil and gas productivity in the GOM over the next 5-10 years	*Seasonal Restrictions:* Precludes use of airguns in coastal waters between February 1 and May 31	Some potential for impacts to oil and gas productivity in the GOM over the next 5-10 years
Area Closures: Precludes use of airguns year round within the Eastern Planning Closure Area and Dry Tortugas Closure Area	Some potential for impacts to oil and gas productivity in the GOM over the next	*Area Closures:* Precludes use of airguns year round within the Central Planning Closure Area, Eastern Planning Closure Area, and Dry Tortugas Closure Area	Substantial potential for impacts to oil and gas productivity in the GOM over

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS	MITIGATION MEASURE	ANNUALIZED COSTS, MILLIONS
	5-10 years		the next 5-10 years

Notes:

1. Costs are presented in terms of 2016 US Dollars and are annualized over the five-year time frame (2018-2022) applying a 7% discount rate.
2. Estimates are rounded to three significant digits.
3. This exhibit reflects incremental costs of the Proposed Rule and More Stringent Alternative relative to the pre-stay agreement baseline. Appendix A presents incremental costs relative to the stay agreement mitigation measures.

* The rationale for the characterization of the potential economic implications of these mitigation measures are discussed in Section 4.3.

4.2 INDUSTRY COMPLIANCE COSTS

This section focuses on direct compliance costs including: the additional costs of employing protected species observers and PAM operators; use of specified technologies and equipment; and increased time required to conduct G&G surveys due to the need to cease operations when marine mammals are present. The baseline for our analysis includes existing requirements for G&G surveys to avoid or minimize potential impacts to marine mammals. This analysis first provides information on the costs of conducting G&G surveys in the GOM, including costs of existing (pre-stay agreement) protections (Section 4.2.1). It then calculates the costs of conducting G&G surveys in the GOM in light of the Proposed Rule requirements (Section 4.2.2). The difference between the two (costs with and without the Proposed Rule) reflects the incremental costs associated with the Proposed Rule.

The analysis of baseline survey costs and incremental compliance costs is based on four primary data sources:

1. International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities;
2. Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region;
3. The BOEM G&G permit history from 2012 through 2015, reflecting the most recent trends in G&G surveys in the GOM; and
4. A forecast of future G&G activities developed by BOEM reflecting the years 2018 through 2022 (see Exhibits 4-16 and 4-17).

These resources reflect the best available information to support the analysis of the costs of the Proposed Rule. The IAGC is a global trade group representing the G&G industry. The cost information provided from the IAGC survey is based on the experience of survey operators actively working in the GOM. The Barkaszi *et al.* research is a summary of historical monitoring reports describing the frequencies of marine mammal observations from PSOs on board G&G vessels. In addition, both of these data sources were recently part of a Programmatic Environmental Impact Statement (PEIS) regarding G&G activities in the GOM and that was subject to public comment.[45] The public comment process did not identify additional or better data on the subject of G&G survey costs or marine mammal observations. Public comment on the PEIS did, however, result in BOEM revisiting the forecast of G&G surveys in the GOM over the next five years. The updated forecast includes both a low-end and high-end forecast of the number of future surveys. This update to the forecast in response to public comment is reflected in this analysis. As previously noted, the high-end forecast reflects industry capacity in the GOM and historical survey frequency whereas the low-end forecast considers a potential reduction in activity levels due, for example, to changing market conditions.

[45] BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

4.2.1 BASELINE COSTS BY SURVEY TYPE

The IAGC provided estimates of the average mobilization cost and the average daily vessel operating cost for four G&G survey categories: 2D, 3D, wide azimuth (WAZ), and high-resolution geophysical (HRG) surveys. IAGC separately estimated the costs associated with 2D and 3D surveys that use Ocean Bottom Survey (OBS) technology. In addition, BOEM reviewed a National Energy Technology Laboratory (NETL) document on seismic data acquisition to estimate a range of costs associated with vertical seismic profile (VSP) surveys.[4647] The estimates in Exhibit 4-2 are inclusive of all survey operating costs, including the marine mammal mitigation measures described in Exhibits 1-1 and 1-2.[48]

To translate daily operating costs estimated by IAGC into total operating costs per survey, we relied on information on average survey duration (in days) for each survey type from the BOEM G&G permit history from 2012 through 2015. Average survey costs are the sum of the average mobilization costs and the product of daily vessel operating costs and average survey duration, as summarized in Exhibit 4-2.

[46] NETL. (2013). Summary of Costs Associated with Seismic Data Acquisition and Processing. NETL document number: DOE/NETL-2014/1671.

[47] The NETL document also provides estimates of typical costs for 2D and 3D seismic surveys. However, these cost estimates are presented per mile or square mile of survey coverage, and thus are difficult to compare to the IAGC estimates which are presented as costs per day. Based on IAGC estimates of survey coverage per day, the NETL cost estimates appear to be higher than the IAGC cost estimates.

[48] IAGC confirmed that the survey operating costs are inclusive of baseline mitigation measures (Personal communication between IEc, IAGC, and API. December 15, 2016).

EXHIBIT 4-2. ESTIMATED BASELINE COSTS OF G&G SURVEYS IN THE GOM

PERMIT TYPE [A]	AVERAGE DURATION ON WATER (DAYS) [B]	MOBILIZATION AND PRE-MOBILIZATION COST [C]	VESSEL OPERATING COST/DAY [D]	TOTAL AVERAGE SURVEY COST [E=C + (B×D)]
2D	176	$5,100,000	$97,500	$22,300,000
2D-OBS	141	$5,100,000	$372,000 - $542,000	$57,800,000 - $81,800,000
3D	137	$5,100,000	$325,000	$49,800,000
3D-OBS	141	$5,100,000	$600,000 - $770,000	$90,000,000 - $114,000,000
WAZ	178	$10,100,000 - $15,100,000	$875,000	$166,000,000 - $171,000,000
Airgun HRG	10	$140,000	$33,500	$458,000
Non-airgun HRG	18	$140,000	$33,500	$742,000
VSP	7	$140,000	$33,500 - $71,400	$375,000 - $640,000
SWD	7	$140,000	$33,500 - $71,400	$375,000 - $640,000

Notes:

1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. IAGC provided ranges for only some survey types and cost categories.
3. IAGC estimated a vessel operating cost/day of $275,000 to $445,000 for OBS. For the purposes of this analysis, we interpret these costs as additive with the provided daily operating cost for 2D and 3D surveys.
4. The VSP costs reflect Zero Offset VSP surveys at the low end, and 3D VSP surveys at the high end. We estimated average daily operating costs for these surveys by dividing total survey costs provided by NETL by estimated survey durations.
5. Absent data specific to SWD surveys, we assume that average survey duration and costs are similar to VSP surveys.

Sources:

1. International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
2. Personal communication between IEc, IAGC, and API. December 15, 2016.
3. NETL. (2013). *Summary of Costs Associated with Seismic Data Acquisition and Processing*. NETL document number: DOE/NETL-2014/1671.

4.2.2 COSTS BY PROPOSED RULE MITIGATION MEASURE

This section is organized by mitigation measure included in the Proposed Rule. This analysis finds that the following mitigation measures increase the overall direct costs to conduct G&G surveys in the GOM:

1. **Mitigation Requirements for PSO Dolphin Observations:** The Proposed Rule requires seismic airgun survey power downs for small dolphins and shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys.
2. **PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Waters and Associated Mitigation for Whale Observations:** The Proposed Rule requires that seismic airgun surveys in water depths less than 200 meters in the Western and Central Planning Areas include PSOs and implement shutdowns for observations of whales in the exclusion zone. Prior to the stay agreement, these requirements pertained only to seismic airgun surveys in waters greater than 200 meters in depth.
3. **Additional Mitigation Requirements for PSO Whale Observations:** The Proposed Rule requires deep penetration seismic airgun survey shutdowns due to PSO sightings of Bryde's whale, Kogia species, and beaked whales outside of the 500-meter exclusion zone.
4. **PAM Implementation Requirements and Associated Mitigation for Whale Detections:** The Proposed Rule requires implementation of PAM constantly (24 hours/day) for deep penetration airgun surveys in water depths greater than 100 meters. PAM detections of any whales requires shutdown of deep penetration seismic airgun surveys.
5. **PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations:** The Proposed Rule requires that non-airgun HRG surveys in deep water (greater than 200 meters depth) include PSO observers. In addition, the Proposed Rule requires shutdowns for observations of any whales and of large dolphins (as described in Section 1) within a 200-meter exclusion zone.

The following sections describe the data sources and assumptions used to generate the compliance cost estimates for each of these measures. As noted above, the potential impacts of area closures and seasonal restrictions are discussed in Section 4.3.

Mitigation Requirements for PSO Dolphin Observations

Under the pre-stay agreement baseline, PSOs are required on all seismic airgun G&G survey vessels during daylight hours. Survey shutdowns are required when whales are observed within a 500-meter exclusion zone for both deep and shallow penetration surveys.

Above and beyond these baseline mitigation requirements for whales, the Proposed Rule includes additional actions when PSOs identify dolphins within the exclusion zone, defined as 500 meters for deep penetration surveys and 200 meters for shallow penetration surveys. Observations of large dolphins within the exclusion zone require a full shutdown of the airgun array. For observations of the four genera of small dolphins (*Lagenodelphis*, *Stenella*, *Tursiops*, and *Steno*) within the exclusion zone, vessels are required to power down to the smallest array element, but not to shut down.

We calculate the incremental costs associated with these requirements in terms of the consequent reduction in efficiency of these surveys; that is, the surveys take additional time to complete in order to gather the same geophysical information. We monetize the costs of the additional time required to complete the surveys in terms of the increased operating costs (costs for running the vessels and compensating staff). This analysis includes the following steps.

- *Step 1: Estimate frequency of large and small dolphin observations within the exclusion zone.*

To estimate the expected frequency of observing dolphins (and, therefore, of additional survey shutdowns and power downs), we reviewed information on the historical sighting frequency of marine mammals in the GOM from Barkaszi *et al.* (2012). This report provides the most recent available analysis of marine mammal observer reports. The authors synthesized information from 1,440 bi-weekly marine mammal observer reports received by BOEM between December 2002 and December 2008. From these reports, the researchers derived an average sighting frequency for various marine mammal species for every 1,000 hours of PSO observation. As PSOs are required during daylight hours, we assume 12 hours of PSO observation per day. Based on this information, we estimate the percentage of survey days with a marine mammal sighting.

Barkaszi *et al.* indicate that 58 percent of dolphin observations were of dolphins within the 500 meter exclusion zone. As a result, we multiplied the percentage of survey days with dolphin sightings by 58 percent to estimate the percentage of survey days with sightings that result in shutdowns for both large and small dolphins.

Exhibit 4-3 describes the sighting frequency for all species of dolphins. Overall, we estimate that sightings of large dolphins occur on 1.4 percent of survey days, and sightings of small dolphins occur on an additional 6.7 percent of days.[49] We assume that the days with sightings of large and small dolphins are mutually exclusive and thus the percentages are additive.

[49] This analysis assumes that because PSO observers are able to distinguish dolphin species as part of the observation reports (as evidenced by the Barkaszi Rreport), PSOs would also be able to distinguish between large and small dolphins. However, a portion of the dolphin species sightings in the Barkaszi report were not identified at the species level. This analysis apportions these sightings between the small and large categories based on the relative frequency of small and large dolphin sightings among sightings with identified species. An alternative approach would be to assume all unidentified dolphin sightings would result in a shut down. If this were the case, the annualized costs quantified in this analysis would increase by less than $1 million at the high end.

EXHIBIT 4-3 ESTIMATED SIGHTING FREQUENCY FOR DELPHINID SPECIES

DELPHINID SPECIES	SPECIES CATEGORY	SIGHTING FREQUENCY PER 1,000 HOURS WITHIN EXCLUSION ZONE	PERCENT OF DAYS WITH SIGHTINGS IN EXCLUSION ZONE
Atlantic Spotted	Small	0.16	0.2%
Bottlenose	Small	1.05	1.3%
Clymene	Small	0.20	0.2%
False Killer Whale	Large	0.13	0.2%
Fraser's	Small	0.46	0.6%
Killer Whale	Large	0.01	0.0%
Melon-headed Whale	Large	0.12	0.1%
Pantropical Spotted	Small	2.20	2.6%
Pygmy Killer Whale	Large	0.13	0.2%
Risso's	Large	0.09	0.1%
Rough-toothed	Small	0.31	0.4%
Short-finned Pilot Whale	Large	0.52	0.6%
Spinner	Small	0.23	0.3%
Stenellid (genus identified only)	Small	0.10	0.1%
Striped	Small	0.03	0.0%
Unidentified species – assumed small (Delphinidae Family)	Small	0.80	1.0%
Unidentified species – assumed large (Delphinidae Family)	Large	0.17	0.2%
Small Dolphin Total		**5.54**	**6.7%**
Large Dolphin Total		**1.17**	**1.4%**
All-Dolphin Total		**6.71**	**8.1%**

Note: For the purposes of this analysis, we apportioned the unidentified dolphin sightings between the small and large species categories based on the relative frequency of small and large dolphin sightings among sightings with identified species.

Source: Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.

- *Step 2: Estimate likelihood that power downs will result in the need for surveys to reshoot.*

Although the Proposed Rule only requires G&G vessels to power down to the smallest array element (as opposed to shutting down) following observations of small dolphins, some portion of power downs may still require the vessel to reshoot the survey line as a result of the lower quality of data collected without the full airgun array in operation. It is likely that some fraction of the power downs will not require reshooting. For example, as

part of a comment on IHAs for G&G surveys in the Atlantic, one industry operator stated of power downs:

> *"This action will allow for a tolerable hole in the acquired seismic data and will not require the vessel to immediately terminate the survey line and carry out a six hour circle for infill. Based on the operational impact analysis, as mentioned above, implementation of power downs as an alternative to shutdowns would save hundreds of thousands of dollars in operating costs by not prolonging the survey duration."*[50]

This analysis recognizes, however, that the GOM is a different environment than the Atlantic for G&G surveys, including both different geophysical conditions and also potentially requiring more detailed data due to the level of exploration and development activity. Specifically, the comment on the Atlantic IHA was related to 2D seismic surveys, and thus may not apply to the more detailed 3D and WAZ surveys which are common in the GOM. Additionally, data gaps may be more acceptable for broader speculative surveys than for lease-specific contract (targeted) surveys, both of which occur in the GOM. Given the differences between these locations, we recognize some potential for power downs to increase the length of surveys in the GOM. Estimating the fraction of power downs that require reshoots would, however, be speculative given that it depends on the length of power down (how long the marine mammal is present) and whether the power down results in unacceptable holes in survey data. Absent data on the proportion of dolphin power downs that would require reshoots, our analysis reflects the full range of power down costs: the low-end estimate assumes that no power downs require reshoots and the upper bound conservatively assumes that all power downs require reshoots.

- *Step 3: Estimate additional time (days) required for surveys due to shutdowns and power downs.*

The incremental cost of marine mammal shutdowns under the expanded PSO program is a function of the total number of days added to a survey (additional time required to gather the needed information). The marine mammal sightings increase the time required for a survey for two reasons: 1) the discontinued use of the seismic airguns, resulting in time over which data acquisition is not occurring, until the marine mammals leave the exclusion zone; and 2) the time required to reshoot an interrupted survey line (1-12 hours, depending on the survey type).

The IAGC estimated an average shutdown time following a marine mammal sighting in the exclusion zone in the GOM of 1.6 to 2 hours.[51] Additionally, following a shutdown, vessels may need to backtrack and reshoot areas that were not surveyed while the sound

[50] CGG. 2017. Comments on the Proposed Incidental Harassment Authorization for the Incidental Taking of Marine Mammals during CGG's 2D Atlantic Seismic Program in the Mid- and South Atlantic OCS.

[51] International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

source was off. Exhibit 4-4 presents IAGC's estimates of the average reshoot time for each survey type following a shutdown event.

For shutdowns related to observations of large dolphins, we calculate additional surveys days as the sum of hours spent shut down and reshooting at both the low and high end. For power downs related to observations of small dolphins, at the low end, we assume no additional survey days are added (no reshooting is required) and, at the high end, we calculate additional survey days based on the time required to reshoot.

EXHIBIT 4-4. AVERAGE RESHOOT TIME FOLLOWING SHUTDOWN

SURVEY TYPE	ADDITIONAL HOURS
2D	6
2D-OBS	1 to 2
3D	4 to 10
3D-OBS	1 to 2
WAZ	12
HRG (airgun and non-airgun)	1 to 2
VSP	1 to 2
SWD	1 to 2

Notes:
1. The OBN reshoot time is used as a proxy for HRG, VSP, and SWD reshoot times (which were not provided).

Source: International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

- *Step 4: Calculate costs per survey as product of additional survey days and daily vessel operating costs.*

To monetize the additional costs associated with increasing the duration of a G&G survey, we multiply the total number of added days by the daily vessel operating cost for each survey type that uses seismic airguns. The daily vessel operating costs are summarized in Exhibit 4-2. Exhibit 4-5 summarizes the efficiency losses and associated costs for each survey type. These per survey costs are summed across the survey forecast (2018-2022) to quantify total incremental costs of the shutdowns and power downs for dolphins.

EXHIBIT 4-5. ADDITIONAL COSTS PER SURVEY DUE TO DOLPHIN SHUTDOWNS AND POWER DOWNS

PERMIT TYPE	PERCENT OF DAYS WITH DOLPHIN SHUTDOWN (EXHIBIT 4-3) [A]	PERCENT OF DAYS WITH DOLPHIN POWER DOWNS (EXHIBIT 4-3) [B]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [C]	ADDITIONAL HOURS PER SHUTDOWN* [D]	ADDITIONAL HOURS PER POWER DOWN** [E]	TOTAL ADDED DAYS (24 HOURS) DUE TO SHUTDOWN [F = A × C × D / 24]	TOTAL ADDED DAYS (24 HOURS) DUE TO POWER DOWN [G = B × C × E / 24]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [H]	AVERAGE COST OF DOLPHIN SHUTDOWNS PER SURVEY*** [I = (F × H) + (G × H)]
2D	1.4%	6.7%	176	7.6 to 8	0 to 6	0.8	0 to 2.9	$97,500	$76,100 - $361,000
2D-OBS	1.4%	6.7%	141	2.6 to 4	0 to 2	0.2	0 to 0.8	$372,000 - $542,000	$79,900 - $542,000
3D	1.4%	6.7%	137	5.6 to 12	0 to 10	0.4	0 to 3.8	$325,000	$146,000 - $1,380,000
3D-OBS	1.4%	6.7%	141	2.6 to 4	0 to 2	0.2	0 to 0.8	$600,000 - $770,000	$129,000 - $769,000
WAZ	1.4%	6.7%	178	13.6 to 14	0 to 12	1.4	0 to 5.9	$875,000	$1,230,000 - $6,410,000
Airgun HRG	1.4%	6.7%	10	2.6 to 4	0 to 2	0.01	0 to 0.1	$33,500	$483 - $2,250
VSP	1.4%	6.7%	7	2.6 to 4	0 to 2	0.03	0 to 0.04	$33,500 - $71,400	$356 - $3,530
SWD	1.4%	6.7%	7	2.6 to 4	0 to 2	0.01	0 to 0.04	$33,500 - $71,400	$356 - $3,530

Sources:
Barkaszi *et al*. (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Additional hours per shutdown is the sum of the estimated shutdown time (1.6-2 hours) and the additional time to reshoot, as described in Exhibit 4-4.
** Additional hours per power down ranges from zero in the low-end (no reshoot needed) to the additional time associated with reshoots in the high-end.
*** Column I may not equal (F * H + G * H) due to rounding.

PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Water and Associated Mitigation for Whale Observations

Under the Pre-Stay Agreement Baseline, PSOs and shutdowns for observations of whales within the exclusion zone are required in water depths greater than 200 meters in the Western and Central Planning Areas and in all water depths in the Eastern Planning Area. The Proposed Rule requires that seismic airgun surveys in water depths less than 200 meters in the Western and Central Planning Areas also include PSOs and shutdowns for observations of whales. This analysis calculates the additional operational costs associated with having PSOs on board survey vessels, as well as the efficiency losses associated with shutdowns due to PSO detections of whales. We applied these costs only to forecasted surveys in the Central and Western Planning Areas expected to occur in water depths less than 200 meters.

- *Step 1: Estimate frequency of PSO detections of whale species.*

To estimate the efficiency losses due to the PSO requirement, we again rely on the marine mammal sighting data from Barkaszi *et al.* (2012). Barkaszi *et al.* found that whales were sighted within the 500-meter airgun exclusion zone on average 0.7 times per 1,000 hours of observation. Assuming 12 hours of observation per day, this translates to shutdowns for whales on 0.9 percent of days.

- *Step 2: Estimate additional time (days) required for surveys due to shutdowns.*

This analysis again references the estimated average shutdown (1.6 to 2 hours) and reshoot time from the 2014 IAGC survey (see Exhibit 4-4) in order to calculate the increased time required to complete a seismic airgun survey in shallow water.

- *Step 3: Calculate costs per survey as product of additional survey days and daily vessel operating costs.*

To monetize these efficiency losses, we multiply the additional number of survey days by the average vessel daily operating cost to estimate the total cost of additional shutdowns per non-airgun survey, as described in Exhibit 4-6.

- *Step 4: Estimate additional operational costs for PSOs.*

IAGC and CSA estimate that PSO wages range between $200 and $500 per day in the GOM, and shift change costs range between $100 and $150 per PSO. Using these estimates and the average survey duration from the BOEM G&G permit history, we calculate average PSO operational costs over the duration of a survey for each survey type, as described in Exhibit 4-10.

EXHIBIT 4-6. ADDITIONAL COSTS DUE TO WHALE SHUTDOWNS PER SHALLOW WATER SURVEY

PERMIT TYPE	PERCENT OF DAYS WITH WHALE SHUTDOWNS [A]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [B]	ADDITIONAL HOURS PER SHUTDOWN* [C]	TOTAL ADDED DAYS (24 HOURS) DUE TO SHUTDOWN [D = A × B × C / 24]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [E]	AVERAGE COST OF WHALE SHUTDOWNS PER SHALLOW SURVEY** [F = D × E]
2D	0.9%	176	7.6 to 8	0.49 to 0.52	$97,500	$48,200 - $50,700
2D-OBS	0.9%	141	2.6 to 4	0.14 to 0.21	$372,000 - $542,000	$50,600 - $113,000
3D	0.9%	137	5.6 to 12	0.28 to 0.61	$325,000	$92,400 - $198,000
3D-OBS	0.9%	141	2.6 to 4	0.14 to 0.21	$600,000 - $770,000	$81,600 - $161,000
WAZ	0.9%	178	13.6 to 14	0.89 to 0.92	$875,000	$782,000 - $805,000
Airgun HRG	0.9%	10	2.6 to 4	0.01 to 0.01	$33,500	$306 - $471
VSP	0.9%	7	2.6 to 4	0.007 to 0.010	$33,500 - $71,400	N/A
SWD	0.9%	7	2.6 to 4	0.007 to 0.010	$33,500 - $71,400	$225 - $739

Sources:
Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Additional hours per shutdown is the sum of the estimated shutdown time (1.6-2 hours) and the additional time to reshoot, as described in Exhibit 4-4.
**Column F may not equal the product of columns D and E due to rounding.

EXHIBIT 4-7. ADDITIONAL OPERATIONAL COSTS DUE TO PSO OBSERVERS PER SHALLOW WATER SURVEY

PERMIT TYPE	PSO WAGES (PER DAY PER PERSON) [A]	PSO SHIFT CHANGE COST PER PERSON [B]	NUMBER OF VESSELS PER SURVEY [C]	NUMBER OF PSOs PER VESSEL [D]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [E]	AVERAGE NUMBER OF SHIFT CHANGES [F]	TOTAL PSO OPERATIONAL COST [G = (A × C × D × E) + (B × F)]
2D	$200 to $500	$100 to $150	1	3	176	3.7	$107,000 to $266,000
2D-OBS	$200 to $500	$100 to $150	1 to 3	3	141	2.7	$85,700 to $640,000
3D	$200 to $500	$100 to $150	1	3	137	2.6	$83,200 to $207,000
3D-OBS	$200 to $500	$100 to $150	1 to 3	3	141	2.7	$85,700 to $640,000
WAZ	$200 to $500	$100 to $150	2 to 5	3	178	3.7	$216,000 to $1,340,000
Airgun HRG	$200 to $500	$100 to $150	1	3	10	0.0	$5,700 to $14,300
VSP	$200 to $500	$100 to $150	1	3	7	0.0	$1,400 to $3,500
SWD	$200 to $500	$100 to $150	1	3	7	0.0	$1,400 to $3,500

Sources:
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

Additional Mitigation Requirements for PSO Whale Observations

As noted previously, under the pre-stay agreement baseline, survey shutdowns are required when whales are observed within a 500-meter exclusion zone for both deep and shallow penetration surveys. As shutdowns for whale observations in the exclusion zone are required in the baseline, we do not calculate any costs related to these shutdowns for the Proposed Rule.

The Proposed Rule includes an additional shutdown requirement during deep penetration airgun surveys for sightings of Bryde's whale, Kogia species, and beaked whales at any distance. In addition, the Proposed Rule offers some regulatory relief in reducing the size of the exclusion zone for shallow penetration surveys. Whereas the baseline specifies an exclusion zone of 500 meters, the Proposed Rule requires shutdowns only for whale observations within a 200-meter exclusion zone for shallow penetration surveys. Barkaszi *et al.* (2012) does not include information on the fraction of whale observations that occur within 200 meters of the vessel, only providing information on the number of total observations and number of observations within the 500-meter exclusion zone. Consequently, this analysis does not have the information necessary to calculate the potential reduction in costs for shallow penetration surveys. We note, however, that the costs associated with shallow penetrations surveys are low compared to the costs associated with deep penetration surveys. Thus, we do not expect the inability to monetize this cost reduction to significantly affect the findings of the analysis.

As with the dolphin shutdown requirement, the incremental costs of the expanded whale shutdown requirement for deep penetration airgun surveys reflect increased operating costs associated with the additional time required to complete surveys. The method and assumptions applied to estimate these costs are the same as for the dolphin-related shutdowns described above.

- *Step 1: Estimate frequency of observations of Bryde's whale, Kogia species, and beaked whales outside of the exclusion zone.*

The Barkaszi *et al.* (2012) report indicates that, between 2002 and 2008, Bryde's whale, Kogia species, and beaked whales were observed outside the 500 meter exclusion zone 0.3 times per 1,000 hours of observation.[52] Assuming 12 hours of PSO observation per day, this translates to sightings on 0.4 percent of survey days.

- *Step 2: Estimate additional time (days) required for surveys due to shutdowns.*

Based on the IAGC estimated shutdown time following a marine mammal sighting (1.6 to 2 hours) and the reshoot times listed in Exhibit 4-4, we estimate the total number of days added to the typical survey due to shutdowns for whales outside the exclusion zone.

[52] Specifically, Barkaszi *et al*. (2012 specify that 144 whales were detected in the exclusion zone, of which 139 were sperm whales. Thus, five whale sightings were not sperm whales. In addition, Table 2 of the report lists 73 sightings of whales not identified as sperm whales. This analysis accordingly estimates that 93 percent ((73-5)/73) of other (non-sperm whale) whale sightings occurred outside of the exclusion zone. Table 3 additionally describes that the frequency of other whale sightings was 0.36 per 1,000 hours. Assuming 93 percent of these sightings occur outside of the exclusion zone results in a sighting frequency of approximately 0.3 per 1,000 hours.

- *Step 3: Calculate costs per survey as product of additional survey days and daily vessel operating costs.*

We then calculate the incremental cost by multiplying the total number of added days by the daily vessel operating cost (Exhibit 4-2) for each survey type that uses seismic airguns. Exhibit 4-8 summarizes the efficiency losses and associated costs for each survey type due to shutdowns for whale observations beyond the exclusion zone. These per survey costs are summed across the survey forecast (2018-2022) to quantify total incremental costs of the shutdowns for whales outside the exclusion zone.

EXHIBIT 4-8. ADDITIONAL COSTS PER SURVEY DUE TO WHALE SHUTDOWNS FOR OBSERVATIONS OUTSIDE OF EXCLUSION ZONE

PERMIT TYPE	PERCENT OF DAYS WITH WHALE SHUTDOWNS OUTSIDE EZ [A]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [B]	ADDITIONAL HOURS PER SHUTDOWN* [C]	TOTAL ADDED DAYS (24 HOURS) DUE TO SHUTDOWN [D = A × B × C / 24]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [E]	AVERAGE COST OF WHALE SHUTDOWNS OUTSIDE EZ PER SURVEY** [F = D × E]
2D	0.4%	176	7.6 to 8	0.22 to 0.24	$97,500	$21,900 - $23,000
2D-OBS	0.4%	141	2.6 to 4	0.06 to 0.09	$372,000 - $542,000	$23,000 - $51,500
3D	0.4%	137	5.6 to 12	0.13 to 0.28	$325,000	$41,900 - $89,800
3D-OBS	0.4%	141	2.6 to 4	0.06 to 0.09	$600,000 - $770,000	$37,000 - $73,000
WAZ	0.4%	178	13.6 to 14	0.41 to 0.42	$875,000	$355,000 - $365,000
Airgun HRG	0.4%	10	2.6 to 4	0.00 to 0.01	$33,500	$139 - $213
VSP	0.4%	7	2.6 to 4	0.003 to 0.005	$33,500 - $71,400	$102 - $335
SWD	0.4%	7	2.6 to 4	0.003 to 0.005	$33,500 - $71,400	$102 - $335

Sources:
Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Additional hours per shutdown is the sum of the estimated shutdown time (1.6-2 hours) and the additional time to reshoot, as described in Exhibit 4-4.
**Column F may not equal the product of columns D and E due to rounding.

PAM Implementation Requirements and Associated Mitigation for Whale Detections

Under the pre-stay agreement baseline, G&G surveyors are strongly encouraged to use PAM during periods of poor visibility (e.g., fog or nighttime) and would need to employ it in order to ramp-up during poor visibility conditions (otherwise ramp-up would be prohibited). However, there is no regulatory requirement for use of PAM during survey operation under the baseline. As a result, if G&G vessels avoid the need to ramp-up during poor visibility, they do not need PAM equipment and operators on board the vessel.

The Proposed Rule requires use of PAM at all times (24 hours/day) for deep penetration airgun surveys, regardless of visibility, in waters greater than 100 meters in depth. PAM detections of whales (at any distance from the vessel) require shutdowns. The Proposed Rule does not include any additional PAM requirements for shallow penetration airgun surveys. This analysis calculates the additional operational costs associated with PAM equipment and operators on board survey vessels, as well as the efficiency losses associated with shutdowns due to PAM detection of whales.

- *Step 1: Estimate frequency of PAM detections of whale species.*

BOEM estimates that the use of PAM would result in marine mammal detection on 14.9 percent of survey days. BOEM generated this estimate by multiplying the percent of survey days with PSO observations of whales (7.4 percent) by two, to account for the fact that PAM will be used 24 hours a day (compared to 12 hours of PSO observation per day). This effectively assumes PAM detections of whales double the number of shutdowns during the day hours during which both PSOs and PAM are used, and that PAM detects an equal number of whales during nighttime hours as it does during daytime hours.[53]

- *Step 2: Estimate additional time (days) required for surveys due to shutdowns.*

Similar to the expanded PSO requirements, this analysis estimates the incremental time required to conduct G&G surveys as a result of the additional shutdowns (1.6 to 2 hours) and reshoot time (see Exhibit 4-4) necessitated by marine mammal detection from PAM.

- *Step 3: Calculate costs per survey as product of additional survey days and daily vessel operating costs.*

To monetize these efficiency losses, we multiply the additional number of survey days by the average vessel daily operating cost to estimate the total cost of additional shutdowns per deep penetration airgun survey, as described in Exhibit 4-9.

[53] BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

EXHIBIT 4-9. ADDITIONAL COSTS PER SURVEY DUE TO WHALE SHUTDOWNS FROM PAM DETECTIONS

PERMIT TYPE	PERCENT OF DAYS WITH PAM SHUTDOWNS [A]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [B]	ADDITIONAL HOURS PER SHUTDOWN* [C]	TOTAL ADDED DAYS (24 HOURS) DUE TO SHUTDOWN [D = A × B × C / 24]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [E]	AVERAGE COST OF PAM SHUTDOWNS PER SURVEY** [F = D × E]
2D	14.9%	176	7.6 to 8	8.3 to 8.7	$97,500	$981,000 - $1,160,000
2D-OBS	14.9%	141	2.6 to 4	2.3 to 3.5	$372,000 - $542,000	$990,000 - $2,650,000
3D	14.9%	137	5.6 to 12	4.8 to 10.2	$325,000	$1,690,000 - $3,560,000
3D-OBS	14.9%	141	2.6 to 4	2.3 to 3.5	$600,000 - $770,000	$1,510,000 - $3,450,000
WAZ	14.9%	178	13.6 to 14	15.0 to 15.4	$875,000	$13,500,000 - $15,000,000
VSP	14.9%	7	2.6 to 4	0.1 to 0.2	$33,500 - $71,400	$21,200 - $35,300
SWD	14.9%	7	2.6 to 4	0.1 to 0.2	$33,500 - $71,400	$21,200 - $35,300

Sources:
Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Additional hours per shutdown is the sum of the estimated shutdown time (1.6-2 hours) and the additional time to reshoot, as described in Exhibit 4-4.
**Column F may not equal the product of columns D and E due to rounding.

❖ *Step 4: Estimate additional operational costs for PAM equipment and observers.*

In addition to these efficiency losses, G&G operators may incur additional costs for PAM equipment and wages for PAM operators. Data from BOEM indicate that 74 percent of surveys conducted between 2010 and June 2013 included PAM equipment and two PAM operators on board.[54] This reflects recent industry practice to have the capacity to utilize PAM under the baseline. As a result, this analysis assumes that these surveys only incur the incremental costs of including an additional two PAM operators on board to accommodate 24 hour use of PAM. For the remaining 26 percent of surveys not expected to bear any PAM costs under the baseline, this analysis assumes that the full PAM installation and associated labor costs are incremental costs of the Proposed Rule.

IAGC and Continental Shelf Associates (CSA), which conduct G&G surveys in the GOM, provided estimates of the average cost of PAM installation, rental, mobilization/demobilization, operator wages, and operator shift change costs, as presented in Exhibit 4-10a. We calculated average PAM operator wages, rental, training, and shift change costs per survey based on the estimates of average survey duration from the BOEM G&G permit history. We then added the fixed costs associated with PAM installation and mobilization/demobilization to estimate the total wage and capital costs associated with the addition of PAM to a G&G survey, as described in Exhibit 4-10b. We did not include training costs for third party operators in these total wage and capital costs. BOEM is taking comment on how frequently G&G surveyors are likely to incur third party PSO training costs, if at all, as a result of the proposed rule.

[54] Personal communication between IEc and BOEM Biologist on July 28, 2017. As G&G surveys are only required to use PAM to ramp-up in low visibility in the baseline, we assume that these surveys only include two PAM operators, as opposed to four for 24-hour PAM.

EXHIBIT 4-10A. PAM COSTS

PERMIT TYPE	PAM INSTALLATION COST (PER VESSEL) [a] [A]	PAM MOB/DEMOB COST (PER VESSEL)[b] [B]	PAM RENTAL COST (PER DAY PER BOAT) [C]	PAM WAGES (PER DAY PER PERSON) [D]	PAM SHIFT CHANGE COST PER PERSON[c] [E]	NUMBER OF VESSELS PER SURVEY[D] [F]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [G]	AVERAGE NUMBER OF SHIFT CHANGES [H]	NUMBER OF PAM OPERATORS[E] [I]
2D	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1	176	3.7	4
2D-OBS	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1 to 3	141	2.7	4
3D	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1	137	2.6	4
3D-OBS	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1 to 3	141	2.7	4
WAZ	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	2 to 5	178	3.7	4
VSP	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1	7	0.0	4
SWD	$2,400 to $3,000	$40,000	$600	$300 to $600	$100 to $150	1	7	0.0	4

Sources:
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
Notes:
[a] Installation usually requires 2 people for 2 days @ $750 / day plus travel expenses.
[b] A large portion of the mobilization and demobilization costs is the shipping of PAM systems.
[c] Shift change costs include items such as transit, meals, hotels, and insurance.
[d] We assume that each source vessel has PAM based on personal communication with BOEM Biologist on May 10, 2017.
[e] We assume that 24 hour PAM requires 4 operators based on the information provided in the Final PEIS. BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

EXHIBIT 4-10B. PAM COSTS

PERMIT TYPE	PAM TOTAL FIXED COST [J = (A + B) × F]	PAM TOTAL VARIABLE COST PER DAY [K = (C × F) + (D × I × F)]	PAM TOTAL COST PER SHIFT CHANGE [L = (E × F × I]	TOTAL COST OF PAM PER SURVEY* [M = J + (K × G) + (L × H)]
2D	$42,400 to $43,000	$1,800 to $3,000	$400 to $600	$361,000 - $573,000
2D-OBS	$42,400 to $129,000	$1,800 to $9,000	$400 to $1,800	$298,000 - $1,410,000
3D	$42,400 to $43,000	$1,800 to $3,000	$400 to $600	$291,000 - $457,000
3D-OBS	$42,400 to $129,000	$1,800 to $9,000	$400 to $1,800	$298,000 - $1,410,000
WAZ	$84,800 to $215,000	$3,600 to $15,000	$800 to $3,000	$728,000 - $2,890,000
VSP	$42,400 to $43,000	$1,800 to $3,000	$400 to $600	$55,000 - $64,000
SWD	$42,400 to $43,000	$1,800 to $3,000	$400 to $600	$55,000 - $64,000

Sources:
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

We added these additional operational costs (presented in Column M of Exhibit 4-10B) to 26 percent of forecasted deep penetration airgun surveys to account for additional costs to the expected proportion of surveys that would not have included PAM equipment and operators under the baseline. For the 74 percent of surveys expected to have included PAM equipment and operators under the baseline, we only added the costs associated with increasing the number of PAM operators from 2 to 4. These costs, combined with the efficiency costs of additional marine mammal shutdowns, represent the total incremental costs of the PAM requirement.

PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations

There are no requirements for PSOs or survey shutdowns due to observations of marine mammals for non-airgun surveys under the pre-stay agreement baseline. The Proposed Rule requires that one PSO be on board and that surveys occurring in waters greater than 200 meters depth shut down for observations of whales or large dolphins within a 200-meter exclusion zone. This analysis calculates the additional operational costs associated with having PSOs on board survey vessels, as well as the efficiency losses associated with shutdowns due to PSO detections of whales and large dolphins.

BOEM estimates that 95 percent of HRG surveys will not use airguns (i.e., non-airgun HRG surveys). Additionally, BOEM estimates that 100 percent of the forecasted non-airgun HRG surveys will use sound sources with frequencies below 200 kHz, and thus will need to comply with the PSO Program for Non-Airgun HRG surveys.[55] BOEM's activity forecast distinguishes between surveys expected to occur in shallow waters (<200m water depth) and deep waters (>200m water depth). We apply the costs associated with the PSO requirement and whale shutdowns to only the approximately 35 percent of forecasted non-airgun HRG surveys that are expected to occur in deep waters.

- *Step 1: Estimate frequency of PSO detections of large dolphins and whale species.*

To estimate the efficiency losses due to the PSO requirement, we again rely on the marine mammal sighting data from Barkaszi *et al.* (2012). Barkaszi *et al.* found that whales were sighted within the 500-meter airgun exclusion zone on average 0.7 times per 1,000 hours of observation. Additionally, Barkaszi *et al.* found that large dolphins were sighted within the 500-meter exclusion zone 1.2 times per 1,000 hours of observation. Assuming 12 hours of observation per day, this translates to shutdowns for whales and large dolphins on 2.3 percent of days.

- *Step 2: Estimate additional time (days) required for surveys due to shutdowns.*

This analysis again references the estimated average shutdown (1.6 to 2 hours) and reshoot time from the 2014 IAGC survey (see Exhibit 4-4) in order to calculate the increased time required to complete a non-airgun survey.

[55] Personal communication between CSA and BOEM geophysicist on December 8, 2016.

- *Step 3: Calculate costs per survey as product of additional survey days and daily vessel operating costs.*

To monetize these efficiency losses, we multiply the additional number of survey days by the average vessel daily operating cost to estimate the total cost of additional shutdowns per non-airgun survey, as described in Exhibit 4-11.

- *Step 4: Estimate additional operational costs for PSOs.*

IAGC and CSA estimate that PSO wages range between $200 and $500 per day in the GOM, and shift change costs range between $100 and $150 per PSO. Using these estimates and the average HRG survey duration from the BOEM G&G permit history, we calculate average PSO operational costs over the duration of an HRG survey, as described in Exhibit 4-12. As mentioned previously, we only apply these costs to forecasted surveys in water depths less than 200 meters.

EXHIBIT 4-11. ADDITIONAL COSTS PER SURVEY DUE TO WHALE AND DOLPHIN SHUTDOWNS DURING NON-AIRGUN SURVEYS

PERMIT TYPE	PERCENT OF DAYS WITH WHALE AND DOLPHIN SHUTDOWNS [A]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [B]	ADDITIONAL HOURS PER SHUTDOWN* [C]	TOTAL ADDED DAYS (24 HOURS) DUE TO SHUTDOWN [D = A × B × C / 24]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [E]	AVERAGE COST OF WHALE AND DOLPHIN SHUTDOWNS PER SURVEY** [F = D × E]
Non-Airgun HRG	2.3%	18	2.6 to 4	0.04 to 0.07	$33,500	$1,490 - $2,290

Sources:
Barkaszi *et al.* (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region.
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Additional hours per shutdown is the sum of the estimated shutdown time (1.6-2 hours) and the additional time to reshoot using OBN surveys as a proxy for non-airgun HRG surveys, as described in Exhibit 4-4.
**Column F may not equal the product of columns D and E due to rounding.

EXHIBIT 4-12. ADDITIONAL OPERATIONAL COSTS PER SURVEY DUE TO PSO OBSERVERS

PERMIT TYPE	PSO WAGES (PER DAY PER PERSON) [A]	PSO SHIFT CHANGE COST PER PERSON [B]	NUMBER OF VESSELS PER SURVEY [C]	NUMBER OF PSOs PER VESSEL [D]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [E]	AVERAGE NUMBER OF SHIFT CHANGES [F]	TOTAL PSO OPERATIONAL COST [G = (A × C × D × E) + (B × F)]
Non-Airgun HRG	$200 to $500	$100 to $150	1	1	18	0.2	$3,610 to 9,010

Sources:
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

Other Operational and Administrative Costs

The Proposed Rule includes additional reporting and operational requirements that we anticipate would generate minor or negligible, if any, additional costs for G&G surveys in the GOM, as follows:

- Vessels Deep penetration airgun surveys and non-airgun HRG surveys in water depths greater than 200 meters are required to provide pedestal-mounted "bigeye" binoculars for PSOs. Given NMFS' and BOEM's experience with G&G surveys in the GOM, this analysis expects that the use of "bigeye" binoculars is standard industry practice. Accordingly, we do not anticipate that including this specification increases the costs of the Proposed Rule.
- The Proposed Rule requires that all observers (PSOs): a) must have appropriate training and must be third-party (i.e., not crew members); b) at least one visual PSO must have a minimum 90 days relevant experience, completed not less than 18 months prior; and c) all at least two acoustic PSOs must have a minimum 90 days relevant experience, completed not less than 18 months prior. Based on NMFS' and BOEM's experience with G&G surveys in the GOM, this analysis expects that the industry generally relies on experienced third-party PSOs. Accordingly, we do not anticipate that including this specification increases the costs of the Proposed Rule.
- All surveys (with exception of non-airgun HRG using sources > 200kHz) must submit reports within 90 days of the conclusion of the survey concerning the activity conducted, observations of marine mammals, and details of mitigation implementation, as applicable. Submitting final monitoring reports is standard industry practice in most places.[56] Even in the case that G&G surveys would not develop this report as part of the baseline, it is expected to be a very low level of effort given the bi-weekly existing reporting requirements they already undertake in the baseline. We therefore find that any additional costs associated with providing this report would be negligible.

In addition, the Proposed Rule has the potential to generate some cost savings due to reduced administrative effort required to obtain incidental take authorization. There are two types of incidental take authorizations. An Incidental Harassment Authorization (IHA) is required if an action has the potential to result in harassment (injury or disturbance) to a marine mammal. Absent the rule, G&G surveys in the GOM would be required to apply for an IHA. On the other hand, a Letter of Authorization (LOA) is required for harassment that is planned as part of future actions for up to five years (e.g., for a rulemaking). Under the Proposed Rule, NMFS would issue a LOA for G&G surveys in the GOM that comply with the rule requirements precluding the need for IHAs for each survey. In this way, the rule would reduce the administrative effort required of industry and regulatory agencies to acquire the necessary authorization for incidental take

[56] Personal communication between IEc, NMFS, and BOEM on August 16, 2017.

of marine mammals over the five-year timeframe of the rule. The potential for this reduced administrative effort to result in cost savings would offset some of the additional compliance costs at both the low end and the high end of the Proposed Rule costs. Absent information on the relative administrative effort for IHAs in the GOM versus an LOA for this rule, we do not quantify these potential cost savings but note that this contributes to an overall conservative estimate of the direct costs of the Proposed Rule.

Summary of Incremental Costs by Mitigation Measure

Exhibit 4-13 summarizes the estimated incremental costs per survey for each mitigation measure and survey type.

EXHIBIT 4-13. AVERAGE INCREMENTAL COSTS BY MITIGATION MEASURE (2016$)

SURVEY TYPE	EXPANDED PSO PROGRAM: DOLPHINS	PSO PROGRAM FOR AIRGUN SURVEYS IN SHALLOW WATERS	EXPANDED PSO PROGRAM: WHALES	USE OF PAM REQUIRED	PSO PROGRAM FOR NON-AIRGUN HRG SURVEYS	TOTAL INCREMENTAL COST
2D	$76,100 - $361,000	$155,000 - $361,000	$21,900 - $23,000	$981,000 - $1,160,000	N/A	$1,230,000 - $1,860,000
2D-OBS	$79,900 - $542,000	$136,000 - $542,000	$23,000 - $51,500	$990,000 - $2,650,000	N/A	$1,230,000 - $3,990,000
3D	$146,000 - $1,380,000	$176,000 - $1,380,000	$41,900 - $89,800	$1,690,000 - $3,560,000	N/A	$2,050,000 - $5,440,000
3D-OBS	$129,000 - $769,000	$167,000 - $769,000	$37,000 - $73,000	$1,510,000 - $3,450,000	N/A	$1,840,000 - $5,090,000
WAZ	$1,230,000 - $6,410,000	$998,000 - $6,410,000	$355,000 - $365,000	$13,500,000 - $15,000,000	N/A	$16,100,000 - $24,000,000
Airgun HRG	$483 - $2,250	$6,010 - $2,250	$139 - $213	N/A	N/A	$6,630 - $17,200
Non-airgun HRG	N/A	NA	N/A	N/A	$5,100 - $11,300	$5,100 - $11,300
VSP	$356 - $3,530	$1,630 - $3,530	$102 - $335	$21,200 - $35,300	N/A	$23,300 - $43,400
SWD	$356 - $3,530	$1,630 - $3,530	$102 - $335	$21,200 - $35,300	N/A	$23,300 - $43,400

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. The costs associated with seasonal restrictions and area closures are not quantified. Section 4.3 discusses the potential impacts of these mitigation measures.

4.2.3 COSTS OF THE MORE STRINGENT ALTERNATIVE MITIGATION MEASURES

NMFS is also considering additional regulatory requirements as an alternative to the Proposed Rule described above. The More Stringent Alternative includes additional requirements for survey shutdowns to mitigate impacts of G&G surveys on marine mammals as follows:

1. **Mitigation Requirements for PSO Dolphin Observations:** In line with the Proposed Rule, the More Stringent Alternative requires seismic airgun survey shutdowns for large dolphins identified within the 500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys. The Proposed Rule and More Stringent Alternative differ in terms of mitigation for small dolphins. The Proposed Rule requires power downs for all observations of small dolphins within the exclusion zone whereas the More Stringent Alternative requires shutdowns for observations of non-bow-riding dolphins but does not require shutdown or power down for bow-riding small dolphins.

   We employed the same methods as described above to quantify the costs of shutdowns for non-bow-riding small dolphins under the More Stringent Alternative. This method relied on information on: a) the fraction of small dolphin observations that exhibit bow-riding-behavior in the exclusion zone;[57] b) the additional time required for surveys as a result of these shutdowns (1.6 to 2 hours shut down plus time required to reshoot (see Exhibit 4-4)); and b) the costs per survey day by survey time (see Exhibit 4-2).

   At the low-end, the More Stringent Alternative results in a higher cost for mitigation requirements for PSO dolphin observations than the Proposed Rule. However, the More Stringent Alternative high-end cost is lower than the Proposed Rule high-end cost. This is because power downs are required for observations of all small dolphins regardless of bow-riding behavior in the Proposed Rule, and at the high-end this analysis assumes that all power downs require reshoots.

2. **PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Waters and Associated Mitigation for Whale Observations:** The More Stringent Alternative matches the Proposed Rule in requiring that seismic airgun surveys in water depths less than 200 meters in the Western

[57] The Barkaszi *et al.* report states that 33 percent of dolphin observations included bow-riding behavior. Additionally, based on data provided in this report, we calculate that the Barkaszi report indicates that 70.6 percent of dolphin observations were of small dolphins. Table 2 of the report provides the sighting frequency for each dolphin species, indicating that small dolphins were observed 8.1 times per 1,000 hours and that the frequency of all dolphin observations was 11.57 per 1,000 hours. Thus, the percentage of small dolphin observations is 70.6% (8.1/11.57). Assuming that all of the bow-riding observations are of small dolphins, we estimate that 47 percent of small dolphin observations include bow-riding (0.33 / 0.706 = 0.467).

and Central Planning Areas include PSOs and shutdowns for observations of whales. Costs for PSO implementation (operational costs) and associated mitigation (efficiency losses associated with shutdowns) for seismic airgun surveys in shallow waters are therefore the same as for the Proposed Rule.

3. **Additional Mitigation Requirements for PSO Whale Observations:** While the Proposed Rule only requires shutdowns for observations of Bryde's whale, Kogia species, and beaked whales outside the exclusion zone, the More Stringent Alternative also requires shutdowns for sperm whales outside the exclusion zone.

   We employed the same methods as described above to quantify additional costs of shutdowns for sperm whale observations beyond the exclusion zone under the More Stringent Alternative. This method relied on information on: a) the frequency of sperm whale observations beyond the exclusion zone (6.2 percent of survey days);[58] b) the additional time required for surveys as a result of these shutdowns (1.6 to 2 hours shut down plus time required to reshoot (see Exhibit 4-4)); and b) the costs per survey day by survey time (see Exhibit 4-2).

4. **PAM Implementation Requirements and Associated Mitigation for Whale Detections:** The More Stringent Alternative matches the Proposed Rule requirements for PAM in requiring implementation of PAM constantly (24 hours/day) for deep penetration airgun surveys. PAM detections of any whales requires shutdown of deep penetration seismic airgun surveys. Costs for PAM implementation (operational costs) and associated mitigation (efficiency losses associated with shutdowns) are therefore the same as for the Proposed Rule.

5. **PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations:** The More Stringent Alternative matches the Proposed Rule requirements for non-airgun surveys in requiring that non-airgun surveys in deep water (greater than 200 meters depth) include PSO observers and shutdowns for observations of any whales and of large dolphins within a 200-meter exclusion zone. Costs for PSO implementation (operational costs) and associated mitigation (efficiency losses associated with shutdowns) for non-airgun surveys are therefore the same as for the Proposed Rule.

6. **Operational and Administrative Requirements:** Additional operational and administrative requirements of the More Stringent Alternative match

[58] Barkaszi *et al*. (2012). "Seismic Survey Mitigation Measures and Marine Mammal Observer Reports." Published by BOEM, GOM OCS Region. Table 2 on page 11 lists 1,136 sperm whale observations and 5.84 observations per 1,000 hours. Page 1 states that 139 sperm whales were observed in the exclusion zone. This indicates that 88% (1-(139/1,136)) of observations occurred outside the outside exclusion zone. This equates to 5.1 observations outside the exclusion zone per 1,000 hours of observation. Assuming 12 hours per PSO observation per day, 1,000 hours is equivalent to 83.33 survey days. Accordingly, 5.1 observations per 83.33 survey days is equivalent to observations on 6.2% of survey days.

those of the Proposed Rule reporting requirements, PSO experience requirements including specifying use of "bigeye" binoculars, and potential cost saving associated with the issuance of an LOA precluding the need for survey-specific IHAs. As for the Proposed Rule, we expect minor to negligible costs associated with these elements of the More Stringent Alternative.

Exhibit 4-14 displays the average incremental costs for the mitigation measures included in the More Stringent Alternative.

EXHIBIT 4-14. AVERAGE INCREMENTAL COSTS BY MITIGATION MEASURE (2016$)

PERMIT TYPE	EXPANDED PSO PROGRAM: DOLPHINS	EXPANDED PSO PROGRAM: WHALES	USE OF PAM REQUIRED	PSO PROGRAM FOR NON-AIRGUN HRG SURVEYS
2D	$293,000 - $309,000	$356,000 - $375,000	$981,000 - $1,160,000	N/A
2D-OBS	$308,000 - $690,000	$374,000 - $838,000	$990,000 - $2,650,000	N/A
3D	$562,000 - $1,200,000	$683,000 - $1,460,000	$1,690,000 - $3,560,000	N/A
3D-OBS	$496,000 - $979,000	$602,000 - $1,190,000	$1,510,000 - $3,450,000	N/A
WAZ	$4,760,000 - $4,900,000	$5,780,000 - $5,950,000	$13,500,000 - $15,000,000	N/A
Airgun HRG	$1,860 - $2,860	$2,260 - $3,480	N/A	N/A
Non-airgun HRG	N/A	N/A	N/A	$5,100 - $11,300
VSP	$1,370 - $4,500	$1,660 - $5,460	$21,200 - $35,300	N/A
SWD	$1,370 - $4,500	$1,660 - $5,460	$21,200 - $35,300	N/A

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. The costs associated with seasonal restrictions and area closures are not quantified. Section 4.3 discusses the potential impacts of these mitigation measures.

4.2.4 TOTAL COMPLIANCE COSTS

This analysis sums the unit costs per survey associated with each relevant mitigation measure to estimate total direct compliance costs by survey type for the Proposed Rule and the More Stringent Alternative (Exhibit 4-15). As previously noted, these direct compliance costs do not reflect impacts of the seasonal restrictions or area closures (as discussed in Section 4.3).

To estimate total compliance costs over the timeframe of the rule, we multiplied the incremental survey costs by projected survey activity over the 2018 to 2022 timeframe of this analysis. This forecast was developed by BOEM based on an analysis of historic activity levels and recent activity trends and in response to public comments received on the draft PEIS evaluating future G&G activities in the GOM.[59] The low end of the survey forecast takes into account the recent slowdown in G&G activity, although BOEM assumes that future activity levels will return to historical levels within the next ten years at the high end. We confirmed with the IAGC and API that the high-end activity forecast is a reasonable estimate for future survey activities from the perspective of industry.[60]

BOEM forecasted G&G activities separately for each OCS planning area and distinguished between surveys expected to occur in deep and shallow waters. For the purposes of estimating costs, we sum all forecasted surveys of the same type that occur in the same year and planning area. BOEM's activity forecast does not identify which portion of future 2D and 3D surveys will employ OBS technology. As a result, our analysis assumes that approximately ten percent of future 2D surveys and 50 percent of future 3D surveys would use OBS technology, based on the proportion observed in the G&G permit history. Exhibits 4-16 and 4-17 display the forecast of G&G activities by survey type from 2018 to 2022, as well as the historical activity levels observed in the permit history from 2001 to 2015.

[59] BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

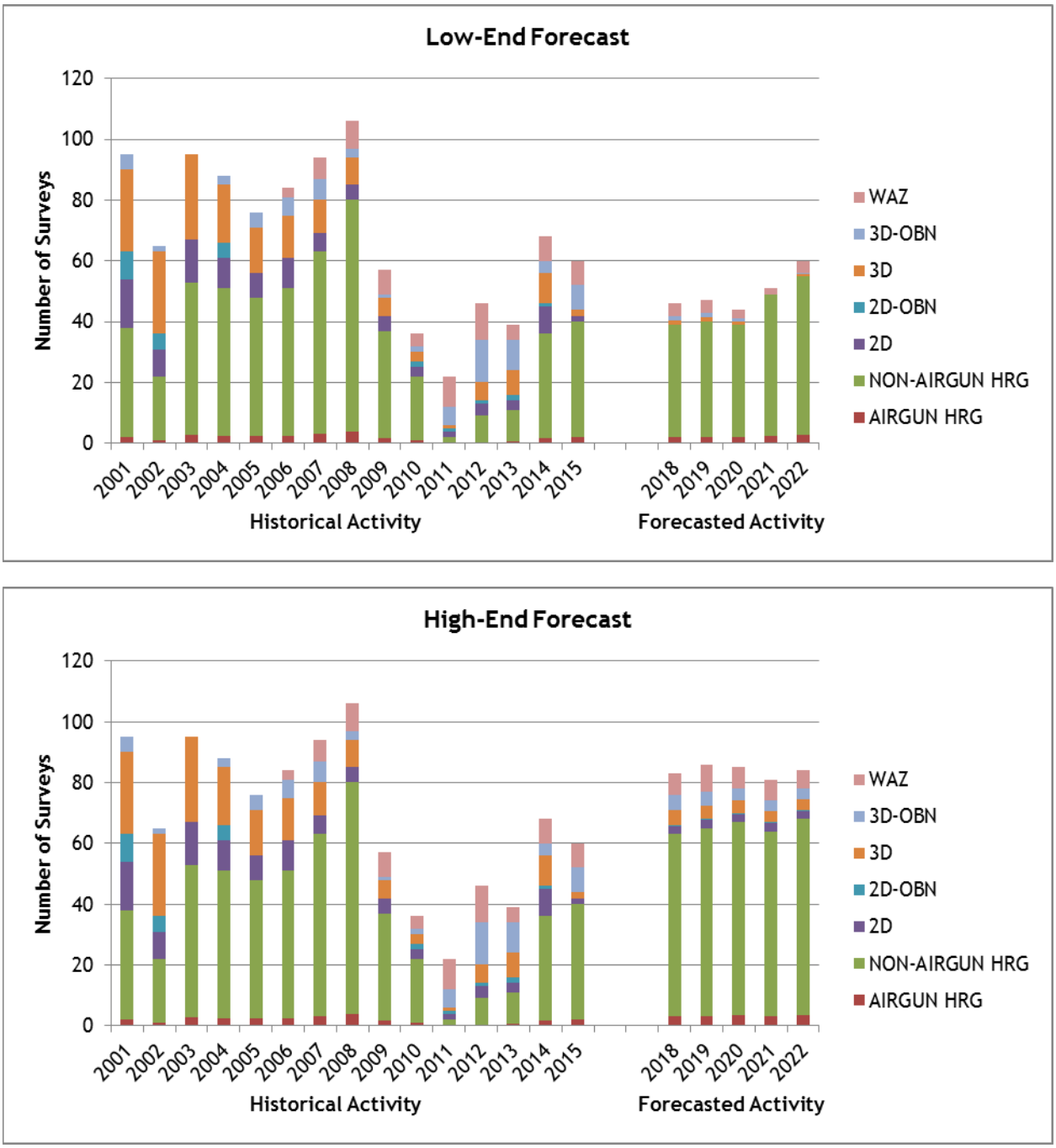
[60] Personal communication between IEc, IAGC, and API. December 15, 2016.

EXHIBIT 4-15. TOTAL COMPLIANCE COSTS PER SURVEY BY SURVEY TYPE (2016$)

SCENARIO	SURVEY TYPE								
	2D	2D-OBS	3D	3D-OBS	WAZ	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD
Proposed Rule	$1,230,000 - $1,860,000	$1,230,000 - $3,990,000	$2,050,000 - $5,440,000	$1,840,000 - $5,090,000	$16,100,000 - $24,000,000	$6,600 - $17,000	$5,100 - $11,300	$23,270 - $43,000	$23,270 - $43,000
(Percent Increase)	(5.5% - 8.3%)	(2.1% - 4.9%)	(4.1% - 10.9%)	(2.0% - 4.5%)	(9.7% - 14.0%)	(1.4% - 3.7%)	(0.7% - 1.5%)	(6.2% - 6.8%)	(6.2% - 6.8%)
More Stringent Alternative	$1,790,000 - $2,160,000	$1,810,000 - $4,930,000	$3,110,000 - $6,640,000	$2,770,000 - $6,420,000	$25,000,000 - $28,000,000	$10,100 - $21,000	$5,100 - $11,300	$25,850 - $49,000	$25,850 - $49,000
(Percent Increase)	(8.0% - 9.7%)	(3.1% - 6.0%)	(6.2% - 13.3%)	(3.1% - 5.6%)	(15.1% - 16.4%)	(2.2% - 4.6%)	(0.7% - 1.5%)	(6.9% - 7.7%)	(6.9% - 7.7%)

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. This exhibit reflects incremental costs above the pre-stay agreement baseline. Appendix A presents incremental costs relative to stay agreement-related mitigation measures.

EXHIBIT 4-16. HISTORICAL AND FORECAST ACTIVITIES BY SURVEY TYPE



Sources:

1. BSEE. Public Information Query for G&G. Accessed November, 2016 at: https://www.data.bsee.gov/Other/DiscMediaStore/ScanGGPermits.aspx
2. BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

Note: This chart does not include VSP and SWD surveys due to the lack of reliable historical information on the frequency of these types of surveys.

EXHIBIT 4-17. HISTORICAL AND FORECASTED ACTIVITIES BY SURVEY TYPE

DATA SOURCE	YEAR	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBN	3D	3D-OBN	WAZ
HISTORICAL PERMIT DATA*	2001	2	36	No data	No data	16	9	27	5	0
	2002	1	21			9	5	27	2	0
	2003	3	50			14	0	28	0	0
	2004	3	48			10	5	19	3	0
	2005	2	46			8	0	15	5	0
	2006	3	48			10	0	14	6	3
	2007	3	60			6	0	11	7	7
	2008	4	76			5	0	9	3	9
	2009	2	35			5	0	6	1	8
	2010	1	21			3	2	3	2	4
	2011	0	2			2	1	1	6	10
	2012	0	9			4	1	6	14	12
	2013	1	10			3	2	8	10	5
	2014	2	34			9	1	10	4	8
	2015	2	38			2	0	2	8	8
ACTIVITY FORECAST	2018	2.0 - 3.2	37.1 - 59.9	46.0 - 77.0	6.0 - 12.0	0.0 - 2.7	0.0 - 0.3	1.5 - 5.0	1.5 - 5.0	4.0 - 7.0
	2019	2.0 - 3.3	38.0 - 61.8	37.0 - 65.0	5.0 - 9.0	0.0 - 2.7	0.0 - 0.3	1.5 - 4.5	1.5 - 4.5	4.0 - 9.0
	2020	2.0 - 3.4	37.1 - 63.7	39.0 - 66.0	6.0 - 12.0	0.0 - 2.7	0.0 - 0.3	1.0 - 4.0	1.0 - 4.0	3.0 - 7.0
	2021	2.5 - 3.2	46.6 - 60.8	45.0 - 65.0	7.0 - 13.0	0.0 - 2.7	0.0 - 0.3	0.0 - 3.5	0.0 - 3.5	2.0 - 7.0
	2022	2.8 - 3.4	52.3 - 64.6	45.0 - 59.0	5.0 - 9.0	0.0 - 2.7	0.0 - 0.3	0.5 - 3.5	0.5 - 3.5	4.0 - 6.0

*Sources:
1. BSEE. Public Information Query for G&G. Accessed November, 2016 at: https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5/
Note: Due to the lack of reliable historical information on VSP and SWD survey frequency, this table only shows forecasted VSP and SWD surveys.
2. BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

To calculate the present value and annualized compliance costs over the five-year rule timeframe, we multiply the average incremental survey cost for the Proposed Rule and the More Stringent Alternative by the expected number of surveys of that type in each year. We calculate present values assuming a seven percent real discount rate (Appendix D provides information on present value and annualized costs assuming a three percent real discount rate for comparison).

Exhibit 4-18 summarizes the present value incremental compliance costs for the Proposed Rule and the More Stringent Alternative by GOM planning area over the five-year timeframe. Exhibit 4-19 presents the annualized value of these incremental costs. Both exhibits reflect costs incremental to the pre-stay agreement baseline management of G&G activities in the GOM.

Overall, the annualized direct compliance costs of the Proposed Rule range from $49 million to $182 million. Annualized direct compliance costs of the More Stringent Alternative range from $78 million to $218 million. The wide range of cost estimates under both the Proposed Rule and the More Stringent Alternative is largely driven by the difference between the low-end and high-end activity forecasts. The high-end forecast includes approximately 65 percent more surveys than the low-end forecast. The difference between the low-end and high-end forecasts is particularly pronounced for the survey types with the greatest estimated compliance costs (2D, 3D, and WAZ).

Of note, these cost estimates assume that the level of future G&G activity in the GOM is the same under the baseline, Proposed Rule, and the More Stringent Alternative. That is, the estimate of direct compliance costs assumes that the increased cost of conducting G&G activities, combined with implementation of seasonal restrictions and area closures, does not reduce overall survey activity levels. It is possible that the Proposed Rule or the More Stringent Alternative may reduce overall G&G activity levels in the GOM and, consequently, future overall oil and gas development in the GOM, at least in the short term.[61] If this is the case (as contemplated in Section 4.3), the survey activity forecast may overestimate G&G activity in the GOM.

[61] IAGC, API, and NOIA. (2016). Comments on Draft Programmatic Environmental Impact Statement for Geological & Geophysical Activities on Gulf of Mexico Outer Continental Shelf.

EXHIBIT 4-18. PRESENT VALUE INCREMENTAL COSTS BY SURVEY TYPE AND PLANNING AREA, 2018-2022 (MILLION 2016$, 7% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.01	$0.05 - $0.22	$0.88 - $2.81	$0.00 - $0.30	$0.00 - $5.31	$0.00 - $1.26	$0.00 - $13.97	$0.00 - $12.25	$23.0 - $167.0	$24.0 - $203.2
	Central	$0.02 - $0.08	$0.48 - $1.42	$2.69 - $7.22	$0.48 - $1.35	$0.00 - $5.31	$0.00 - $1.26	$6.81 - $58.45	$6.08 - $51.5	$174.8 - $427	$191.4 - $554
	Eastern	$0.00 - $0.00	$0.00 - $0.05	$0.00 - $0.28	$0.00 - $0.00	$0.00 - $5.31	$0.00 - $1.26	$0.00 - $9.65	$0.00 - $8.21	$0.00 - $15.56	$0.00 - $40.3
	TOTAL	$0.02 - $0.10	$0.54 - $1.7	$3.6 - $10.3	$0.48 - $1.65	$0.00 - $15.9	$0.00 - $3.78	$6.8 - $82.1	$6.1 - $72.0	$198 - $610	$215 - $797
More Stringent Alternative	Western	$0.00 - $0.02	$0.05 - $0.22	$0.99 - $3.25	$0.00 - $0.35	$0.00 - $6.34	$0.00 - $1.62	$0.00 - $17.20	$0.00 - $15.85	$36.7 - $198.2	$37.7 - $243.0
	Central	$0.05 - $0.12	$0.48 - $1.42	$3.01 - $8.30	$0.54 - $1.56	$0.00 - $6.34	$0.00 - $1.62	$10.65 - $71.93	$9.47 - $66.5	$278.6 - $506	$302.8 - $664
	Eastern	$0.00 - $0.00	$0.00 - $0.05	$0.00 - $0.32	$0.00 - $0.00	$0.00 - $6.34	$0.00 - $1.62	$0.00 - $11.94	$0.00 - $10.76	$0.00 - $18.46	$0.00 - $49.5
	TOTAL	$0.05 - $0.15	$0.54 - $1.7	$4.0 - $11.9	$0.54 - $1.91	$0.00 - $19.0	$0.00 - $4.87	$10.6 - $101.1	$9.5 - $93.1	$315 - $723	$341 - $957

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. This exhibit reflects incremental costs above the pre-stay agreement baseline. Appendix A presents incremental costs relative to the stay agreement-related mitigation measures.
3. Cost estimates less than $50,000 are reported as $0 million due to rounding.

EXHIBIT 4-19. ANNUALIZED INCREMENTAL COSTS BY SURVEY TYPE AND PLANNING AREA, 2018-2022 (MILLION 2016$, 7% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.00	$0.01 - $0.05	$0.20 - $0.64	$0.00 - $0.07	$0.00 - $1.21	$0.00 - $0.29	$0.00 - $3.18	$0.00 - $2.79	$5.2 - $38.1	$5.5 - $46.3
	Central	$0.00 - $0.02	$0.11 - $0.32	$0.61 - $1.65	$0.11 - $0.31	$0.00 - $1.21	$0.00 - $0.29	$1.55 - $13.32	$1.39 - $11.7	$39.8 - $97	$43.6 - $126
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.06	$0.00 - $0.00	$0.00 - $1.21	$0.00 - $0.29	$0.00 - $2.20	$0.00 - $1.87	$0.00 - $3.55	$0.00 - $9.2
	TOTAL	$0.01 - $0.02	$0.12 - $0.38	$0.82 - $2.35	$0.11 - $0.38	$0.00 - $3.63	$0.00 - $0.86	$1.55 - $18.7	$1.39 - $16.4	$45.1 - $139	$49 - $182
More Stringent Alternative	Western	$0.00 - $0.00	$0.01 - $0.05	$0.22 - $0.74	$0.00 - $0.08	$0.00 - $1.44	$0.00 - $0.37	$0.00 - $3.92	$0.00 - $3.61	$8.4 - $45.2	$8.6 - $55.4
	Central	$0.01 - $0.03	$0.11 - $0.32	$0.69 - $1.89	$0.12 - $0.36	$0.00 - $1.44	$0.00 - $0.37	$2.43 - $16.40	$2.16 - $15.2	$63.5 - $115	$69.0 - $151
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.07	$0.00 - $0.00	$0.00 - $1.44	$0.00 - $0.37	$0.00 - $2.72	$0.00 - $2.45	$0.00 - $4.21	$0.00 - $11.3
	TOTAL	$0.01 - $0.03	$0.12 - $0.38	$0.91 - $2.71	$0.12 - $0.44	$0.00 - $4.33	$0.00 - $1.11	$2.43 - $23.0	$2.16 - $21.2	$71.9 - $165	$78 - $218

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. This exhibit reflects incremental costs above the pre-stay agreement baseline. Appendix A presents incremental costs relative to the stay agreement-related mitigation measures.
3. Cost estimates less than $50,000 are reported as $0 million due to rounding.

4.3 POTENTIAL INDIRECT COSTS OF CHANGES IN ACTIVITY LEVELS

This analysis considers the potential for the direct compliance costs, in combination with the area closures, to affect future GOM oil and gas exploration and development activity under the Proposed Rule and More Stringent Alternative. As described in the previous section, the direct compliance costs incurred by the G&G industry in response to this rule would raise the overall costs of oil and gas exploration and development.

The expected increase in the direct cost of G&G surveys under the Proposed Rule and More Stringent Alternative, however, is unlikely to materially reduce the level of oil and gas development in the Gulf of Mexico, given that the costs of G&G activities are relatively minor compared to expenditures on drilling, engineering, installation of platforms, and production operations. For instance, Quest Offshore (2014) estimates that G&G activities would account for only three percent of total spending on oil and gas activities in the Eastern Gulf over a 19 year timeframe if the current moratorium were lifted.[62,63] Consequently, a 13 percent increase in G&G costs, as estimated under the Proposed Rule for some surveys, would represent only a 0.4 percent increase in oil and gas development costs overall.[64] Personal communication with IAGC and API confirmed that the direct compliance costs of the regulatory requirements are unlikely to result in materially reduced oil and gas activities in the Gulf of Mexico.[65]

While the increases in G&G survey costs under the Proposed Rule and More Stringent Alternative are unlikely to materially affect the level of oil and gas development activity in the GOM, the seasonal and year-round area closures have the potential to generate reductions in leasing, exploration, and subsequent development activity. While the timeframe of this rule covers just five years (2018-2022), any reductions in seismic data gathering during that five-year period could result in delayed exploration and development of oil and gas resources beyond that five-year timeframe. That is, limiting where G&G surveys can occur over the next five years can have implications on oil and gas development activity in the following years.

The likelihood of the seasonal restrictions and area closures affecting G&G survey levels and, ultimately, oil and gas production is dependent on the factors outlined below. Each of these factors is subject to substantial uncertainty. It would therefore be speculative to draw definitive conclusions regarding the economic impacts of proposed seasonal restrictions and area closures.

---

[62] Quest Offshore. (2014). " The Economic Benefits of Increasing U.S. Access to Offshore Oil and Natural Gas Resources in the Eastern Gulf of Mexico." Prepared for the American Petroleum Institute (API) and the National Ocean Industries Association (NOIA).

[63] Quest Offshore project spending for each of the following activity types: Seismic (G&G), SURF, Platforms, Installation, Drilling, Engineering, and Operating Expenditures.

[64] For instance, Exhibit 4-2 shows that the baseline high-end total cost for a WAZ survey is $171,000,000, and Exhibit 4-11 shows that the incremental compliance cost for a WAZ survey under the Proposed Rule is up to $22,000,000. This represents a 13 percent increase in total survey costs. All other survey types under the Proposed Rule see lower percent cost increases.

[65] Personal communication between IEc, IAGC, and API. December 15, 2016.

- **Oil and gas market conditions:** Demand for G&G data is driven by demand for oil and gas. As described in Chapter 2, recent years have seen a reduction in demand due to relatively low oil prices. Because the oil market tends to be somewhat cyclical, the forecast for future G&G activity reflects the assumption that production of GOM oil and gas will rise in the future with increases in the price of oil, though the timing for this is highly uncertain. In other words, production of oil and gas from the GOM over the narrow timeframe of this analysis is not known with reasonable precision to quantify potential impacts.
- **Relative importance of the area closures to oil and gas production:** The economic implications of seasonal restrictions and area closures depend most directly on the level of activity that would overlap these areas, within the context of broader GOM G&G activity, absent the rule. The forecast of G&G activity levels is not spatially precise within GOM Planning Areas. However, as an indicator of the relative importance of these GOM areas to oil and gas production in the past, the discussion below provides recent historical information on the relative levels of exploration, development and production.
- **The state of existing G&G data covering the areas:** Importantly, the seasonal restrictions and area closures do not directly restrict other offshore oil and gas exploration and development activities, only seismic surveys. Seismic data do exist for the area closures; however, we understand that some of the data are dated and therefore new surveys are required to facilitate efficient exploration and development decisions in these areas.[66] Information specifying the vintage of current seismic data for the closure areas is not available. Therefore, whether existing data are sufficient, or whether exploration, development and ultimate oil and gas production would be delayed in these areas due to restrictions on G&G activities over the next five years is uncertain.
- **Duration of the closure:** Year-round area closures are likely to have greater implications for offshore oil and gas development activity than seasonal area closures. While seasonal area closures have the potential to reduce the number of surveys that occur in a given year, new seismic data to support exploration and development activity may still be collected. Year-round area closures, however, would prevent the acquisition of any new seismic data. Thus, less seismic data would likely be available to industry in the context of a year-round closure. With less information available to inform exploration and development investments, year-round closures are more likely to lead to reduced exploration and development activity than seasonal closures. We do not have sufficient data to quantify the difference in expected impacts from seasonal closures versus year-round closures.

Section 4.3.1 discusses the seasonal area closures specified by the Proposed Rule and More Stringent Alternative in terms of the potential implications on future oil and gas

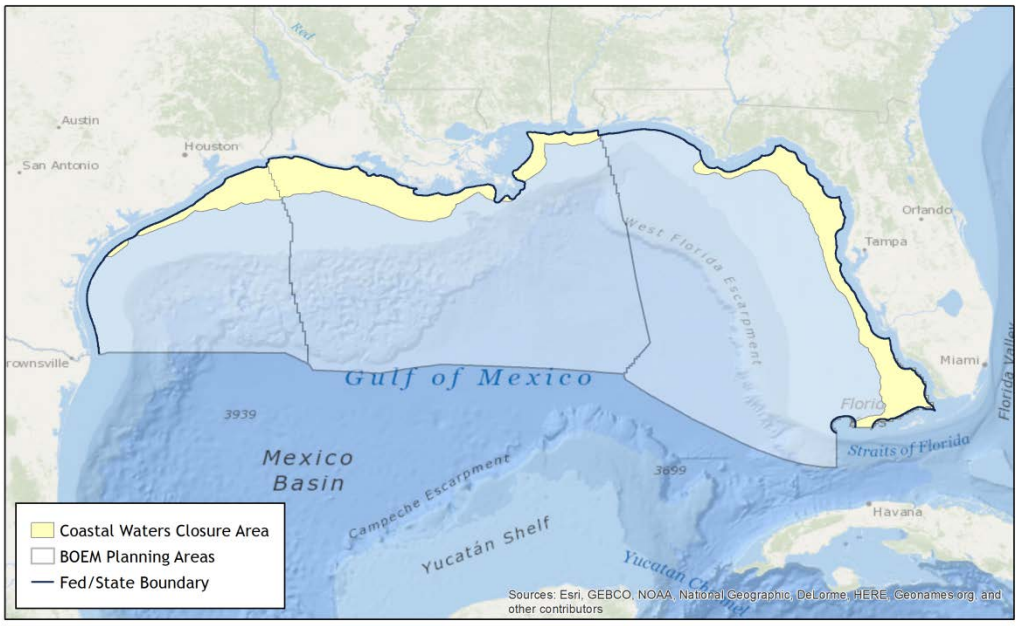
[66] Information provided by BOEM Economist on April 2017.

production. Sections 4.3.2 and 4.3.3 consider the potential effects of the year-round area closures in light of the uncertainties outlined above for the Proposed Rule and More Stringent Alternative, respectively. Overall, the coastal waters seasonal closure is unlikely to have a substantial impact on oil and gas activities, and the Eastern Planning Closure Area is unlikely to result in any short to intermediate term impacts. However, the Central Planning Closure Area would likely reduce oil and gas exploration and development activities.

4.3.1 SEASONAL AREA CLOSURES

The Proposed Rule and the More Stringent Alternative specify the same seasonal restrictions. Thus, this discussion pertains to both. Seasonal restrictions on G&G activity would be in place between February 1st and May 31st in the Coastal Waters Closure Area, as identified in Exhibit 4-20. The Coastal Waters Closure Area includes coastal waters shallower than 20 meters depth. This coastal waters area is mature and remaining hydrocarbon resources are estimated to be mostly deep and ultra-deep gas. If these deep and ultra-deep horizons would be targeted with exploratory drilling, new seismic surveys would likely be required.

EXHIBIT 4-20. MAP OF SEASONAL COASTAL WATERS CLOSURE AREA



During the seasonal closure timeframe, no seismic airgun surveys would be permitted in the Coastal Waters Closure Area. Because the seasonal closure is only in place four months of the year, it is unlikely to permanently prevent the collection of G&G data in the lease blocks that overlap this area. If industry is unable to plan surveys such that it can accomplish the desired seismic data gathering within the remaining eight months of the year, however, the seasonal closures may result in delays with respect to geophysical mapping and subsequent oil and gas development.

As part of a comment letter on BOEM's recent Draft Programmatic Environmental Impact Statement (PEIS) on the G&G program in the GOM, the International Association of Geophysical Contractors (IAGC) and American Petroleum Institute (API) expressed concern that seasonal closures could prevent the oil and gas industry from conducting their desired number of G&G surveys in the closure areas in any given year. As a result, planned surveys in seasonal closure areas would continually be pushed back to succeeding years, delaying the exploration and development of oil and gas resources in these areas.[67] However, depending on the proportion of surveys being conducted in the seasonal closure areas compared to the rest of the GOM, it is also possible that the seasonal closures could instead shift the timing of surveys across the GOM within a given year. For instance, depending on demand for G&G data in these areas in a given year, G&G companies may be able to conduct all planned surveys in the seasonal closure areas while the areas are open by scaling back survey operations in the rest of the GOM. While the seasonal closures are in effect, G&G companies could increase survey operations in the rest of the GOM to compensate for reduced operations over the rest of the year if there are sufficient high-value areas to survey.

Additionally, IAGC and API noted that seasonal closures have the potential to increase the likelihood that seismic surveys would not be completed within the one-year permit timeframe.[68] This concern is unlikely to apply to HRG, VSP, and SWD surveys, as these survey types are completed in 7 to 18 days on average. However, 2D, 3D, and WAZ surveys are considerably more time intensive, and require G&G vessels to remain on the water for an average of 141 to 178 days. Additionally, approximately 19 percent of 2D, 3D, and WAZ surveys between 2012 and 2015 were on the water for more than 245 days (the number of days without seasonal closures). While it may be possible to plan these longer surveys to avoid the closure area during the required months, it is possible that the seasonal closure could disrupt the ability of G&G companies to complete some surveys in a single year with a single permit. If G&G companies were unable to complete surveys within a year, the acquisition of seismic data would be delayed and G&G companies would incur additional permitting, mobilization and demobilization costs. The likelihood of this result depends on the extent to which 2D, 3D, and WAZ surveys may be planned to avoid the restricted areas at the specified time. Absent specific data on the spatial distribution of future G&G surveys, we cannot conclude definitively whether G&G companies could feasibly conduct all planned surveys in the closure areas during the unrestricted seasons.

To the extent that the seasonal closures delay exploration and development of oil and gas resources, the restrictions could reduce economic output and employment in the Gulf

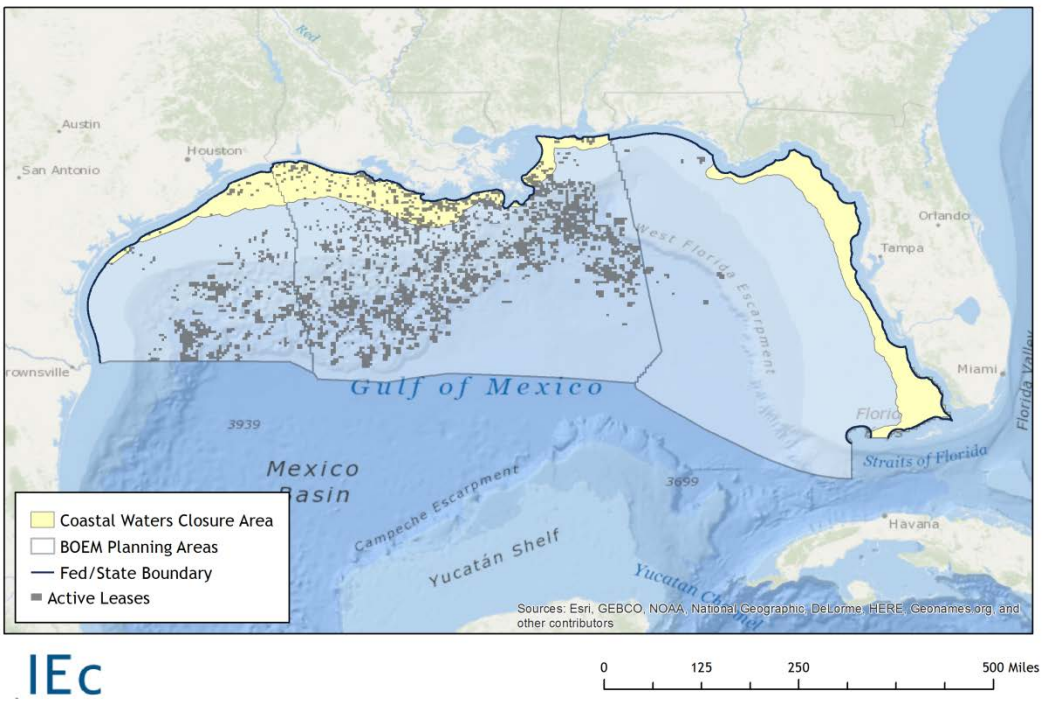
[67] IAGC, API, and NOIA. (2016). Comments on Draft Programmatic Environmental Impact Statement for Geological & Geophysical Activities on Gulf of Mexico Outer Continental Shelf.

[68] Form BOEM-0327 states: "Permitted activities approved for a specified period, including requests for extensions, and activities under a notice may not exceed 1 year." BOEM. 2015. Requirements for Geological and Geophysical Explorations or Scientific Research on the Outer Continental Shelf. Form BOEM-0327. Accessed March 2017 at: https://www.boem.gov/About-BOEM/Procurement-Business-Opportunities/BOEM-OCS-Operation-Forms/BOEM-0327.aspx.

region relative to the baseline. To provide perspective on activity levels, we referenced Geographical Information Systems (GIS) data identifying leases and platforms in the Coastal Waters Closure Area.[69] While locations of leases and platforms are not directly predictive of oil and gas production potential of the area, they provide an indication of the relative levels of industry activity occurring in these areas.

Exhibit 4-21 displays the overlap between active leases in the GOM and the Coastal Waters Closure Area, and Exhibit 4-22 displays the locations of active platforms in relation to the Coastal Waters Closure Area. Overall, the Coastal Waters Closure Area overlaps with 1,244 out of 3,271 active GOM leases (38 percent) and 1,7041,275 out of 2,6742,027 active platforms in the GOM (64 percent).[70]

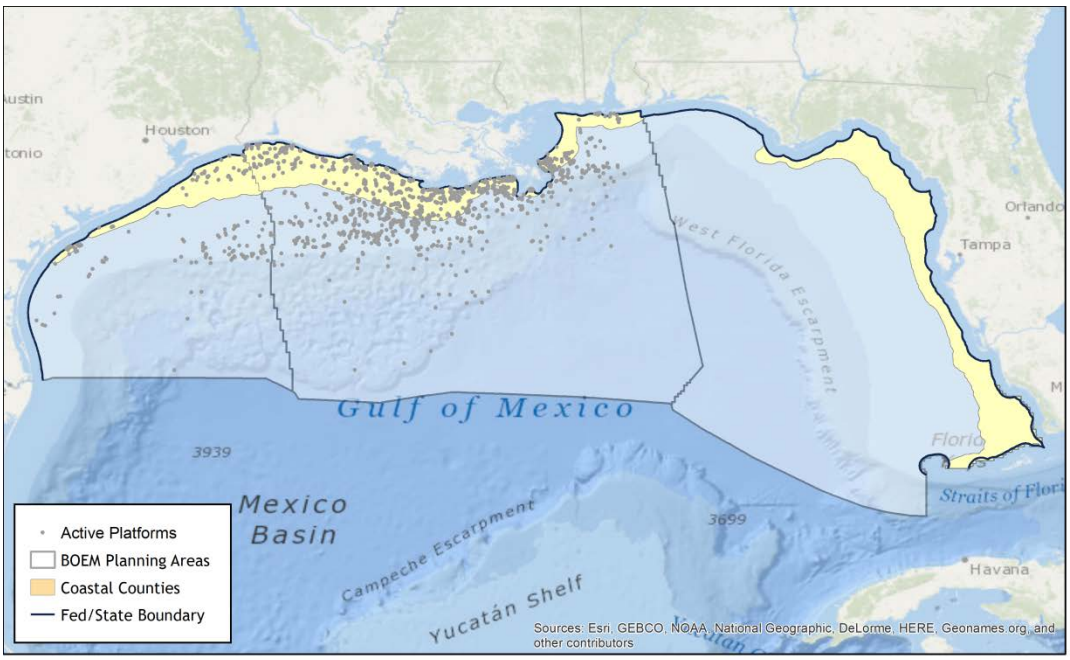
EXHIBIT 4-21. ACTIVE LEASES AND SEASONAL COASTAL WATERS CLOSURE AREA



[69] Leases and platforms were identified from: BOEM. Gulf of Mexico GIS Mapping Data. Accessed December 13, 2016 at: https://www.data.boem.gov/homepg/data_center/mapping/geographic_mapping.asp

[70] BOEM. (2017). BOEM Data Center – Platform Structures Dataset. Accessed December 2017 at: https://www.data.boem.gov/Main/Platform.aspx. The count of active platforms reflects entries in this database with an install date and no removal date.

EXHIBIT 4-22. ACTIVE PLATFORMS AND SEASONAL COASTAL WATERS CLOSURE AREA



In addition to the existing oil and gas production, known oil and gas reserves, and infrastructure in the Coastal Waters Closure Area in the GOM, BOEM assesses Undiscovered Technically Recoverable Resources (UTRR). The portions of the Closure Area in the Western and Central GOM contain parts of fifteen geologic plays,[71] and BOEM estimates that some fraction of the 4.68 billion barrels of oil and 74.41 trillion cubic feet of gas assessed for these geologic plays is located in the Closure Areas.[72] If these resources were to be targeted for exploration and development in the future, additional seismic surveys would likely be necessary.

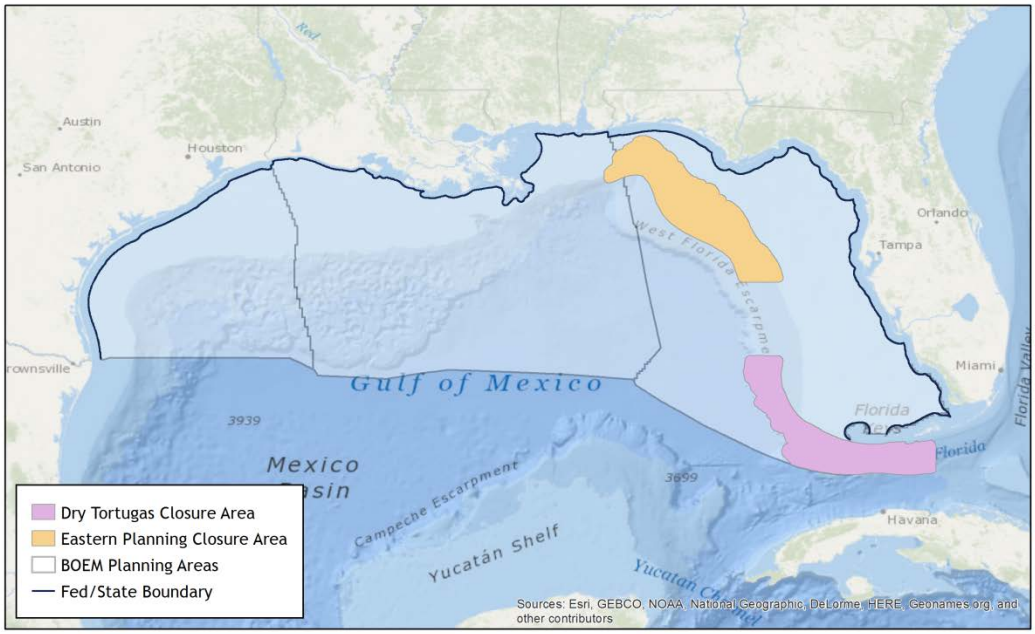
4.3.2 PROPOSED RULE YEAR-ROUND AREA CLOSURES

The Proposed Rule includes complete closure (year-round) to G&G activities in the Eastern Planning Closure Area and the Dry Tortugas Closure Area. Both closure areas fall within BOEM's GOM Eastern Planning Area, with the exception of a small fraction of the Eastern Planning Closure Area, as identified in Exhibit 4-23.

[71] Plays are known and postulated sub-seafloor pools (hydrocarbon accumulations) that share a common history of hydrocarbon generation, migration, reservoir development, and entrapment.

[72] BOEM. 2017: 2016 National Assessment of Undiscovered Oil and Gas Resources of the U.S. Outer Continental Shelf, US Department of the Interior, Bureau of Ocean Energy Management. OCS Report BOEM 2017-038. https://www.boem.gov/2016-National-Assessment/

EXHIBIT 4-23. PROPOSED RULE YEAR-ROUND CLOSURE AREAS



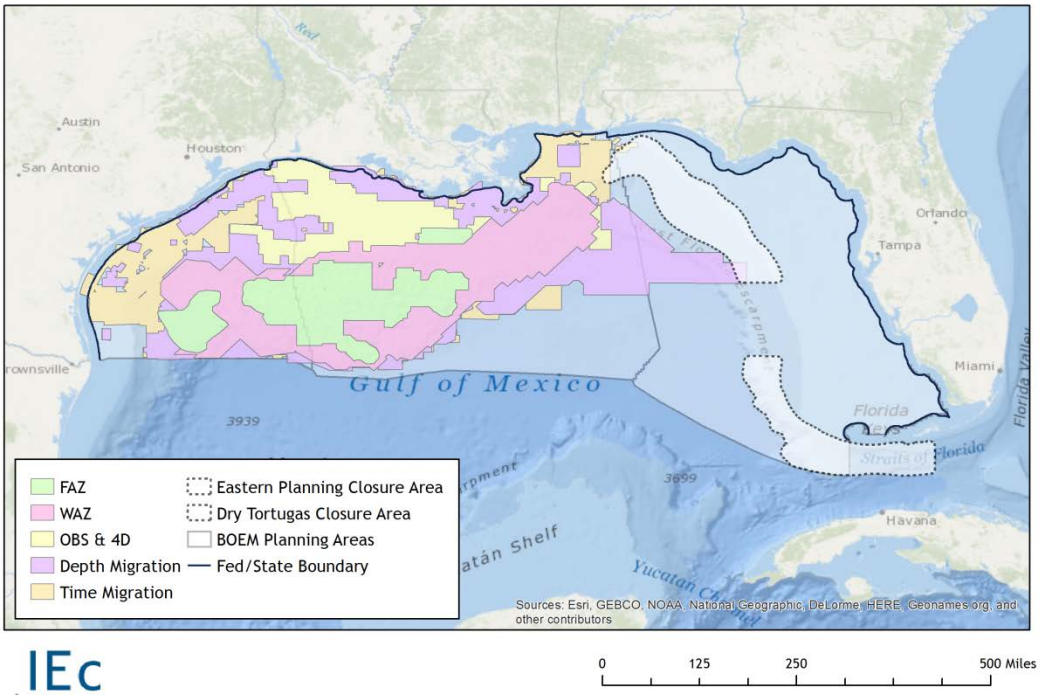
Under the Proposed Rule, all oil and gas drilling for the five-year period of the analysis in these closure areas would become dependent on existing data from historical G&G surveys and/or data that may be gathered over the next five years via non-airgun surveys. Oil and gas leasing is, however, currently banned in both of these closure areas as a result of the Gulf of Mexico Energy Security Act of 2006 (GOMESA). The GOMESA moratorium restricts leasing in these areas until June 30, 2022 and is part of the pre-settlement baseline for this analysis.

While the GOMESA moratorium does not restrict G&G surveys in the Eastern Planning Area, the G&G industry has historically not focused on surveying this area. Exhibit 4-24 identifies the spatial coverage of seismic surveys that BOEM has obtained from industry through mid-2015. The lack of demand for G&G survey data for the Eastern Planning Area is likely due to the GOMESA lease restrictions. Thus, G&G have historically focused in BOEM's Central and Western Planning Areas which supports active leasing and drilling activity.

We note that Exhibit 4-24 does not include information on the geographic extent of 2D seismic data. Though these data were not systematically available for analysis, BOEM may have 2D seismic data for the Destin Dome Unit and other locations in the Eastern Planning Area.[73] Thus, this exhibit does not provide a complete picture of the availability of G&G data within the closure areas.

[73] Personal communication from BOEM Economist, September 8, 2017.

EXHIBIT 4-24. SPATIAL COVERAGE OF SEISMIC SURVEYS OBTAINED BY BOEM



Given the relatively low demand for G&G survey data in the Eastern Planning Area, it is difficult to determine how the Proposed Rule area closures may affect industry. While the GOMESA restrictions will continue to exist over the timeframe of this analysis, demand for G&G may increase over this timeframe of the analysis leading up to the end of the moratorium in 2022. That is, in the case that oil and gas leasing is allowed in the future for portions of the Eastern Planning Area that overlap the Proposed Rule closure areas, it is likely that there will be increased interest in seismic data to support leasing decisions. Thus, the Proposed Rule restrictions may affect the ability of industry to obtain these data in a timely and efficient manner and could affect the level of G&G activity relative to the baseline as well as oil and gas exploration and production relative to the baseline in the period after the moratorium expires.

We are unable to estimate the extent to which exploration and development activity may be affected due to three key uncertainties:

1) *Without detailed information on the spatial extent and usefulness of existing seismic survey data, we cannot estimate the proportion of leases or wells with insufficient seismic data.* As noted above, while some G&G data likely exists for the closure areas, the usefulness of the existing data for making lease decisions and refining drilling targets is significantly uncertain.

2) *Without specific information on the costs and risks associated with drilling exploratory and production wells without recent seismic data, we are unable to evaluate whether the added costs and uncertainty would render exploration and development economically infeasible.* The inability to collect new seismic data

affects future oil and gas development because oil companies typically use this information to redefine their target before drilling a well. In a comment letter on BOEM's PDEIS of the GOM G&G activities, API and IAGC state that seismic is "the only feasible technology available to accurately image the subsurface before a single well is drilled." API and IAGC also assert that seismic imaging "reduces risk by increasing the likelihood that exploratory wells will successfully tap hydrocarbons and by decreasing the number of wells that need to be drilled in a given area."[74] Without access to new seismic data in the closure areas, API and IAGC indicated that the additional risks could render future exploration and development activities economically infeasible. While this may not be an immediate concern for the areas under moratoria until 2022 in the Eastern Planning Area, demand for new seismic data is likely to increase in the years before the moratorium is lifted.

3) *Absent information on the relative importance of these areas to oil and gas production in the GOM and the availability of alternative sites in the GOM to meet demand, we are unable to quantify the likelihood of reduced domestic production.* Whether reducing oil and gas development in the closure areas affects the broader contribution of the GOM to U.S. oil and gas activity depends on whether oil and gas activity is able to shift to substitute parts of the GOM (not subject to area closure) for the five-year timeframe of this analysis and for some time following that until sufficient data are available for the closure areas. That is, in response to greater risks and uncertainty associated with developing the resources within the closure areas absent new G&G data, oil and gas companies may choose to focus exploration and development activities in lower-risk areas without survey restrictions. These alternative areas may be elsewhere within the GOM, though companies could also choose to expand production internationally. As a result, some potential exists for the area closures to reduce domestic oil and gas production, industry income, and employment.

Absent a specific estimate of the potential reduction in exploration and development activity, we examined indicators of the economic value of the closure areas to provide perspective on the magnitude of potential impacts. Two active leases and no platforms occur in these areas, and no oil and gas production has ever occurred. This analysis therefore provides information on the following indicators in order to characterizing the relative importance of the Closure Areas to oil and gas production. We recognize that these data reflect activity in light of the ongoing GOMESA moratorium and are not necessarily indicative of future demand for this area beyond the timeframe of the moratorium. However, this information reflects the best available information to provide context for the economic implications of these area closures.

[74] IAGC, API, and NOIA. (2016). Comments on Draft Programmatic Environmental Impact Statement for Geological & Geophysical Activities on Gulf of Mexico Outer Continental Shelf.

- Number of exploratory and development wells spudded in recent years (Exhibits 4-25, 4-26, and 4-27); and
- Estimated remaining oil and gas reserves (Exhibits 4-28 and 4-29).

EXHIBIT 4-25. DEVELOPMENT WELLS SPUDDED (2012 - 2016) AND CLOSURE AREAS

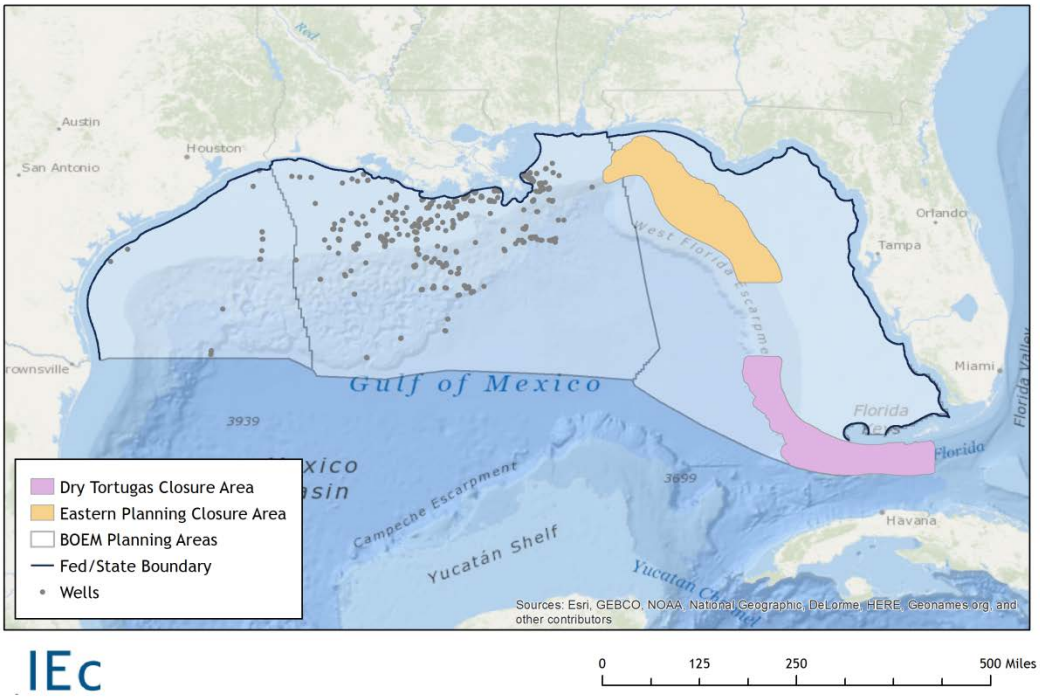


EXHIBIT 4-26. EXPLORATION WELLS SPUDDED (2012 - 2016) AND CLOSURE AREAS

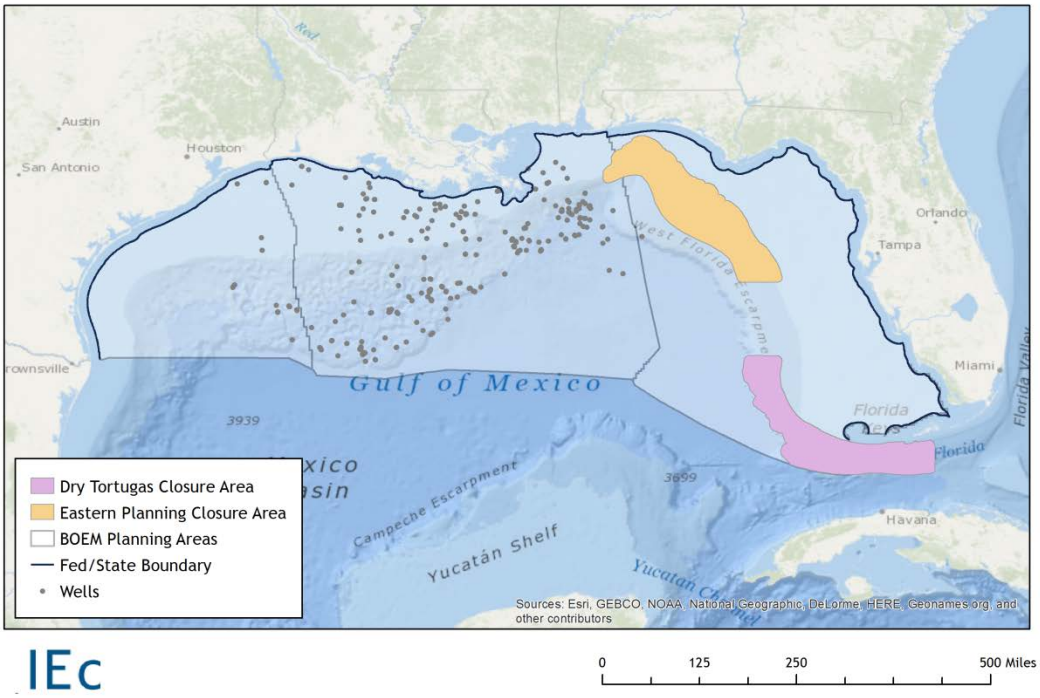
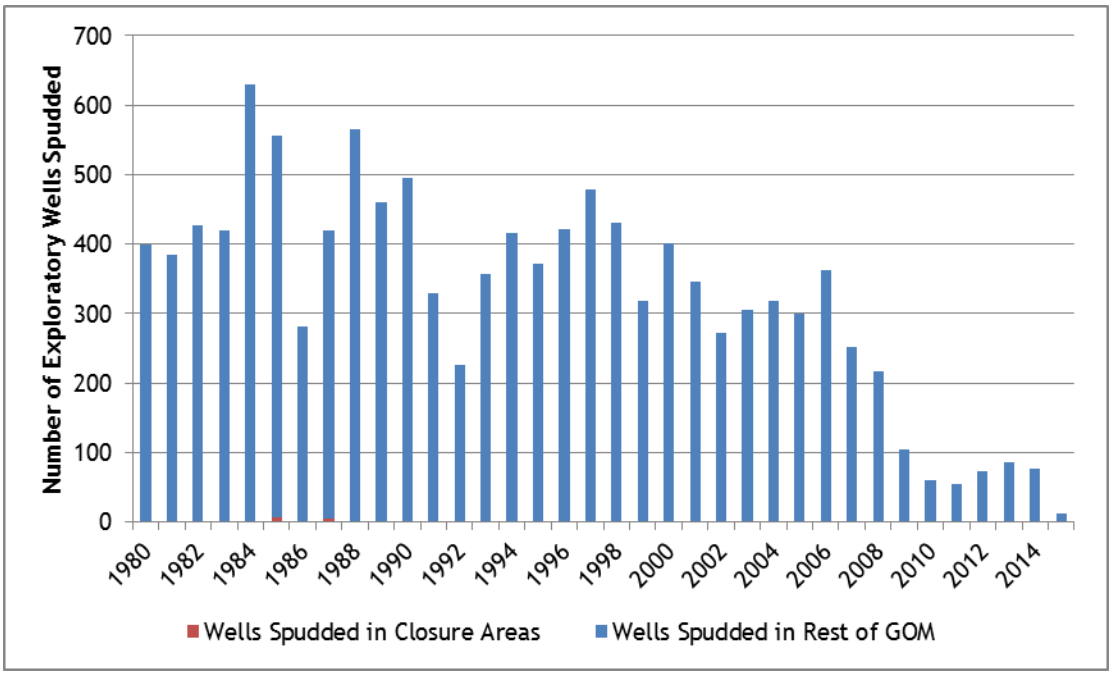


EXHIBIT 4-27. PERCENT OF EXPLORATORY WELLS SPUDDED IN CLOSURE AREAS (1980 - 2015)



While wells spudded are generally a good indicator of demand for exploration and production activity in an area, due to the existing moratorium, no development or exploration wells have been spudded in the Eastern Planning Closure Area or the Dry Tortugas Closure Area in the past five years.[75]

Prior to the GOMESA moratorium, however, the oil and gas industry displayed interest in exploration and production activity in the Eastern Planning Area. As an example, the former Destin Dome Unit was a significant natural gas discovery in the Eastern Planning Closure area. The Destin Dome Unit included 11 OCS leases acquired by Chevron, ConocoPhillips, and Murphy Oil between 1984 and 1988 and was located about 25 miles off the northwest Florida coast, south of Pensacola Beach Florida.[76] The Destin Dome Unit was estimated to hold recoverable natural gas resources of 1.6 to 3 trillion cubic feet. The federal government repurchased the leases and the lessees booked no reserves.

Chevron U.S.A. drilled three exploratory wells in the unitized Destin Dome area between 1987 and 1995. Each of these wells showed significant amounts of dry gas. In 1996, Chevron and its partners (ConocoPhillips and Murphy Oil) filed a development plan with

[75] "Spudding" refers to the beginning of drilling operations.

[76] U.S. Department of the Interior, Minerals Management Service. (1997), MMS Begins Review Process on Chevron's Destin Dome Development Plan. Accessed at: https://www.boem.gov/BOEM-Newsroom/Press-Releases/1997/081597.aspx

the Minerals Management Service (now BOEM). Under the development plan, Chevron proposed to drill 12-21 development wells.[77]

The State of Florida denied the consistency of the Destin Dome development plan with its coastal management program.[78] The lessees filed suit against the U.S. government for denying the companies "timely and fair review" of Destin Dome Unit plans and permits. In 2002, the Department of the Interior settled with the lessees and repurchased most of the Destin Dome Unit leases which ended the proposed development of the Destin Dome Unit.[79]

Additionally, BOEM produces annual estimates of remaining reserves at active fields in the GOM through the Reserves Inventory Program.[80] These data provide an additional indicator of potential future interest in developing the closure areas. The Eastern Planning Closure Area overlaps with two active lease blocks in the former Destin Dome Unit. Reserves have not been recorded for these leases. The Dry Tortugas Closure Area does not overlap with any active lease blocks, so data on potential oil and gas reserves are not available. Exhibits 4-28 and 4-29 display the spatial distribution of recorded oil and gas reserves at active lease blocks in the GOM.

[77] U.S. Department of the Interior, Minerals Management Service. (1997), MMS Begins Review Process on Chevron's Destin Dome Development Plan. Accessed at: https://www.boem.gov/BOEM-Newsroom/Press-Releases/1997/081597.aspx

[78] Furlow, William. (1998). Florida dispute delays Destin Dome project. Offshore Magazine. Accessed at: http://www.offshore-mag.com/articles/print/volume-58/issue-6/departments/drilling-production/florida-dispute-delays-destin-dome-project.html

[79] Natural Gas Intelligence. (2002). Producers: Government's Destin Dome Repurchase Will Cut Nation's Gas Supply. Accessed at: http://www.naturalgasintel.com/articles/7435-producers-government-s-destin-dome-repurchase-will-cut-nation-s-gas-supply

[80] BOEM. (2016). Estimated Oil and Gas Reserves, Gulf of Mexico OCS Region, December 31, 2015. Accessed March 2017 at: https://www.data.boem.gov/Main/HtmlPage.aspx?page=estimated2015. The program's reserves estimates are "proved plus probable (2P) reserves estimates" and "must be discovered, recoverable, commercial, and remaining."

EXHIBIT 4-28. OIL RESERVES AT ACTIVE LEASE BLOCKS (2015) AND CLOSURE AREAS

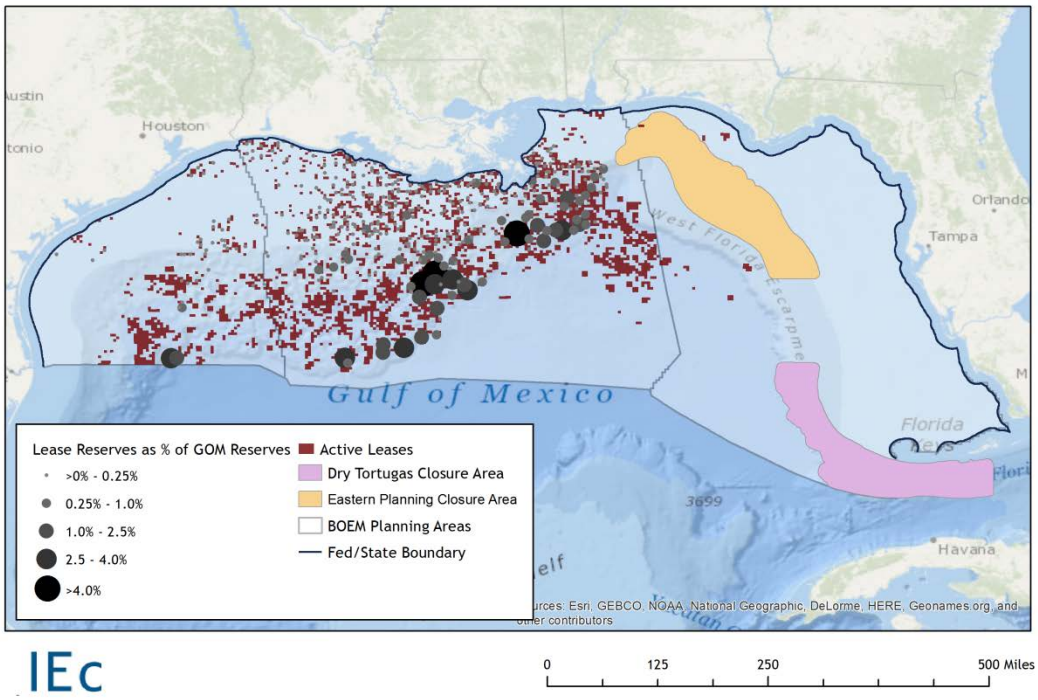
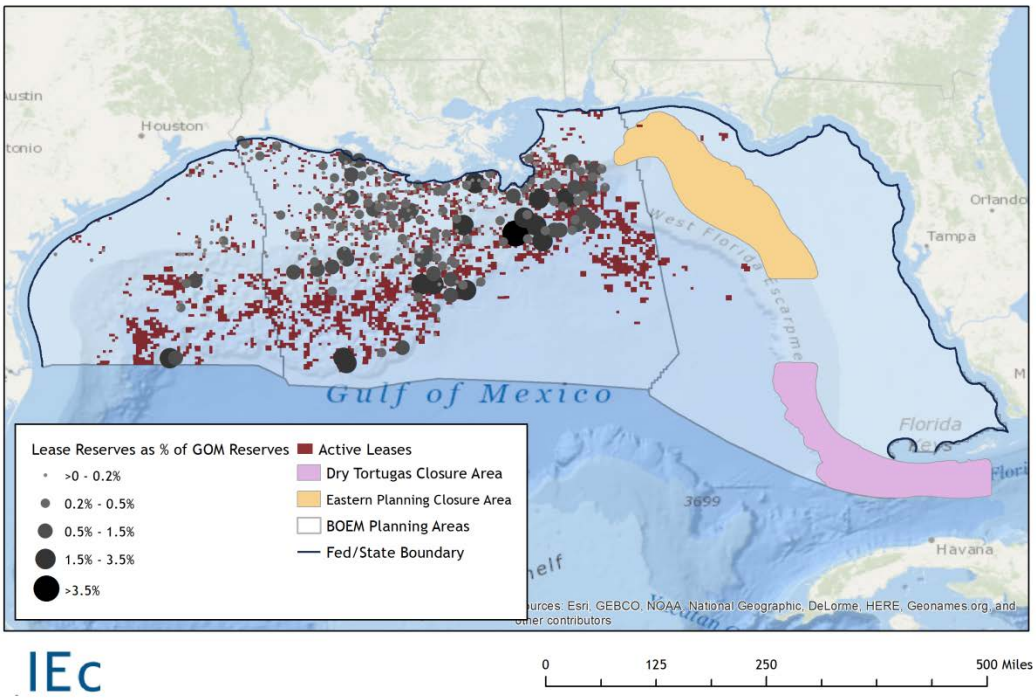


EXHIBIT 4-29. GAS RESERVES AT ACTIVE LEASE BLOCKS (2015) AND CLOSURE AREAS



BOEM assesses Undiscovered Technically Recoverable Resources (UTRR) throughout the Closure Areas in the Eastern Planning Area, including several areas that include multiple geologic plays with stacked opportunities (i.e. overlapping plays at different depths) for oil and gas accumulations. These geologic plays are known to contain hydrocarbon accumulations. BOEM projects a mean estimate of UTRR in the Eastern Planning Area that will exceed five billion barrels of oil equivalent.

In summary, quantifying the impacts of precluding G&G surveys in the Proposed Rule closure areas over the timeframe of the rule would be speculative in light of the layered uncertainties. In particular, demand for new survey data for these areas, while likely to increase over the timeframe of this analysis, is significantly uncertain. In recent history, these areas have not been the target of the oil and gas industry, in particular, due to the GOMESA and preceding executive withdrawals and congressional moratoria. Oil and gas development has occurred primarily in the Central and Western Planning Areas of the GOM. As these areas become developed, however, the industry may seek to expand into the Eastern Planning Area given the estimated UTRR. While the timeframe of this rule is five years, if the Eastern Planning Closure Area were available for leasing while seismic activity is prohibited, companies may be hesitant to risk capital investments. Absent the ability to gather updated seismic data over the five-year time of the rule, future production of currently undiscovered hydrocarbon resources may be delayed even beyond the timeframe of the rule and could represent a social welfare loss. Both the quantity of undiscovered resources in the year-round closure areas and future oil and gas prices make quantification of potential welfare losses significantly uncertain.

4.3.3 MORE STRINGENT ALTERNATIVE YEAR-ROUND AREA CLOSURES

The More Stringent Alternative includes the two year-round closure areas in the Eastern Planning Area described for the Proposed Rule, and also includes additional Central Planning Closure Areas (East and West) in the BOEM Central Planning Area (comprising two discrete areas as depicted in Exhibit 4-30). Under the More Stringent Alternative, oil and gas development of these closure areas would likewise become dependent on existing data from historical G&G surveys, some of which, as noted above, are likely to be outdated or obsolete.

EXHIBIT 4-30. MORE STRINGENT ALTERNATIVE CLOSURE AREAS

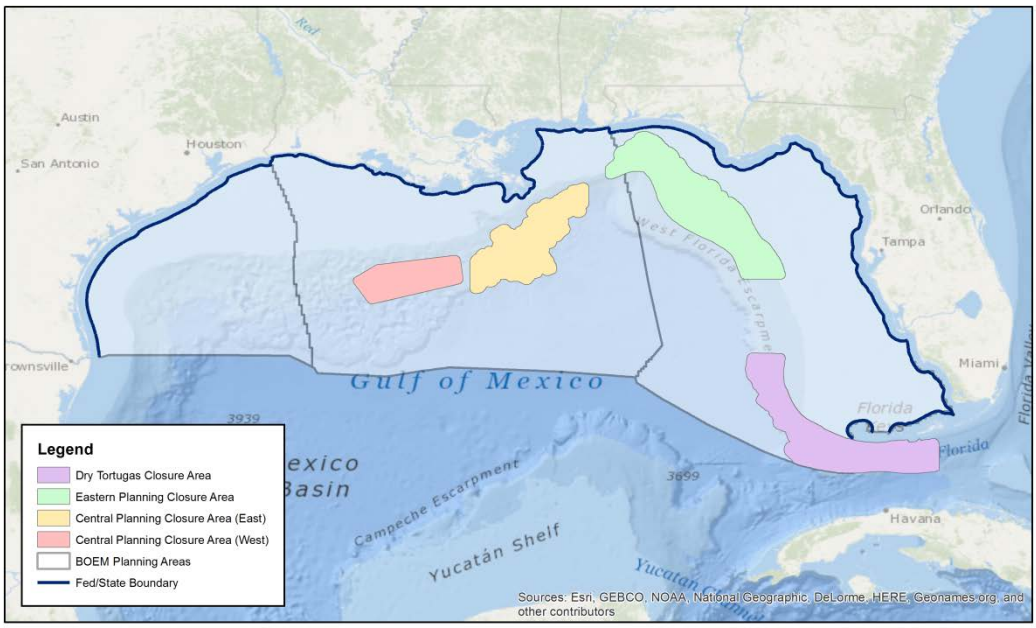
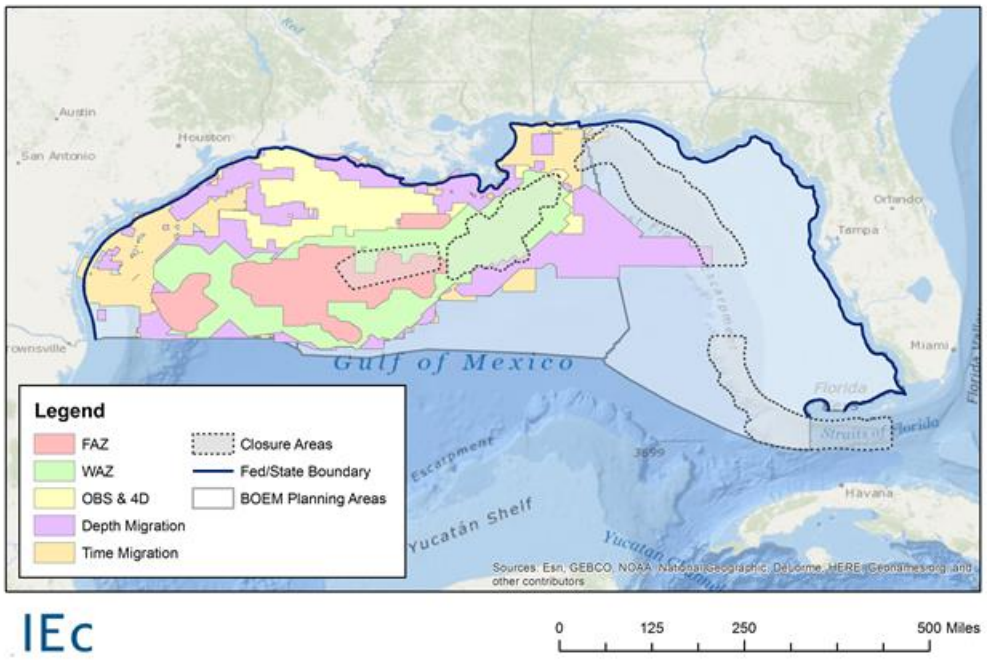


Exhibit 4-31 identifies the spatial coverage of seismic surveys that BOEM has obtained from industry through mid-2015, demonstrating overlap with the More Stringent Alternative Closure Areas (as noted above, these data are incomplete as they do not include 2D survey data). As the exhibit highlights, BOEM has obtained some seismic survey data over most of the Western and Central Planning Areas. Coverage varies significantly by type of survey data, however. Depth Migration and Time Migration seismic data are the most prevalent, with historical data available across nearly 100 percent of the Central Planning Closure Areas. However, data coverage for other survey types is less consistent. WAZ data overlap with 97 percent of the Central Planning Closure Areas, FAZ data overlap with 24 percent of the Central Planning Closure Areas, and OBN & 4D data overlap with 18 percent of the Central Planning Closure Areas. While the graphic does not display multiple surveys over the same acreage, many blocks were surveyed several times.

EXHIBIT 4-31. SPATIAL COVERAGE OF SEISMIC SURVEYS OBTAINED BY BOEM



While Exhibit 4-31 provides some information on where seismic data exist, we do not have information on where these data are of lesser value and companies would not make leasing or exploration decisions without updated data or processing. Thus, although the exhibit indicates some data are available covering the Central Planning Closure Areas, this exhibit does not provide a complete picture of the demand for new G&G data. Additionally, as noted above, even for relatively recent data, the inability to collect new seismic data could affect oil and gas development given that oil companies typically use targeted seismic to refine their geologic analysis before drilling a well.

The ability to quantify the effects of the closure areas on oil and gas productivity is limited by the same three factors as outlined for the Proposed Rule in Section 4.3.2.

However, we note that the recent levels of leasing and drilling activity in the Central Planning Closure Area indicate that this area is among the most productive in the entire GOM. Given this, it is less likely that other GOM areas will offer equivalent alternative opportunities to the Central Planning Closure Areas. As a result, the area closures under the More Stringent Alternative have greater potential to reduce domestic oil and gas production, industry income, and related regional employment opportunities.

Absent a specific estimate of the potential reduction in exploration and development activity, we examined several indicators of the economic value of the closure areas to provide perspective on the magnitude of potential impacts. Specifically, this analysis provides information on the following indicators characterizing the relative importance of the More Stringent Alternative Closure Areas to oil and gas production:

- Number of active leases;
- Number of active platforms;
- Bid values from recent lease sales (Exhibit 4-32);
- Number of exploratory and development wells spudded in recent years (Exhibits 4-33, 4-34, and 4-35);
- Recent oil and gas production (Exhibits 4-36 through Exhibit 4-39); and
- Estimated remaining oil and gas reserves (Exhibits 4-40 and 4-41).

Overall, the potential More Stringent Alternative closure areas overlap with 21 percent (645) of active GOM leases and four one percent (9528) of active platforms in the GOM.[81] All of these active platforms and 643 (>99 percent) of the active leases are located in the Central Planning Closure Areas. According to GIS data maintained by BOEM on the location and value of leases and the spatial extent of the closure areas, 308 lease blocks in the Central Planning Area Closure Areas received bids between 2012 and 2016.[82] The accepted bids across these leases totaled nearly $2 billion over this five-year period (Exhibit 4-32). Over the past five years, the two Central Planning Area Closure Areas accounted for a significant portion of the total bonus bid payments for leases in the GOM, ranging from roughly 30 to 60 percent. This reflects the relatively high value of these areas to industry.

[81] The BOEM database did not provide an install date or removal date for 245 platforms. Absent this information, we assumed that these platforms are currently active. 67 of these 245 platforms overlap with the Central Planning Closure Area. Platform counts are not necessarily a helpful metric since the Central Planning Closure Areas are in deepwater and fewer GOM platforms are installed in deepwater.

[82] BOEM. GOMR Historical Lease Sale Information. Accessed December 16, 2016 at: https://www.boem.gov/GOMR-Historical-Lease-Sale-Information/.

EXHIBIT 4-32. VALUE OF BIDS ON LEASES IN THE CENTRAL PLANNING CLOSURE AREAS

YEAR	SUM OF ACCEPTED BIDS IN CENTRAL PLANNING CLOSURE AREA (EAST) (NOMINAL DOLLARS)	SUM OF ACCEPTED BIDS IN CENTRAL PLANNING CLOSURE AREA (WEST) (NOMINAL DOLLARS)	PERCENT OF TOTAL GOM BID VALUE IN CLOSURE AREAS
2012	$619,430,078	$42,318,795	39%
2013	$207,317,718	$174,740,081	31%
2014	$457,659,774	$43,683,797	59%
2015	$102,908,436	$207,388,991	58%
2016	$44,024,071	$21,029,569	42%
Total	$1,431,340,077	$489,161,233	43%

Source: BOEM. GOMR Historical Lease Sale Information. Accessed December 16, 2016 at: https://www.boem.gov/GOMR-Historical-Lease-Sale-Information/.

Additionally, we examined data on wells spudded within the Closure Areas. Exhibits 4-33 and 4-34 overlay development and exploratory wells spudded from 2012 to 2016 with the closure areas. As the exhibits show, a significant number of wells have been spudded in the Central Planning Closure Areas in the past five years. From 2012 to 2016, 93 exploratory wells and 102 development wells were spudded in the Central Planning Closure Area, representing 27 percent and 13 percent, respectively, of all wells spudded in the Gulf of Mexico over that time period. Additionally, the wells spudded in the Central Planning Closure Area represent 38 percent of deepwater exploratory wells (>400m water depth) and 67 percent of deepwater development wells spudded in the Gulf of Mexico from 2012 to 2016.

EXHIBIT 4-33. EXPLORATION WELLS SPUDDED (2012 – 2016) AND CLOSURE AREAS

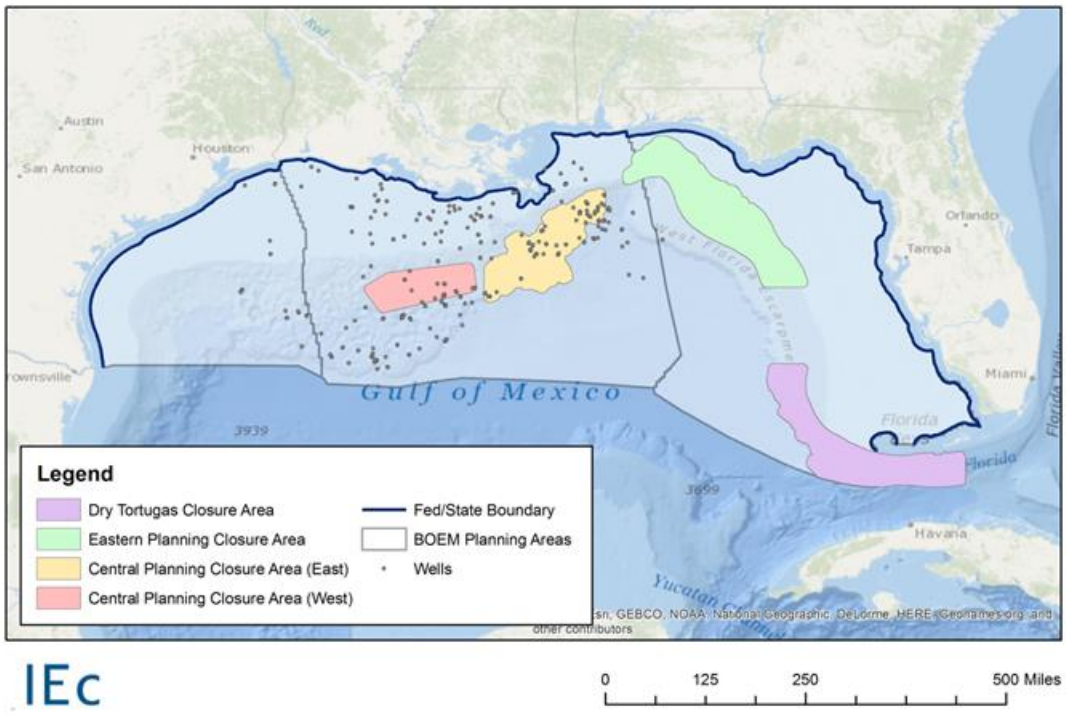
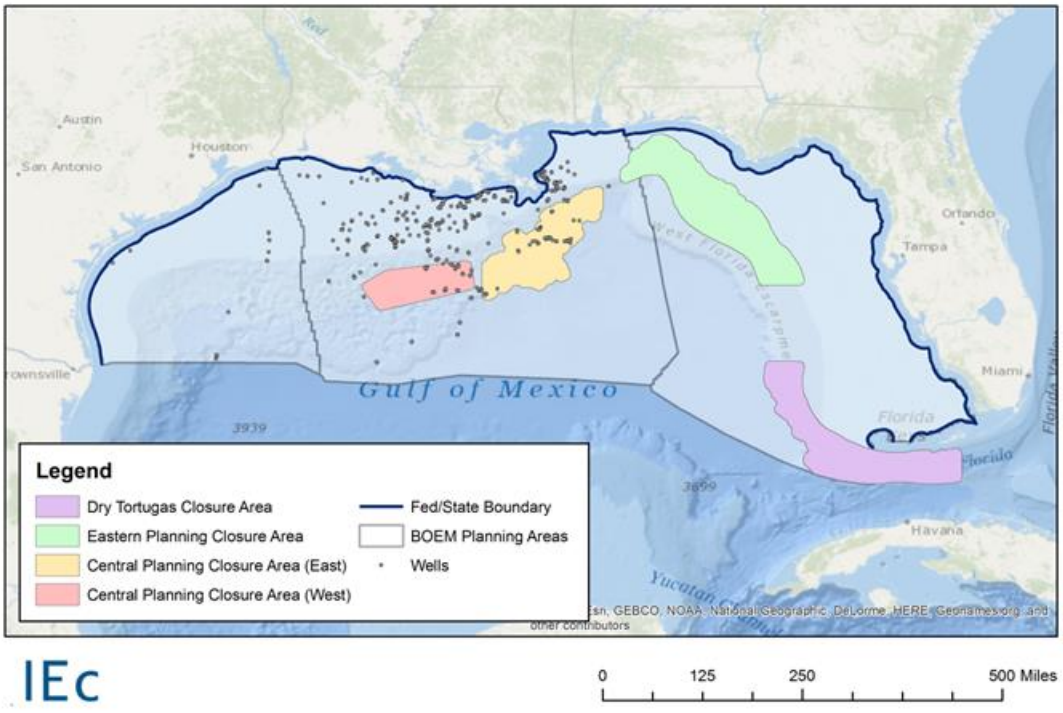
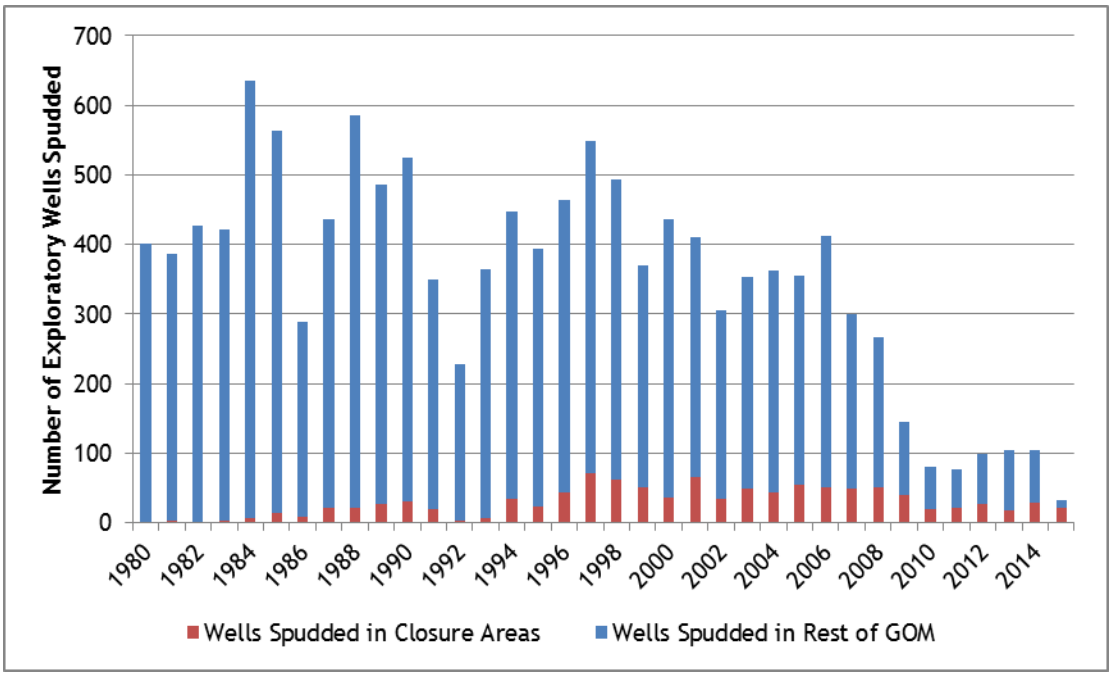


EXHIBIT 4-34. DEVELOPMENT WELLS SPUDDED (2012 – 2016) AND CLOSURE AREAS



Though spudding of exploratory wells has declined in recent years, a growing proportion of wells have been spudded in the Central Planning Closure Areas as drilling has declined in shallow water and increased in more prospective deepwater areas. The recent increase in the percentage of exploratory wells spudded in the Central Planning Closure Areas indicates the high interest in these areas.

EXHIBIT 4-35. PERCENT OF EXPLORATORY WELLS SPUDDED IN CENTRAL PLANNING CLOSURE AREAS (1980 - 2015)



While not entirely predictive, recent oil and gas production levels in the closure areas provide some insight regarding the potential magnitude of the oil and gas production impacts of the area closures. As discussed previously, there has not been historical oil and gas production in the Eastern Planning Closure Area or Dry Tortugas Closure Area. However, recent oil and gas production levels in the Central Planning Closure Areas are significant. Based on well production data tracked in BOEM's Oil and Gas Operation Reports (OGOR-A),[83] leases within the Central Planning Closure Areas accounted for approximately 50 percent of total oil production in the GOM between 2012 to 2016 and 24 percent of total gas production. Exhibits 4-36 and 4-37 present oil and gas production, respectively, in the Central Planning Closure Area in each year from 2012 to 2016. Exhibits 4-38 and 4-39 present the spatial distribution of 2016 oil production across the GOM.

[83] BOEM. Oil and Gas Operations Reports - Part A (OGOR-A) Well Production for 2012-2016. Accessed March 2017 at: https://www.data.boem.gov/homepg/pubinfo/freeasci/product/freeprod_ogora.asp.

EXHIBIT 4-36. OIL PRODUCTION IN THE CENTRAL PLANNING CLOSURE AREA 2012 THROUGH 2016

YEAR	OIL PRODUCTION IN CLOSURE AREAS (BARRELS)	TOTAL GOM OIL PRODUCTION (BARRELS)	PERCENT OF GOM PRODUCTION IN CENTRAL PLANNING CLOSURE AREA
2012	234,000,000	465,000,000	50.4%
2013	224,000,000	459,000,000	48.7%
2014	262,000,000	511,000,000	51.3%
2015	275,000,000	553,000,000	49.7%
2016	287,000,000	565,000,000	50.8%
Total	1,282,000,000	2,550,000,000	50.2%

Source: BOEM. Oil and Gas Operations Reports - Part A (OGOR-A) Well Production for 2012-2016. Accessed March, 2017 at: https://www.data.boem.gov/homepg/pubinfo/freeasci/product/freeprod_ogora.asp.

EXHIBIT 4-37. GAS PRODUCTION IN THE CENTRAL PLANNING CLOSURE AREA 2012 THROUGH 2016

YEAR	GAS PRODUCTION IN CLOSURE AREAS (MMCF)	TOTAL GOM GAS PRODUCTION (MMCF)	PERCENT OF GOM PRODUCTION IN CENTRAL PLANNING CLOSURE AREA
2012	288,000,000	1,540,000,000	18.7%
2013	270,000,000	1,330,000,000	20.3%
2014	307,000,000	1,280,000,000	23.9%
2015	338,000,000	1,310,000,000	25.8%
2016	375,000,000	1,210,000,000	31.0%
Total	1,580,000,000	6,680,000,000	23.6%

Source: BOEM. Oil and Gas Operations Reports - Part A (OGOR-A) Well Production for 2012-2016. Accessed March, 2017 at: https://www.data.boem.gov/homepg/pubinfo/freeasci/product/freeprod_ogora.asp.

EXHIBIT 4-38. OIL PRODUCTION (2016) AND CLOSURE AREAS

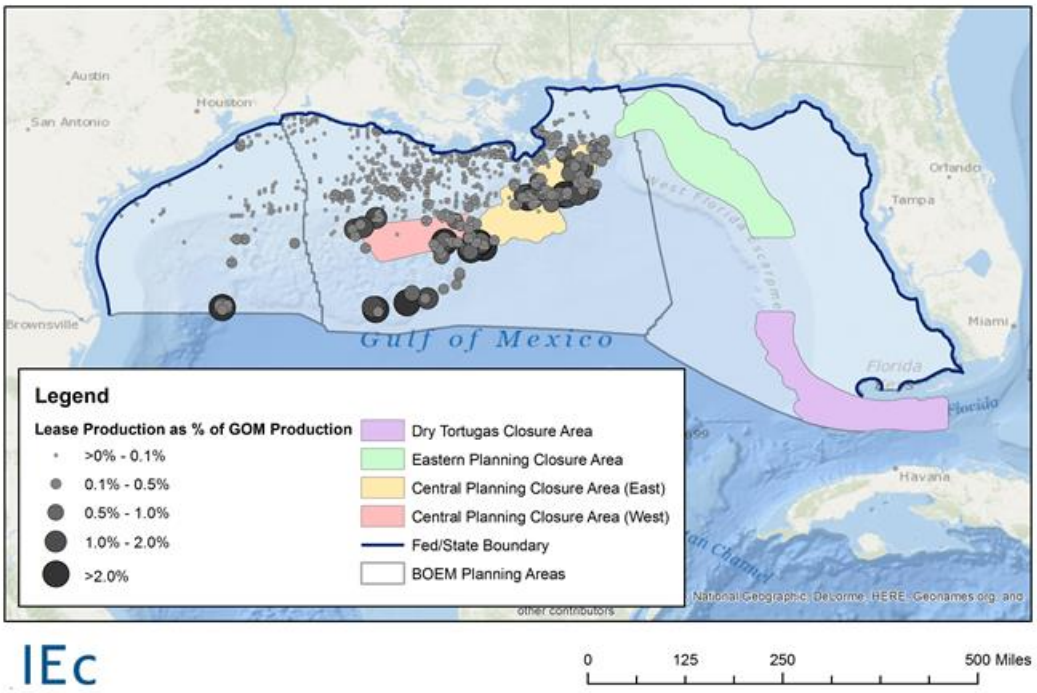
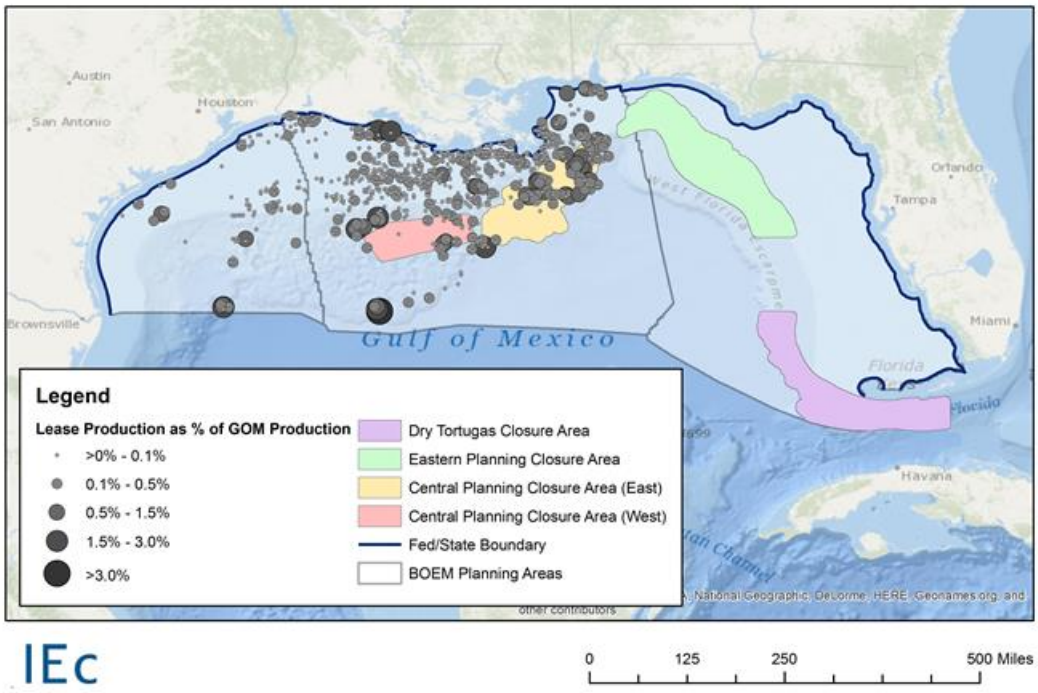
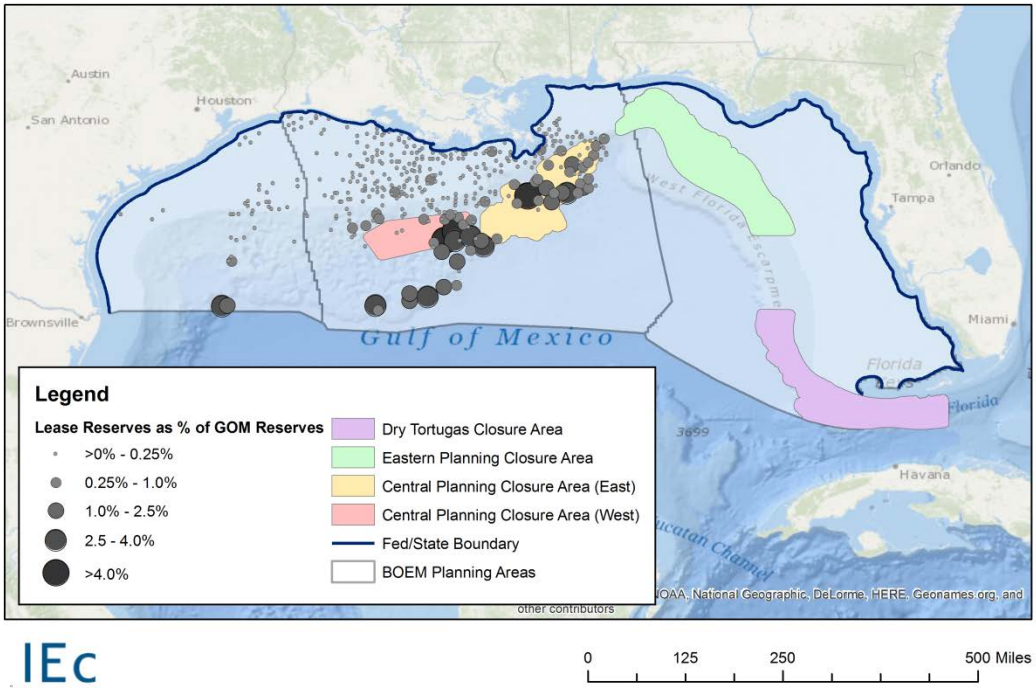


EXHIBIT 4-39. GAS PRODUCTION (2016) AND CLOSURE AREAS



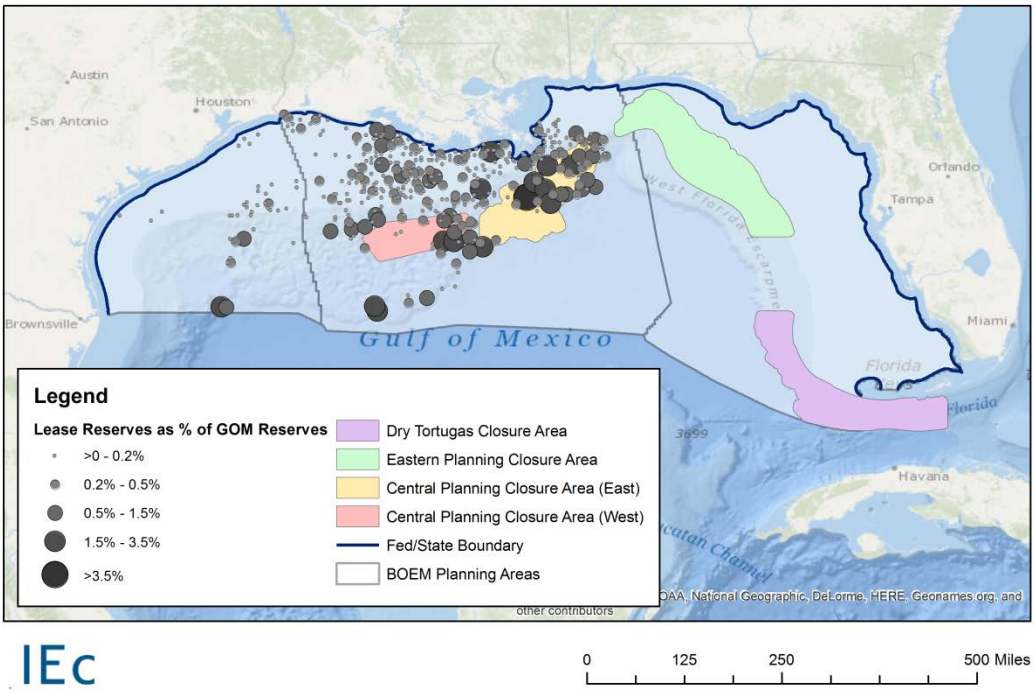
Additionally, BOEM produces annual estimates of remaining reserves at active fields in the GOM through the Reserves Inventory Program.[84] These data provide an additional indicator of future production levels within the closure areas. The Central Planning Closure Areas overlap with 55 active lease blocks in the GOM that are estimated to contain 1.98 billion barrels of oil and 2.67 trillion cubic feet of natural gas. These reserves represent 57 percent of estimated oil reserves and 37 percent of estimated gas reserves in the GOM. Exhibits 4-40 and 4-41 display the spatial distribution of remaining oil and gas reserves at active lease blocks in the GOM.

EXHIBIT 4-40. OIL RESERVES AT ACTIVE LEASE BLOCKS (2015) AND CLOSURE AREAS



[84] BOEM. (2016). Estimated Oil and Gas Reserves, Gulf of Mexico OCS Region, December 31, 2015. Accessed March 2017 at: https://www.data.boem.gov/Main/HtmlPage.aspx?page=estimated2015. The program's reserves estimates are "proved plus probable (2P) reserves estimates" and "must be discovered, recoverable, commercial, and remaining."

EXHIBIT 4-41. GAS RESERVES AT ACTIVE LEASE BLOCKS (2015) AND CLOSURE AREAS



In summary, the data describing active leases and platforms, recent bid amounts, recent oil and gas production levels, and remaining reserves indicate that the level of oil and gas activity in the Central Planning Closure Areas is significant and a compelling indication that these closure areas are of significant importance to GOM oil and gas production in the near term. If the potential restriction on G&G surveys under the More Stringent Alternative were to displace reduce exploration and development of oil and gas within the Central Planning Closure Areas, oil and gas production from the GOM has significant potential to decline over the next five to ten years. The potential magnitude of the overall decline in oil and gas activity and resulting production from the entire GOM over this timeframe depends on the extent to which existing G&G data are sufficiently available to support development activities in the closure areas and the extent which other GOM areas contain large economically viable hydrocarbon deposits and result in increased production to substitute for the reduced production from the Closure Areas.

To the extent that the closure areas shift oil and gas development to higher cost areas, within or out of the GOM, oil prices could theoretically be affected. However, given that oil production in the closure areas accounts for a relatively small proportion of global production, we expect that any associated decrease in production would be unlikely to materially influence global oil prices. In 2015, the EIA estimates that global crude oil production totaled 29 billion barrels.[85] As shown previously in Exhibit 4-36, oil

[85] EIA. (2016). International Energy Outlook 2016. Table: World crude oil production by region and country. Accessed March 2017 at: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=39-IEO2016&cases=Reference&sourcekey=0

production in the closure areas totaled 287 million barrels in 2016, accounting for less than one percent of estimated global production. Thus, while the More Stringent Alternative may affect GOM oil and gas production levels over the next five to ten years, it is unlikely to rise to the level of affecting oil and gas prices. Reductions in oil and gas production in the GOM would, in turn, affect the regional economic activity supported by the industry, as described in the following section.

4.3.4 REGIONAL ECONOMIC IMPACTS

If the More Stringent Alternative reduces exploration and development activity in the GOM, the displaced capital expenditures would likely shift to the next-lowest cost opportunities promising the greatest development potential. Given that oil is produced and sold in a global market, the next-lowest cost areas may be elsewhere within the GOM, but also may be international locations. The magnitude of the impact of the seasonal restrictions and area closures on the regional economy depends on the extent to which any reduction in exploration and development activities would be compensated with increased activity elsewhere in the GOM versus increased activity elsewhere in the U.S. or internationally.

If exploration and development activity shifts to locations outside the GOM, the economic impact on the regional Gulf economy could be significant. As discussed in Chapter 2, the direct, indirect, and induced impacts of oil and gas exploration and development in the GOM are estimated to generate $29 to $58 billion in spending, supporting between 285,000 and 382,000 jobs in a given year. Given that the Central Planning Closure Areas account for an estimated 57 percent of oil reserves and 37 percent of gas reserves at active leases in the Gulf of Mexico, these areas account for a sizable contribution to regional economic productivity and employment.

4.4 KEY UNCERTAINTIES AND LIMITATIONS

As discussed throughout this Chapter, several uncertainties affect the social welfare implications of the Proposed Rule. The range of cost estimates reflect the uncertainty related to the direct compliance costs. Exhibit 4-42 summarizes the major sources of uncertainty associated with the Proposed Rule cost analysis (with some notes on the implications on the More Stringent Alternative) that are not reflected in the range of costs quantified. The exhibit also describes the direction of any potential bias associated with each source of uncertainty, and describes the likely significance with respect to impacts. As part of the public comment period for the proposed rule, we request feedback on the data, assumptions, and uncertainties associated with this analysis, as characterized in Exhibit 4-42. Following public comment, this analysis will integrate, as appropriate, any improvements or refinements to the data and assumptions.

EXHIBIT 4-42. SOURCES OF UNCERTAINTY REGARDING COSTS OF THE PROPOSED RULE

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
DIRECT COMPLIANCE COSTS		
The estimated frequencies of encountering marine mammals are the primary driver of the cost analysis. We relied on historical marine mammal observer reports from G&G surveys to estimate the expected rate of survey shut downs. Absent more specific data, this analysis assumes the rate of shutdowns is uniform throughout the study area.	**Unknown.** May overestimate or underestimate incremental impacts.	**Potentially major.** The shutdown rates for future G&G surveys is the key uncertainty in the direct compliance cost estimates. It is difficult to forecast with any reasonable precision how frequently these vessels will encounter marine mammals and, further whether this varies by geographic location within the GOM. The historical monitoring reports we rely on are the best available information to inform this assumption. However, in the case that the estimated shutdown rates, particularly for the more expensive WAZ surveys, are low or high, this has significant implications in the quantified direct compliance costs.
The analysis relies on a forecast of surveys developed by BOEM based on historical activity levels and feedback provided through public comment on the activity forecast.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** This analysis includes a broad range in G&G activity levels to forecast impacts and we expect this range encompasses the likely future activity levels. That is, it is unlikely that actual future levels of activity will fall above or below this range.
The analysis relies on baseline G&G survey cost estimates from a 2014 IAGC survey and follow on communication with API and IAGC in 2016 to confirm the costs provided were still reflective of the G&G activities in the GOM.	**Unknown.** May overestimate or underestimate incremental impacts.	**Unknown.** The 2014 IAGC survey costs were used to inform the PEIS which was subject to public comment. Thus, industry operators in the GOM were able to comment on the cost estimates provided in that document; no comments were provided that improved upon the G&G survey cost information as a result of public comment. Additionally, IEc discussed the cost estimates from the survey with IAGC and API in 2016 and they verified that the estimates were accurate to their knowledge. As a result, we think that these baseline costs are likely representative of current survey costs. However, any inaccuracies in the baseline cost estimates would affect the estimated costs of the proposed rule as many of the mitigation requirements are calculated as a percentage of baseline costs.
The analysis assumes that the proportion of future 2D and 3D surveys that use OBS technology will match the proportion observed in the G&G permit history.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** Estimated incremental costs do not differ greatly between OBS and non-OBS 2D and 3D surveys, so the exact proportion using OBS technology in the future is not likely to significantly affect the overall costs associated with the alternatives.
The analysis assumes that the costs of SWD surveys are similar to VSP surveys.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** We were not able to identify any recent data on the costs of SWD surveys. However, given that SWD surveys are relatively inexpensive and account for less than 7 percent of forecasted surveys, a revised cost estimate would not greatly affect the total estimated costs associated with the alternatives.

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
The analysis estimates impacts of survey shutdowns based on a 500-meter exclusion zone for shallow penetration airgun surveys and non-airgun HRG surveys although the Proposed Rule specifies a 200-meter exclusion zone for both.	**Overestimate.** Analysis leads to a higher than expected cost estimate for this mitigation measure.	**Likely Minor.** We were not able to identify data on the frequency of marine mammal observations within a 200-meter exclusion zone. Absent these data, this analysis relied on marine mammal observation data within a 500-meter exclusion zone. We expect the implications of this uncertainty are likely to be minor with respect to the total estimated compliance costs because non-airgun HRG surveys account for less than 0.5 percent of total direct compliance costs, and shallow penetration airgun surveys account for approximately 3 percent of total high-end compliance costs.
The analysis assumes costs for several administrative and operational rule requirements are minor and they are not quantified in this analysis. In particular, the analysis does not include costs of experience requirements for PSOs and PAM operators.	**Underestimate.** Analysis leads to a lower than expected cost estimate for this mitigation measure.	**Likely Minor.** The analysis does not quantify costs associated with the requirement that vessels provide pedestal-mounted "bigeye" binoculars, the requirement that PSOs and PAM operators must be third party and have prior experience, or the requirement that surveys submit reports 90 days after the conclusion of a survey regarding observations of marine mammals and mitigation implementation. BOEM and NMFS indicated that these requirements are in line with standard industry practice, and thus we do not anticipate that these requirements increase the costs of the proposed rule.
POTENTIAL INDIRECT COSTS		
The demand for and timing of oil and gas production in the GOM over the next five years is uncertain.	**Not quantified.**	**Moderate.** The impacts of the seasonal restrictions and year-round area closures are highly dependent on volatile oil and gas market conditions over the next five years, which dictate the demand for activities in the GOM. The greater the demand for oil and gas, the greater the expected impacts of the regulatory alternatives. Given the five-year timeframe of the rule overlaps the GOMESA moratorium that overlaps the Proposed Rule area closures, however, we expect a low likelihood of significant oil and gas production effects, as described in Section 4.3.2. While extending the area closures beyond the five-year timeframe of the analysis would increase the likelihood and magnitude of potential social welfare effects associated with reduced or delayed production, the timeframe of this rule is limited to five years. Thus, this analysis does not speculate regarding longer timeframes for closures. Any additional closures would need to be proposed as part of a separate rulemaking and evaluated in the associated economic analysis. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, however, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.
The extent to which future G&G surveys can incorporate avoidance of seasonal restriction areas in planning stages is uncertain.	**Not quantified.**	**Moderate.** Seasonal restrictions require surveys to avoid specified areas during specified times. We expect that many G&G surveys may incorporate these restrictions as part of survey planning without measurably affecting the cost or effectiveness of the survey. However, this is likely to be more complicated for longer-term surveys that cover a larger area overlapping the restricted areas.

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
The suitability of existing G&G data to direct oil and gas production in the closure areas is unknown.	**Not quantified.**	**Moderate.** The extent to which oil and gas production is delayed because of the need for newer, better G&G data is a key source of uncertainty for this analysis. We expect some sites may be able to employ existing data from recent surveys. While demand for new G&G data in the Proposed Rule closure areas is likely to increase over the timeframe of this rule due to the potential expiration of the GOMESA moratorium, no new leasing will be permitted in these areas over the timeframe of the rule. Thus, we expect these area closures will have minor to moderate effects on oil and gas production over the next five to ten years. If the Proposed Rule closure areas are closed for longer than a five year period, we would anticipate more significant economic implications. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, however, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.
The most likely substitute sites for oil and gas production are uncertain.	**Not quantified.**	**Likely Minor.** As no oil and gas production is expected from the Proposed Rule closure areas over the timeframe of this analysis in the baseline (due to the GOMESA moratorium), the effect of this uncertainty on our findings related to indirect impacts is likely minor. We expect it is unlikely that the area closures in the Eastern Planning area over the next five years will influence the likelihood that oil and gas production levels move out of the GOM and into other substitute markets in the near term. With respect to the More Stringent Alternative, some fraction of reductions in production from the closure areas may be made up for with production in other areas in the GOM, mitigating potential regional economic impacts. To the extent that substitute areas are outside of the GOM but within the U.S., national-level impacts of the closure areas will likely be limited. However, to the extent that industry moves displaced activities outside of the U.S., national-level impacts associated with industry income and employment may be substantial. Given the relative importance of the Central Planning Closure Area to oil and gas productivity in the GOM in the near term, this uncertainty has *potentially major implications on the economic impacts of the More Stringent Alternative*.

CHAPTER 5 | ECONOMIC BENEFITS

5.1 SUMMARY OF BENEFITS ANALYSIS

The purpose of the Proposed Rule is to authorize, after making the required findings, the take of marine mammals incidental to G&G surveys for oil and gas activities in the GOM, and to prescribe regulations containing mitigation under the statutory "least practicable adverse impact" standard, monitoring, and reporting required in authorizations issued pursuant to the rule, as required under Section 101(a)(5)(A) of the MMPA. Under the MMPA, "take" means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal" (16 U.S.C. 1362). The estimated changes in Level A and B harassment from the requirements of the rule do not directly translate into the presence or absence of a given marine mammal population or into changes in population levels.[86]

While existing information does not support monetizing the benefits of the Proposed Rule (i.e., monetizing the public's willingness to pay for reductions in harassment of marine mammals in the GOM), this chapter provides perspective on the multiple ways in which the marine mammals in the GOM support economic activity and contribute to people's well-being. This information characterizes the value of marine species to people and economies. This chapter first summarizes the regional economic contribution of marine mammal-related activities in the GOM, in particular whale watching (Section 5.2). It then provides qualitative information on the anticipated ecological benefits of the Proposed Rule and More Stringent Alternative (Section 5.3). This chapter then summarizes the economics literature characterizing the social welfare benefits people derive from marine mammal protection (Section 5.4). Finally, it describes potential indirect, or "ancillary," benefits of the Proposed Rule, including enhanced conditions for ecosystem services such as commercial fishing and sea turtle viewing (Section 5.5).

Overall, this chapter describes first, that the Proposed Rule will have a beneficial effect on marine mammal populations in the GOM and, second, that the economics literature demonstrates that these species provide social welfare benefits and contribute to regional economic productivity. The economic studies described do not evaluate benefits specifically of the Proposed Rule, however, and do not provide information to reliably quantify or monetize the benefits of the Proposed Rule protections.

[86] Sound can potentially injure marine mammals (Level A Harassment, as defined by the MMPA) or disrupt their behavioral patterns (Level B Harassment).

5.2 REGIONAL ECONOMIC VALUES OF MARINE MAMMALS: TOURISM AND RECREATION IN THE GOM

Marine mammal populations generate economic activity in the GOM and, more broadly, in the U.S. For example, the U.S. leads the world in whale watcher participation, with an estimated 4.9 million trips taken in 2008, or 38 percent of global whale watching trips.[87] In 2013, the tourism and recreation sector of ocean-related activities in the GOM region (inclusive of all counties bordering the GOM) generated nearly $6.2 billion in wages and employed 310,000 individuals at 17,300 establishments, for a total GDP contribution of approximately $13 billion.[88,89] Much of that ocean-related tourism is reliant on the diverse and abundant marine mammal and other marine wildlife populations.

The presence of marine mammals generates regional income and employment opportunities most directly through businesses that conduct marine mammal watching tours and other marine wildlife-related operations, such as educational and environmental organizations. Whale watching activities alone support hundreds of jobs and tens of millions in regional income in the GOM. In addition, tourists drawn to the region to participate in these tours and activities spend money on goods and services in the regional economy, for example for meals, accommodations, or transportation to and from the whale watching destination. According to a 2009 report, the number of whale watchers in the GOM states increased to over 550,000 in 2008, nearly an order of magnitude increase over a ten year time period (Exhibit 5-1).[90] Direct revenues from sales of whale watching tickets was $14.1 million that year, and the overall regional spending related to whale watching was nearly $45 million. An estimated 625 full-time equivalent jobs were directly involved in marine mammal recreation across all GOM states in 2008.[91]

---

[87] O'Connor, S., Campbell, R., Cortez, H., and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large.

[88] This report compiles Bureau of Labor Statistics data from the Quarterly Census of Employment. All monetized estimates are presented in terms of 2016$ employing the GDP implicit price deflator data.

[89] National Ocean Economics Program. 2016. Ocean Economy Market Data. Accessed December 14, 2016 and available at: http://oceaneconomics.org/Market/ocean/oceanEcon.asp. Original values (2013 dollars): nearly $6 billion in wages, nearly $12.5 billion total GDP contribution.

[90] O'Connor, S., Campbell, R., Cortez, H., and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large.

[91] O'Connor, S., Campbell, R., Cortez, H., and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large. Original reported direct expenditure value $12.7 million; indirect expenditure value $27.5 million (2009 dollars).

EXHIBIT 5-1. WHALE WATCHING STATISTICS IN GULF OF MEXICO STATES

YEAR	NUMBER OF WHALE WATCHERS	DIRECT EXPENDITURE[1] (MILLIONS 2016$)	TOTAL EXPENDITURE[2] (MILLIONS 2016$)
1998	61,000	Not reported	Not reported
2008	550,653	$14.1	$44.7

Notes:
1. Direct expenditure is defined here as expenditure on tickets and items directly related to the whale watching trip itself. It excludes costs such as accommodation, transport, and food not included in the trip ticket price.
2. Total expenditure includes both direct and indirect expenditures.

Source:
O'Connor, S., Campbell, R., Cortez, H., and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large.

Florida is the leading state for cetacean-based tourism in the country. Bottlenose dolphin viewing constitutes the majority of Florida's marine mammal-related tourism with average ticket prices of approximately $43 for boat-based trips and $95 for swim-with tours.[92] Elsewhere in the GOM, in Alabama and Texas, average ticket prices are $11 to $22. Commercial whale watching activity is minimal in Mississippi and Louisiana.[93]

Of note, as discussed in Section 4.3, BOEM does not expect significant levels of G&G activity in the federal waters off the coast of Florida in the next five years due to the existing GOMESA moratorium in the Eastern Planning Area, which applies to all submerged lands within 125 miles of Florida until June 30, 2022. G&G activities have been very limited in the area due to the GOMESA prohibitions on leasing activity. In the event that the moratorium is lifted, there would likely be an increased demand for G&G activities in these areas in the future, potentially within the five-year timeframe of this analysis. Mitigation measures applied to G&G activities in the broader GOM region, however, may benefit the marine mammal populations that support this economic activity across the Gulf States, including Florida.

5.3 ECOLOGICAL BENEFITS

G&G activities may negatively affect marine mammals and other marine wildlife, including sea turtles and fish species, in a number of ways, including underwater acoustic disturbances; vessel traffic (risk of ship strikes to marine organisms, vessel noise, and disruption of other marine-based activities); entanglement of commercial fishing

[92] Of note, NMFS considers swim-with-dolphin tours to be at risk of unlawful harassment. NMFS, "does not support, condone, approve, or authorize activities that involve closely approaching, interacting, or attempting to interact with whales, dolphins, porpoises, seals, or sea lions in the wild. This includes attempting to swim with, pet, touch, or elicit a reaction from the animals." (http://www.nmfs.noaa.gov/pr/dontfeedorharass.htm)

[93] O'Connor, S., Campbell, R., Cortez, H., and T. Knowles. 2009. Whale Watching Worldwide: Tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare, Yarmouth, MA, USA, prepared by Economists at Large. Original reported value for Florida's average boat-based ticket price of $39 and swim-with ticket of $85 (2009 dollars).Original reported value for Alabama average ticket of $10 and Texas average ticket of $20 (2009 dollars).

equipment with G&G equipment; impacts of stand-off distances on commercial fishing activity; and impacts of accidental spills on biological resources and commercial fishing activity. The Proposed Rule and More Stringent Alternative specifically address the acoustic disturbance introduced by seismic surveys. Sound generated by G&G surveys can potentially injure marine mammals (Level A harassment, as defined by the MMPA) or disrupt their behavioral patterns (Level B harassment). Sound may affect marine mammals by inducing stress responses or "masking" of other acoustic signals important to an animal's well-being. These potential affects to individual animals may or may not lead to a reduction in fitness and, ultimately, population-level consequences.[94,95]

The potential for exposure of an animal to survey noise to result in Level A harassment depends not only on the sound level of the survey, but also on other sound sources that are present, the type of marine mammal, and the distance from and position of the animal relative to the sound source. The significance of a disturbance event resulting in behavioral disruptions (Level B harassment) depends on all of these factors plus the duration of the exposure, the age and sex of the animal, and the particular behavior in which the animal is engaged at the time of exposure. These uncertainties complicate a quantitative analysis of the expected benefits of the Proposed Rule in terms of reductions in injury and behavioral disruption. With respect to the biological benefits of the Proposed Rule to the species, Appendix D of BOEM's PEIS includes a detailed set of test scenarios.[96]The mitigation measures of the Proposed Rule and More Stringent Alternative are designed to reduce the number and or intensity of exposures of marine mammals to acoustic disturbance from G&G surveys. In particular, as described in Chapter 1, Proposed Rule mitigation measures include:

1. Airgun survey shutdown requirements for PSO observations of large dolphins in the exclusion zone and power down requirements for observations of small dolphins in the exclusion zone (500-meter exclusion zone for deep penetration surveys and 200-meter exclusion zone for shallow penetration surveys).
2. Shutdown requirements for deep penetration airgun surveys due to PSO observations of Bryde's whale, Kogia species, and beaked whales outside of the 500-meter exclusion zone.
3. PAM implementation shutdowns for whale detections 24 hours/day for deep penetration airgun surveys in water depths greater than 100 meters.

---

94 Gulf of Mexico OCS Proposed Geological and Geophysical Activities Final PEIS: Appendix D. Zeddies, D.G., M. Zykov, H. Yurk, T. Deveau, L. Bailey, I. Gadoury, R. Racca, D. Hannay, and S. Carr. 2015. *Acoustic Propagation and Marine Mammal Exposure Modeling of Geological and Geophysical Sources in the Gulf of Mexico: 2016-2025 Annual Acoustic Exposure Estimates for Marine Mammals.* JASCO Document 00976, Version 3.0. Technical report by JASCO Applied Sciences for Bureau of Ocean Energy Management (BOEM).

95 Gulf of Mexico OCS Proposed Geological and Geophysical Activities Final PEIS: Appendix H. Southall, B. L. Marine Mammal Hearing and Sensitivity to Acoustic Impacts. Report by SEA, Inc. for Bureau of Ocean Energy Management (BOEM).

96 For more information, see Appendix D of: Bureau of Ocean Energy Management, August 2017, Gulf of Mexico OCS Proposed Geological and Geophysical Activities: Final Programmatic Environmental Impact Statement.

4. PSO implementation for non-airgun HRG surveys in deep water (greater than 200 meters depth) and shutdowns for observations of any whales and of large dolphins within a 200-meter exclusion zone.
5. Other operational and administrative requirements, including use of "big-eye" binoculars, PSO training, and reporting requirements.

Additional mitigation measures associated with the More Stringent Alternative include:

1. Shutdowns for PSO observations of sperm whales outside of the exclusion zone;
2. Shutdowns for PSO observations of non-bow-riding small dolphins within the exclusion zone.

In addition, seasonal restrictions and year-round area closures confer additional benefits to marine mammals and all marine wildlife by reducing the occurrence of acoustic sound sources within the identified area closures. These area closures reduce impacts of G&G surveys to marine mammals in areas of particular importance. Section 4.2.7 of the Final PEIS for G&G activities in the GOM describes the importance of the identified area closures to marine mammal populations. In summary, NMFS identified Coastal Waters Closure Area, Eastern Planning Closure Area, and Dry Tortugas Closure Area under the Proposed Rule and the Central Planning Closure Area under the More Stringent Alternative based on relative densities of the target species, including sperm whales (endangered), Bryde's whales, and beaked whales.

5.3.1 ECOLOGICAL BENEFITS OF PROPOSED RULE SEASONAL CLOSURE AREAS

The Proposed Rule specifies seasonal restrictions on seismic airgun surveys between February 1st and May 31st in the Coastal Waters Closure Area, which includes coastal waters shallower than 20 meters in depth. The impacts of active acoustic sound sources and vessel and equipment noise would be reduced over this timeframe. The timeframe of the seasonal closure is designed to protect particular stocks of the GOM common bottlenose dolphin during the time of their reproductive activity peak. Thus, while the seasonal closures may result in redistributing G&G survey activity over the year (as opposed to reducing overall levels), they would benefit bottlenose dolphins during their calving season.

5.3.2 ECOLOGICAL BENEFITS OF PROPOSED RULE YEAR-ROUND CLOSURE AREAS

The Proposed Rule additionally includes year-round closure to seismic airgun surveys in the Eastern Planning Closure Area and the Dry Tortugas Closure Area, both of which fall within BOEM's GOM Eastern Planning Area. The Eastern Planning Closure Area was delineated to encompass the small resident population of Bryde's whales and is an area of particular biological importance to this species. Sighting data indicate that the Dry Tortugas Closure Area contains very dense populations of sperm and beaked whales and this area may be important for sperm whale calving. This area likely supports a segment of the sperm whale stock's core abundance area. These closure areas provide a refuge from acoustic disturbance for these whale species, as well as any other marine mammals that occupy these areas. These area closures may also benefit other co-existing species,

including sea turtles and fish. Due to the current moratorium covering the GOM Eastern Planning Area, these closures are unlikely to affect overall levels of oil and gas production in the short to intermediate term; however, the year-round closures in these areas benefit multiple species of whales by minimizing adverse impacts from acoustic disturbance in particularly important habitat areas.

5.3.3 ECOLOGICAL BENEFITS OF THE ADDITIONAL YEAR-ROUND CLOSURE AREAS UNDER THE MORE STRINGENT ALTERNATIVE

The Central Planning Closure Area under the More Stringent Alternative contains relatively high densities of sperm and beaked whales, and likely supports a segment of the sperm whale stock's home range. While the Central Planning Closure Areas would still be subject to other oil and gas-related activities, the overall level of sound disturbance and vessel traffic would be reduced.[97]

Restrictions on G&G activities in the Central Planning Closure Areas are likely to affect the levels of oil and gas exploration and development given the relatively significant demand for development of these areas. To the extent that oil and gas production is curbed in these areas due to the year-round closure to G&G surveys, associated environmental impacts may be avoided. For example, reductions in oil and gas exploration and development activity may reduce the local risk of water quality degradation and air pollutant emissions. Reductions in oil and gas related activities in the GOM could further benefit local wildlife by reducing risk of other threats, such as those noted above (e,g., vessel strike). Of note, however, if world oil and gas demand is not correspondingly reduced, there may be environmental and social impacts from oil and gas production activities at substitute sites.

5.4 WILLINGNESS T0 PAY FOR MARINE MAMMAL PROTECTION

As described in Chapter 3, OMB defines opportunity cost as the appropriate measure of both costs and benefits in the context of a regulatory impact analysis. Opportunity costs reflect an individual (or population's) willingness-to-pay (often abbreviated WTP) to receive a particular benefit. If the benefit being valued is traded in a market, market data may readily inform value. However, for goods or services not traded in markets, estimating WTP is more difficult.

An ideal analysis monetizing the value of the benefits of reductions in marine mammal harassment would require two primary pieces of information:

1. A quantified incremental change in impacts to marine mammals that is expected to result from the Proposed Rule; and
2. Information on the public's willingness-to-pay for this incremental change.

[97] For more information, see Chapter 4, Section 4.2.7 of: Bureau of Ocean Energy Management, August 2017, Gulf of Mexico OCS Proposed Geological and Geophysical Activities: Final Programmatic Environmental Impact Statement.

Neither of these pieces of information is available to inform a quantitative estimate of the benefits of the Proposed Rule, however. As previously discussed, we do not have a quantitative estimate of the change in impacts for the various species of marine mammals due to the Proposed Rule. Furthermore, even if we had that information, existing studies valuing marine mammals or programs that protect them do not focus on monetizing the benefits of reduced harassment or reduced risk of adverse impacts. Estimates of the WTP for wildlife species are generally focused on changes in overall population levels or likelihood of recovery and, for the most part, are focused on endangered species.

In the absence of information that would allow us to monetize the rule's benefits, we discuss existing literature demonstrating people's positive WTP for marine mammals, including some species relevant to this rulemaking. People's WTP may reflect both use and non-use values for a species. Use values derive from a direct use for a species, such as commercial harvesting or recreational wildlife-viewing opportunities. Non-use values are not derived from direct use of the species, but instead reflect the utility the public derives from knowledge that a species continues to exist (e.g., existence or bequest values).

Economists apply a variety of methodological approaches in estimating both use and non-use values for species and for habitat improvements, including stated preference and revealed preference methods. Stated preference techniques include such tools as the contingent valuation method, conjoint analysis, or contingent ranking methods. In simplest terms, these methods employ survey techniques, asking respondents questions to elicit information on what they would be willing to pay for a resource or for programs designed to protect that resource. A substantial body of literature has developed that describes the application of this technique to the valuation of natural resource assets. Stated preference surveys are the only methods that may be employed to elicit information on non-use values.[98] However, while stated preference studies provide useful insights regarding non-use values, the limitations of these studies are well documented in the economics literature.

More specific to use values for species or habitats, revealed preference techniques examine individuals' behavior in markets in response to changes in environmental or other amenities (i.e., people "reveal" their value through their behavior). For example, travel cost models are frequently applied to value access to recreational opportunities, as well as to value changes in the quality and characteristics of these opportunities. Basic travel cost models are rooted in the idea that the value of a recreational resource can be estimated by analyzing the travel and time costs incurred by individuals visiting the site. Another revealed preference technique is hedonic analysis, which is often employed to determine the effect of site-specific characteristics on property values.

[98] NOAA recently completed a stated preference survey to elicit information on the total value of the ecological injuries associated with the Deepwater Horizon oil spill in the Gulf of Mexico. While the species injuries included in that study included dolphins, the study did not provide information specifically on values for dolphins.

As previously described, wildlife-viewing, and marine mammal viewing in particular, is a popular activity in the GOM. While we did not identify any studies focused on the GOM, in particular, the economics literature demonstrates the positive value that people hold for whale watching opportunities. Leeworthy and Wiley (2003) estimate the consumer surplus (i.e., the WTP for the activity above and beyond the cost of participating) per person per whale watching day in California as $52 (2016 dollars) in 1999.[99,100] Near Massachusetts Bay, the consumer surplus value per person per whale watching day was estimated as $27 in 1996, according to a study by Hoagland and Meeks.[101] The overall consumer surplus associated with whale watching off the East Coast, based on 2009 estimated whale watching participant numbers and Hoagland and Meeks' east coast consumer surplus value per day, is an estimated $148 million per year.[102]

The extent to which the Proposed Rule or More Stringent Alternative affect opportunities for, or values of, whale watching trips in the GOM is highly uncertain. Any changes in expected impacts to marine mammals may or may not affect the overall experience of wildlife viewing trips. Based on existing literature, attributes of whale watching that influence participant satisfaction (i.e., consumer surplus) include both whale-related and non-whale related factors.[103] Whale-related factors are the most important determinants of participant satisfaction, and include whale behaviors, whether whales are observed, and the number of whales observed.[104,105] Other factors that may influence whale watchers' satisfaction include distance from whales, educational information provided by the tour operators, environmental factors, the vessel size, and the behavior of fellow whale watchers.[106] Theoretically, the Proposed Rule may influence these factors to the extent that there is an increased likelihood of seeing whales or that whale watchers perceive the populations to be healthier or safer based on educational information provided about mitigation measures associated with the Proposed Rule or More Stringent Alternative.

---

[99] Leeworthy and Wiley 2003, as cited in Pendleton *et al*. 2014. Original reported value of $49.70 (2012 dollars).

[100] All values reported in 2016 dollars unless otherwise specified. Values adjusted using Bureau of Economic Analysis Implicit Price Deflators for Gross Domestic Product, Table 1.1.9, accessed December 15, 2016 at: https://bea.gov/iTable/iTable.cfm?reqid=9&step=3&isuri=1&903=13#reqid=9&step=3&isuri=1&903=13.

[101] Hoagland and Meeks 2000, as cited in Pendleton *et al*. 2014. Original reported value of $25.90 (2012 dollars).

[102] Pendleton, L., Krowicki, F., Strosser, P., & Hallett-Murdoch, J. 2014. Assessing the value of marine and coastal ecosystem services in the Sargasso Sea. Duke Environmental and Energy Economics Working Paper Series. Original reported value of $140 million per year (2012 dollars).

[103] Warren, S. 2012. Passenger Preferences for whale watching tour attributes and payment for grey whale habitat protection: A case study in Tofino, B.C. Master's thesis, Simon Fraser University.

[104] Warren, S. 2012. Passenger Preferences for whale watching tour attributes and payment for grey whale habitat protection: A case study in Tofino, B.C. Master's thesis, Simon Fraser University.

[105] Kessler, E., Harcourt, R., and W. Bradford. 2014. Will whale watchers sacrifice personal experience to minimize harm to whales?. Tourism in Marine Environments, 10(1-2):21-30.

[106] Kessler, E., Harcourt, R., and W. Bradford. 2014. Will whale watchers sacrifice personal experience to minimize harm to whales?. Tourism in Marine Environments, 10(1-2):21-30.

In addition to use values, people may value marine mammals based on a desire to preserve them for future generations (i.e., bequest value) or simply for altruistic reasons (sometimes referred to as existence values). Limited information exists specifically focused on relative non-use values across different marine mammal species. However, numerous published studies focus on estimating individuals' WTP to protect endangered species.[107] A selection of values from relevant studies is presented in Exhibit 5-2.

The economic values reported in these studies reflect various groupings of benefit categories (including both use and non-use values). For example, these studies assess people's WTP for wildlife-viewing opportunities, for the option of seeing or experiencing the species in the future, to assure that the species will exist for future generations, and simply knowing a species exists, among other values. Willingness to pay for a preservation fee (indicative of both use and non-use values, depending on the study) demonstrates that the public values, and is willing to pay, to support the long-term health of whale populations.

The sperm whale is currently listed as endangered under the ESA and occurs in the GOM. The Florida subspecies of the West Indian manatee resides in nearshore tidal habitat. According to a 1995 study, Floridians were willing to pay approximately $23 per household per year for protection of the manatee population; the authors translate that into a total asset value of the Florida manatee population of about $4.1 billion (WTP per year in perpetuity).[108] A recent study by Solomon (2014) in the Gulf coast county of Citrus, Florida concluded that the total WTP by county residents for manatee protection was nearly $260,000 per year.[109] While manatees generally stay close to the shore and are therefore unlikely to occur in the G&G survey areas, this information provides perspective on how regional populations value marine mammal species.

The studies summarized in Exhibit 5-2 generally express values of marine mammal species in terms of annual WTP per household for a given region (e.g., state or county). A recent study by Wallmo and Lew compares regional household WTP (for communities adjacent to marine mammal habitat) for marine mammal protection with national household WTP. This study finds only slight differences between regional values and national values for protection of marine mammals. This suggests that the U.S. public values protection of these species outside of just direct use values and, therefore, that household WTP for marine species protection is likely relevant across a much greater population than local households.

---

[107] See, for example, the summary in Richardson, L. and J. Loomis. March 2009. The Total Economic Value of Threatened, Endangered, and Rare Species: An Updated Meta-Analysis. Ecological Economics 68(5): 1535-1548.

[108] Bendle, B. J., & Bell, F. W. 1995. An estimation of the total willingness to pay by Floridians to protect the endangered West Indian manatee through donations. Report to the Save the Manatee Club and the Florida Department of Environmental Protection's Bureau of Protected Species Management. Original reported value of $14.78 (1992 dollars).

[109] Solomon, B. D., Corey-Luse, C. M., & Halvorsen, K. E. 2014. The Florida manatee and eco-tourism: toward a safe minimum standard. Ecological Economics 50(1):101-115. Original reported value of $10.25 (2014 dollars).

As noted above, the degree to which the Proposed Rule or More Stringent Alternative may affect these values is highly uncertain. The estimated changes in adverse effects to marine mammals do not directly translate into the presence or absence of a given marine mammal population or necessarily into changes in population levels. These studies do demonstrate, however, that the public is willing to pay for programs to protect marine mammals.

EXHIBIT 5-2. MARINE MAMMAL PROTECTION VALUATION STUDIES

STUDY	MARINE MAMMAL SPECIES	DESCRIPTION OF VALUE CHARACTERIZED	REPORTED VALUES (2016$)
GULF OF MEXICO STUDIES			
Bendle and Bell (1995)[1]	West Indian manatee	Floridians' willingness to pay for manatee protection	• WTP per FL household (HH): **$23/year** • FL manatee population value: $4.1 billion
Solomon *et al*. (2014)[2]	West Indian manatee	Citrus County, Florida households' willingness to pay for manatee protection	• WTP per County HH: **$14/year** • WTP across County HHs: $260,000/year
STUDIES IN NON-GULF LOCATIONS			
Hageman (1986)[3]	Bottlenose dolphin	California households' willingness to pay to avoid a decline in the CA bottlenose dolphin population	• WTP per CA HH to protect bottlenose dolphin population: **$34/year**
Loomis and Larson (1994)[4]	Gray whale	California households' willingness to pay for 50 and 100 percent increases in gray whale populations and corresponding increase in sightings along the California coast	• WTP per CA HH for a 50% increase: **$25/year** • WTP per CA HH for a 100% increase: **$29/year**
Wallmo and Lew (2015)[5]	Southern resident killer whales	WTP for species recovery for West Coast households and national households (WTP per year over 10 years)	• WTP per West Coast HH for recovery: $91/year • WTP per national HH for recovery: $85/year
Wallmo and Lew (2015)[5]	Humpback whale	WTP for species recovery for West Coast households and national households (WTP per year over 10 years)	• WTP per West Coast HH for recovery: $64/year • WTP per national HH for recovery: $62/year

Sources and notes:

1. Bendle, B. J., & Bell, F. W. 1995. An estimation of the total willingness to pay by Floridians to protect the endangered West Indian manatee through donations. Report to the Save the Manatee Club and the Florida Department of Environmental Protection's Bureau of Protected Species Management. Original reported value of $14.78 (1992 dollars).

2. Solomon, B. D., Corey-Luse, C. M., & Halvorsen, K. E. 2014. The Florida manatee and eco-tourism: toward a safe minimum standard. Ecological Economics 50(1):101-115. Original reported value of $10.25 (2014 dollars).

3. Hageman, R. K. 1986. Economic valuation of marine wildlife: does existence value exist?. In Association of Environmental and Resource Economists Workshop on Marine Pollution and Environmental Damage Assessment, Narragansett, RI. Original reported value of $17.73 (1986).

4. Loomis and Larsen 1994, as cited in Pendleton *et al*. 2014.

5. Wallmo, Kristy and Daniel K. Lew. 2015. Public preferences for endangered species recovery: an examination of geospatial scale and non-market values.

5.5 ANCILLARY BENEFITS

The Proposed Rule and More Stringent Alternative may also generate additional benefits unrelated to the intended purpose of the rulemaking. These ancillary benefits are defined by OMB as favorable impacts of a rulemaking that are typically unrelated or secondary to the statutory purpose of the rulemaking.[110] For example, temporary shutdowns and seasonal or year-round closure areas may reduce exposure of other, co-existing marine species to acoustic disturbance, G&G vessel strikes and equipment entanglement, seafloor-disturbing activities, or accidental oil spills associated with G&G activities. Potential species that may experience ancillary benefits of the rule include manatees and sea turtles, including loggerhead, green, Kemp's ridley, hawksbill, and leatherback, which are ESA-listed as threatened or endangered.[111]

As is the case with marine mammals, a limited number of studies examine how the public values changes in the conservation status of other marine species, although studies are not available to support monetizing the incremental benefits of the Proposed Rule with respect to protection of these species. While the targeted benefit of this rule is to reduce harassment of marine mammals, other species may benefit and these studies demonstrate that the public values these ancillary benefits, as well. For example, a study by Whitehead (1993) applied the contingent valuation method to elicit information on the public's WTP to reduce the risk of loggerhead sea turtle extinction to zero for the next 25 years. Results from North Carolina household respondents indicate the mean willingness to pay for a loggerhead protection program that would preclude extinction of the species for 25 years is $17.69 per household.[112] Wallmo and Lew (2012) evaluated people's preferences to downlist eight threatened and endangered marine species, including the loggerhead sea turtle. Respondents' mean willingness to pay to recover the loggerhead from its status as threatened was $47.05 per household every year for ten years.[113] In terms of use values, a survey implemented by Oceana (2008) asked scuba divers in the United States to indicate the maximum amount they were willing to pay per dive, in addition to the regular costs of diving, for an increased likelihood of viewing sea turtles. The mean willingness to pay was $33.18. The Oceana survey did not indicate the percent increase in likelihood of viewing a sea turtle.[114]

---

[110] U.S. Office of Management and Budget, "Circular A-4," September 17, 2003, available at http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf.

[111] BOEM, September 2016 Draft PEIS.

[112] Whitehead, John. 1993. Total Economic Values for Coastal and Marine Wildlife: Specification, Validity, and Valuation Issues. Marine Resource Economics 8:119-132. Original reported value of $10.98 (1991 dollars).

[113] Wallmo, Kristy and Daniel K. Lew. 2012. Public Willingness to Pay for Recovering and Downlisting Threatened and Endangered Marine Species. Conservation Biology 48(5):830-839. Original reported value of $43.72 (2011 dollars).

[114] Oceana. 2008. Sea the Value: Quantifying the Value of Marine Life to Divers. Accessed December 14, 2016 and available at: http://oceana.org/reports/sea-value-quantifying-value-marine-life-divers. Original reported value of $29.62, assumed dollar year 2008.

Overall, the published literature is clear that healthy populations of marine mammals and other co-existing species benefit regional economies and provide social welfare benefits to people. The available literature, however, does not provide a basis for quantitatively valuing the anticipated incremental changes in environmental disturbance and marine mammal harassment associated with the Proposed Rule or More Stringent Alternative.

APPENDIX A | INDUSTRY COMPLIANCE AND ECONOMIC COST ANALYSIS – STAY AGREEMENT BASELINE

A.1 INTRODUCTION

The main body of this report evaluates the impacts of the Proposed Rule and More Stringent Alternative relative to the state of the G&G industry prior to the 2013 Stay Agreement (as discussed in Chapter 1). This appendix presents costs of the Proposed Rule and More Stringent Alternative relative to the costs of the G&G survey mitigation measures described in the Stay Agreement. As the Stay Agreement resulted in additional marine mammal mitigation for G&G surveys in the GOM, G&G operations in the GOM under the Stay Agreement Baseline are more costly than under Pre-Stay Agreement Baseline. Some mitigation measures described in the Stay Agreement are not included in the Proposed Rule and More Stringent Alternative. For these reasons, the Proposed Rule and More Stringent Alternative have the effect of reducing costs of G&G surveys relative to the Stay Agreement Baseline, as discussed in this appendix.

In order to present costs incremental to the Stay Agreement Baseline, we first evaluate the costs of the mitigation measures included in the Stay Agreement. The Stay Agreement includes the following mitigation measures:

- Minimum separation distance requirements between simultaneous deep penetration airgun surveys;
- Shutdowns for protected species observer (PSO) observations of manatees within the exclusion zone;
- PSO requirements for seismic airgun surveys operating in water depths less than 200 meters in the Central and Western Planning Areas and associated shutdowns for whale observations in the exclusion zone;
- Use of passive acoustic monitoring (PAM) during times of reduced visibility (darkness, fog, rain, etc.); and
- Seasonal restrictions on G&G surveys in the Coastal Waters Closure Area and year-round closures in defined Areas of Concern in the Eastern Planning Area (subject to exceptions).

The first four measures have the potential to directly increase compliance costs of G&G surveys. Section A.2 presents our estimates of the costs associated with these measures, as well as the total estimated costs associated with seismic surveys under the Stay Agreement Baseline. Section A.3 presents the incremental costs of the Proposed Rule and More Stringent Alternative in comparison to the Stay Agreement Baseline. The potential indirect impacts of the seasonal and area closures included under the Proposed Rule and

More Stringent Alternative in comparison to the seasonal restrictions and area closures included in the Stay Agreement Baseline are described in Section A.4.

Exhibit A-1 summarizes the costs of the Proposed Rule and More Stringent Alternative compared to the stay agreement baseline. The parenthetical numbers reflect negative costs (or cost savings).

EXHIBIT A-1. ANNUALIZED COSTS BY MITIGATION MEASURE – STAY AGREEMENT BASELINE, 2018-2022 (2016$, 7 PERCENT DISCOUNT RATE)

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	**ANNUALIZED COSTS, MILLIONS**	**MITIGATION MEASURE**	**ANNUALIZED COSTS, MILLIONS**
QUANTIFIED DIRECT COMPLIANCE COSTS			
Mitigation Requirements for PSO Dolphin Observations: Shutdowns for large dolphins in the exclusion zone and power downs for small dolphins in the exclusion zone	$3.9 – $49.7	*Mitigation Requirements for PSO Dolphin Observations:* Shutdowns for large dolphins in the exclusion zone and for small dolphins that are not bow-riding in the exclusion zone	$15.2 - $40.2
Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone: Shutdowns for Bryde's/beaked/Kogia whales for deep penetration airgun surveys	$1.1 - $3.0	*Additional Mitigation Requirements for PSO Whale Observations outside of Exclusion Zone:* Shutdowns for Bryde's/beaked/Kogia and sperm whales for deep penetration airgun surveys	$18.4 - $48.8
PAM Implementation Requirements and Associated Mitigation for Whale Detections: Shutdowns for all whale detections for deep penetration airgun surveys*	$21.9 - $65.8	*PAM Implementation Requirements and Associated Mitigation for Whale Detections:* Shutdowns for all whale detections for deep penetration airgun surveys*	$21.8 - $53.2
PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations: Shutdowns for whale and large dolphin observations in the exclusion zone	$0.12 - $0.39	*PSO Implementation Requirements for Non-Airgun HRG surveys and Associated Mitigation for Whale and Dolphin Observations*: Shutdowns for whale and large dolphin observations in the exclusion zone	$0.12 - $0.39
AVOIDED COSTS – COSTS ASSOCIATED WITH STAY AGREEMENT MITIGATION MEASURES THAT WILL NO LONGER BE REQUIRED			
Remove Minimum Separation Distance Requirements for Deep Penetration Airgun Surveys: The stay agreement baseline includes minimum separation distances. Costs reflect the downtime associated with maintaining the minimum separation distance from other surveys. This mitigation measure is not included in the Proposed Rule, thus creating a benefit (negative cost) of the Proposed Rule relative to the stay agreement baseline.	($37.9) – ($266)	*Remove Minimum Separation Distance Requirements for Deep Penetration Airgun Surveys:* The stay agreement baseline includes minimum separation distances. Costs reflect the downtime associated with maintaining the minimum separation distance from other surveys. This mitigation measure is not included in the More Stringent Alternative, thus creating a benefit (negative cost) of the More Stringent Alternative relative to the stay agreement baseline.	($37.8) – ($230)
Proposed Rule Total Net Costs	**($10.8) - ($147)**	**More Stringent Alternative Total Net Costs**	**$18 - ($111)**

PROPOSED RULE		MORE STRINGENT ALTERNATIVE	
MITIGATION MEASURE	**ANNUALIZED COSTS, MILLIONS**	**MITIGATION MEASURE**	**ANNUALIZED COSTS, MILLIONS**
QUALITATIVE ASSESSMENT OF POTENTIAL INDIRECT COSTS			
Seasonal Restrictions: Precludes use of airguns in coastal waters between February 1 and May 31**	Minimal potential for impacts to oil and gas productivity in the GOM over the next 5-10 years	*Seasonal Restrictions*: Precludes use of airguns in coastal waters between February 1 and May 31**	Minimal potential for impacts to oil and gas productivity in the GOM over the next 5-10 years
Area Closures: Precludes use of airguns year round within the Eastern Planning Closure Area and Dry Tortugas Closure Area***	Low potential for impacts to oil and gas productivity in the GOM over the next 5-10 years	*Area Closures*: Precludes use of airguns year round within the Central Planning Closure Area, Eastern Planning Closure Area, and Dry Tortugas Closure Area***	Substantial potential for impacts to oil and gas productivity in the GOM over the next 5-10 years

Notes:

1. Estimates within parentheses indicate negative costs, or cost savings.
2. Costs are presented in terms of 2016 US Dollars and are annualized over the five-year time frame (2018-2022) applying a 7% discount rate.
3. Estimates are rounded to three significant digits.
4. This exhibit reflects incremental costs of the Proposed Rule and More Stringent Alternative relative to the stay agreement baseline.

* Under the stay agreement baseline, we assume PAM is used with two operators for 12 hours per day during all seismic airgun surveys (shallow and deep penetration) and that G&G vessels shut down in response to all whale detections. The Proposed Rule and More Stringent Alternative assume that PAM is used with four operators for 24 hours per day only for deep penetration seismic surveys, and that G&G vessels shut down in response to all whale detections.

** As discussed in Section A.4, the seasonal restrictions included in the Proposed Rule and More Stringent Alternative represent a time shift for seasonal restrictions in the UME area, and a two month extension of seasonal restrictions in the rest of the Coastal Waters Closure Area.

*** As discussed in Section A.4, the Stay Agreement includes some closures to G&G activity in the Eastern Planning Area that are different than under the Proposed Rule and More Stringent Alternative. The Stay Agreement does not include year-round area closures in the Central Planning Area, however.

A.2 COMPLIANCE COSTS ASSOCIATED WITH THE STAY AGREEMENT

The following section describes the costs of the Stay Agreement mitigation measures that are above and beyond the costs of G&G surveys under the Pre-Stay Agreement baseline. Of these mitigation measures, the minimum separation distance requirements have added the greatest cost to deep penetration surveys.

Minimum Separation Distance Requirements

Under the Stay Agreement, simultaneous deep penetration seismic surveys must maintain a minimum separation distance of 40 kilometers in defined Areas of Concern, and 30 kilometers outside the Areas of Concern. Based on a review of historical G&G permits, BOEM estimates that 65 percent of all deep penetration seismic surveys are affected by the minimum separation distance requirements.[1] In response to the 2014 survey, IAGC reported that compliance with the minimum separation distance requirements is associated with a 10 to 25 percent loss in survey efficiency.[2] This analysis estimates the total incremental downtime associated with the minimum separation distance requirements by multiplying this range of potential efficiency losses by the average survey duration for each survey type. We then multiplied the additional number of days added to the typical survey length by the average daily vessel operating cost to estimate the average incremental cost of the minimum separation distance requirements. Exhibit A-2 summarizes the efficiency losses and associated costs for each survey type.

[1] Email communication from BOEM to IEc on September 12, 2017.

[2] International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.

EXHIBIT A-2. ADDITIONAL COSTS PER SURVEY DUE TO COMPLIANCE WITH THE MINIMUM SEPARATION DISTANCE REQUIREMENTS

PERMIT TYPE	EFFICIENCY LOSS DUE TO COMPLIANCE WITH MINIMUM SEPARATON DISTANCE REQUIREMENTS [A]	AVERAGE DURATION ON WATER (DAYS) (EXHIBIT 4-2) [B]	TOTAL ADDED DAYS DUE TO MINIMUM SEPARATION DISTANCE REQUIREMENTS [C = A × B]	VESSEL OPERATING COST/DAY (EXHIBIT 4-2) [D]	AVERAGE COST OF MINIMUM SEPARATION DISTANCE REQUIREMENTS* [E = C × D]
2D	10% to 25%	176	17.6 - 44.0	$97,500	$1,720,000 - $4,290,000
2D-OBS	10% to 25%	141	14.1 - 35.4	$372,000 - $542,000	$5,270,000 - $19,200,000
3D	10% to 25%	137	13.7 - 34.4	$325,000	$4,470,000 - $11,200,000
3D-OBS	10% to 25%	141	14.1 - 35.4	$600,000 - $770,000	$8,490,000 - $27,200,000
WAZ	10% to 25%	178	17.8 - 44.5	$875,000	$15,600,000 - $38,900,000
Airgun HRG	10% to 25%	10	1.0 - 2.4	$33,500	$31,800 - $79,600
VSP	10% to 25%	7	1.8 - 4.5	$33,500 - $71,400	$23,500 - $125,000
SWD	10% to 25%	7	0.7 - 1.8	$33,500 - $71,400	$23,500 - $125,000

Source:
International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
* Estimates are rounded to three significant digits and may not sum to the totals reported due to rounding.

PAM Requirements

Under the stay agreement baseline, PAM is required during reduced visibility conditions in waters greater than 100 meters in depth for all deep penetration seismic airgun surveys. For the purposes of this analysis, we assume that G&G vessels operate during reduced visibility conditions, and use PAM, for 12 hours per day on average. Additionally, we assume that G&G vessels shut down in response to all PAM detections of whales. While the stay agreement does not explicitly specify shutdown requirements associated with PAM use, we understand that standard industry practice is to shut down for PAM detections of whales. This matches the assumption included in the final PEIS evaluating future G&G activities in the GOM.[3] In the case that some survey operators are not

[3] BOEM. (2017). Gulf of Mexico OCS Proposed Geological and Geophysical Activities. Western Central, and Eastern Planning Areas. Final Programmatic Environmental Impact Statement. OCS EIS/EA BOEM 2017-051. https://www.boem.gov/BOEM-2017-051-v1/

shutting down due to whale detections, this analysis may overestimate the costs of industry practices under the Stay Agreement.

We quantify costs (efficiency losses, as well as administrative and operational costs) of PAM for the Stay Agreement applying the same methods as described in Section 4.2.2. Exhibit A-3 summarizes the results.

PSO Implementation Requirements for Seismic Airgun Surveys in Shallow Water and Associated Mitigation for Whale Observations

The Stay Agreement requires that seismic airgun surveys in all water depths in the Western and Central Planning Areas include PSOs. In addition, the Stay Agreement requires shutdowns for observations of any whales in the exclusion zone. By comparison, PSOs were required prior to the Stay Agreement only for those seismic airgun surveys occurring in water depths of 200 meters or more. We quantify the additional operating costs associated with having PSOs on board survey vessels, as well as the efficiency losses associated with shutdowns due to PSO detections of whales using the same methods described in Section 4.2.2. Exhibit A-3 summarizes the results.

Mitigation Requirements for PSO Manatee Observations

Under the Stay Agreement, G&G surveys must shut down seismic operations when manatees are observed within the exclusion zone. However, G&G vessels are unlikely to encounter manatees while operating in federal waters as manatees generally remain in nearshore tidal waters. Federal waters begin three to nine miles offshore; therefore, we find that incremental costs associated with shutdowns for manatee sightings, if any, would be negligible and are not quantified in this analysis.

Summary of Incremental Costs by Mitigation Measure

Exhibit A-3 summarizes the estimated incremental costs per survey for each mitigation measure included in the stay agreement. Exhibit A-4 displays the total Stay Agreement baseline costs of G&G surveys in the GOM, based on the Pre-Stay Agreement baseline costs of surveys in the GOM and the quantified costs of the additional mitigation measures included in the stay agreement.

EXHIBIT A-3. AVERAGE INCREMENTAL COSTS OF STAY AGREEMENT PER SURVEY BY MITIGATION MEASURE (2016$)

PERMIT TYPE	MINIMUM SEPARATION DISTANCE REQUIREMENTS	USE OF PAM REQUIRED DURING LOW VISIBILITY	PSO PROGRAM FOR AIRGUN SURVEYS IN SHALLOW WATERS	TOTAL INCREMENTAL COST
2D	$1,120,000 - $2,790,000	$470,000 - $519,000	$155,000 - $316,000	$1,740,000 - $3,620,000
2D-OBS	$3,420,000 - $12,500,000	$480,000 - $1,180,000	$136,000 - $754,000	$4,040,000 - $14,400,000
3D	$2,900,000 - $7,260,000	$829,000 - $1,740,000	$176,000 - $405,000	$3,910,000 - $9,400,000
3D-OBS	$5,520,000 - $17,700,000	$739,000 - $1,580,000	$167,000 - $801,000	$6,420,000 - $20,100,000
WAZ	$10,100,000 - $25,300,000	$6,690,000 - $7,230,000	$998,000 - $2,150,000	$17,800,000 - $34,700,000
Airgun HRG	N/A	N/A	$6,010 - $14,700	$6,010 - $14,700
Non-airgun HRG	N/A	N/A	N/A	N/A
VSP	$15,200 - $81,300	$15,100 - $20,700	$1,630 - $4,240	$32,000 - $106,000
SWD	$15,200 - $81,300	$15,100 - $20,700	$1,630 - $4,240	$32,000 - $106,000

Notes:
1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
2. This exhibit reflects incremental costs of the Stay Agreement above the Pre-Stay Agreement baseline.

EXHIBIT A-4. ESTIMATED STAY AGREEMENT BASELINE COSTS PER SURVEY IN THE GOM (2016$)

PERMIT TYPE [A]	AVERAGE DURATION ON WATER (DAYS) [B]	MOBILIZATION AND PRE-MOBILIZATION COST [C]	VESSEL OPERATING COST/DAY (PRE-SETTLEMENT) [D]	COST OF MITIGATION MEASURES [E]	TOTAL AVERAGE SURVEY COST [F = C + (B×D) + E]
2D	176	$5,100,000	$97,500	$1,740,000 - $3,620,000	$24,000,000 - $25,900,000
2D-OBS	141	$5,100,000	$372,000 - $542,000	$4,040,000 - $14,400,000	$61,800,000 - $96,200,000
3D	137	$5,100,000	$325,000	$3,910,000 - $9,400,000	$53,700,000 - $59,200,000
3D-OBS	141	$5,100,000	$600,000 - $770,000	$6,420,000 - $20,100,000	$96,400,000 - $134,000,000
WAZ	178	$10,100,000 - $15,100,000	$875,000	$17,800,000 - $34,700,000	$183,000,000 - $205,000,000
Airgun HRG	10	$140,000	$33,500	$6,010 - $14,700	$464,000 - $473,000
Non-airgun	18	$140,000	$33,500	N/A	$742,000 - $742,000
VSP	7	$140,000	$33,500 - $71,400	$32,000 - $106,000	$406,000 - $746,000
SWD	7	$140,000	$33,500 - $71,400	$32,000 - $106,000	$406,000 - $746,000

Notes:

1. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding.
2. IAGC provided ranges for only some survey types and cost categories.
3. IAGC estimated a vessel operating cost/day of $275,000 to $445,000 for OBS. For the purposes of this analysis, we interpret these costs as additive with the provided daily operating cost for 2D and 3D surveys.
4. The VSP costs reflect Zero Offset VSP surveys at the low end, and 3D VSP surveys at the high end. We estimated average daily operating costs for these surveys by dividing total survey costs provided by NETL by estimated survey durations.
5. Absent data specific to SWD surveys, we assume that average survey duration and costs are similar to VSP surveys.

Sources:

1. International Association of Geophysical Contractors (IAGC) responses to a 2014 survey regarding the costs of G&G activities.
2. Personal communication between IEc, IAGC, and API. December 15, 2016.
3. NETL. (2013). *Summary of Costs Associated with Seismic Data Acquisition and Processing*. NETL document number: DOE/NETL-2014/1671.

A.3 INCREMENTAL COMPLIANCE COSTS RELATIVE TO THE STAY AGREEMENT BASELINE

To calculate the incremental compliance costs of the Proposed Rule and More Stringent Alternative relative to the Stay Agreement Baseline, we calculate the difference in per survey costs under each of the regulatory scenarios. Exhibit A-5 displays the summary results per survey, which are summed by mitigation measure in Exhibit A-1. This analysis finds the following:

1) The costs related to non-airgun survey mitigation measures are the same for the Stay Agreement Baseline as they are for the Pre-Stay Agreement Baseline because the Stay Agreement did not change non-airgun requirements.

2) The costs related to the PSO requirement and associated whale shutdowns for airgun surveys in shallow waters are the same for the Proposed Rule and More Stringent Alternative as they are for the Stay Agreement Baseline. As a result there are no PSO mitigation measures that are incremental to the Stay Agreement Baseline (except for the manatee shutdown requirement).

3) Given implementation of PAM and associated shutdowns under the Stay Agreement Baseline, the use of PAM results in shutdowns half as frequently as under the Proposed Rule and More Stringent Alternative (when PAM is used 24 hours per day as opposed to 12). All other costs associated with the PAM requirement, such as wages for PAM operators and installation of PAM equipment, are equivalent to the costs presented in Section 4.2.2.

4) As the exhibit demonstrates, the Proposed Rule is expected to provide compliance cost savings relative to the Stay Agreement Baseline for all survey types except for airgun and non-airgun HRG surveys. HRG surveys are shallow penetration surveys and thus are not subject to the minimum distance requirements under the stay agreement baseline. As a result, these surveys do not realize cost savings from the removal of the minimum distance requirements under the Proposed Rule.

5) Aside from HRG surveys, the More Stringent Alternative is expected to provide compliance cost savings for most survey types except for WAZ surveys and 2D surveys at the low-end. For these survey types, the low-end costs of the mitigation measures included in the More Stringent Alternative are greater than the costs of the mitigation measures included in the Stay Agreement Baseline. However, in the high-end, the 25 percent efficiency loss associated with the Minimum Separation Distance requirements in the Stay Agreement Baseline ultimately costs more than all of the mitigation measures included in the More Stringent Alternative.

6) Compliance cost savings are expected for all other survey types due to the Proposed Rule and More Stringent Alternative removing the Minimum Separation Distance requirements of the Stay Agreement.

Exhibit A-6 combines the per-survey compliance costs or avoided costs (represented by numbers in parentheses) that are incremental to the Stay Agreement Baseline with the

G&G survey forecast (described in Section 4.2.3) to quantify the present value costs of the Proposed Rule and More Stringent Alternative over the rule's five year timeframe. Exhibit A-7 presents the annualized value of these incremental impacts.

As discussed in Chapter 4, overall, the quantified costs of the Proposed Rule are conservative in that they are more likely to overestimate than underestimate costs. In particular, the high-end costs reflect conservative assumptions regarding mitigation generated by the rule; for example, at the high end we assume that power downs for small dolphin observations all result in the need to reshoot in order to effectively gather the needed geophysical data. In reality, it is likely that some fraction of the power downs would be relatively short or otherwise not result in the need to reshoot. In addition, the Proposed Rule has the potential to generate some cost savings due to:

- Reduced administrative effort require to obtain a letter of authorization (LOA) from the National Marine Fisheries Service (NMFS) rather than an Incidental Harassment Authorization (IHA) for each survey; and
- Smaller exclusions zones for shallow penetration airgun surveys (200 meters as compared with 500 meters under the baseline).

The potential for these aspects of the Proposed Rule to result in cost savings would offset some of the additional compliance costs at both the low end and the high end as compared with the Stay Agreement Baseline. While data limitations precluded quantification of these potential cost savings, we include them as key uncertainties leading to a generally conservative estimate of the Proposed Rule costs.

EXHIBIT A-5. INCREMENTAL COMPLIANCE COSTS PER SURVEY RELATIVE TO THE STAY AGREEMENT BASELINE BY SURVEY TYPE (2016$)

SCENARIO	SURVEY TYPE								
	2D	2D-OBS	3D	3D-OBS	WAZ	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD
Proposed Rule	($510,000) - ($1,766,000)	($2,810,000) - ($10,400,000)	($1,860,000) - ($3,960,000)	($4,580,000) - ($15,000,000)	($1,749,000) - ($10,700,000)	$600 - $2,500	$5,100 - $11,300	($8,690) - ($62,800)	($8,690) - ($62,800)
Percent Change	(2.1%) - (6.8%)	(4.5%) - (10.8%)	(3.5%) - (6.7%)	(4.8%) - (11.2%)	(1.0%) - (5.2%)	0.1% - 0.5%	0.7% - 1.5%	(2.1%) - (8.4%)	(2.1%) - (8.4%)
More Stringent Alternative	$40,000 - ($1,470,000)	($2,230,000) - ($9,480,000)	($799,000) - ($2,760,000)	($3,650,000) - ($13,700,000)	$7,190,000 - ($6,610,000)	$4,120 - $6,300	$5,100 - $11,300	($6,120) - ($56,700)	($6,120) - ($56,700)
Percent Change	0.2% - (5.7%)	(3.6%) - (9.8%)	(1.5%) - (4.7%)	(3.8%) - (10.2%)	3.9% - (3.2%)	0.9% - 1.3%	0.7% - 1.5%	(1.5%) - (7.6%)	(1.5%) - (7.6%)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
3. This exhibit reflects incremental costs above the Stay Agreement Baseline.

EXHIBIT A-6. PRESENT VALUE INCREMENTAL COSTS BY SURVEY TYPE, 2018-2022 (MILLION 2016$, 7% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.01 - $0.03	$0.54 - $1.69	($1.41) - ($16.1)	($0.19) - ($2.65)	$0.00 - ($18.2)	$0.00 - ($12.1)	($6.74) - ($63.0)	($16.6) - ($239)	($23.0) - ($297)	($47.4) - ($646)
More Stringent Alternative	$0.03 - $0.08	$0.54 - $1.69	($0.99) - ($14.5)	($0.14) - ($2.40)	$0.00 - ($15.2)	$0.00 - ($11.1)	($2.90) - ($44.0)	($13.3) - ($218)	$94.5 - ($184)	$77.8 - ($487)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
3. This exhibit reflects incremental costs above the stay agreement baseline.
4. Present value incremental costs assuming a 3% discount rate are included in Appendix D.

EXHIBIT A-7. ANNUALIZED INCREMENTAL COSTS BY SURVEY TYPE, 2018-2022 (MILLION 2016$, 7% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.00 - $0.01	$0.12 - $0.38	($0.32) - ($3.67)	($0.04) - ($0.60)	$0.00 - ($4.16)	$0.00 - ($2.77)	($1.54) - ($14.4)	($3.79) - ($54.4)	($5.24) - ($67.7)	($10.8) - ($147)
More Stringent Alternative	$0.01 - $0.02	$0.12 - $0.38	($0.23) - ($3.31)	($0.03) - ($0.55)	$0.00 - ($3.45)	$0.00 - ($2.52)	($0.66) - ($10.02)	($3.02) - ($49.6)	$21.55 - ($41.9)	$17.7 - ($111)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error.
3. This exhibit reflects incremental costs above the stay agreement baseline.
4. Annualized incremental costs assuming a 3% discount rate are included in Appendix D.

A.4 POTENTIAL INDIRECT IMPACTS ASSOCIATED WITH SEASONAL RESTRICTIONS AND AREA CLOSURES

In addition to the mitigation measures that affect direct compliance costs, the Stay Agreement includes seasonal restrictions for G&G activities in the Coastal Waters Closure Area and year-round restrictions for G&G activities in the portions of defined Areas of Concern within the Eastern Planning Area.

Seasonal Restrictions

The Stay Agreement seasonal restrictions are in place between January 1st and April 30th within the boundaries of the Unusual Mortality Event (UME) area,[4] and between March 1st and April 30th throughout the remainder of the Coastal Waters Closure Area. Exhibit A-8 displays the geographic extent of the seasonal restriction areas under the Stay Agreement.

The Proposed Rule and the More Stringent Alternative include seasonal restrictions in the Coastal Waters Closure Area between February 1st and May 31st. In comparison to the Stay Agreement Baseline, these restrictions represent a time shift for seasonal restrictions in the UME area, and a two-month extension of seasonal restrictions in the rest of the Coastal Waters Closure Area. Given these minor differences, we anticipate it is unlikely that the seasonal restrictions under the Proposed Rule and More Stringent Alternative will affect oil and gas productivity in the GOM relative to the Stay Agreement Baseline. As discussed in Section 4.3, we expect that G&G surveys will generally be able to plan around the seasonal restrictions. In this case, this would require planning around the additional two months of restrictions within the Coastal Waters Closure Area outside of the UME.

Area Closures

In addition, the stay agreement includes year-round closures in the portions of defined Areas of Concern within the Eastern Planning Area. The Stay Agreement area closures, while also in the Eastern Planning Area, do not match the Eastern Planning Closure Area and Dry Tortugas Closure Area specified in the Proposed Rule. It is unclear which of the closure area scenarios (Stay Agreement or Proposed Rule) has greater potential to affect oil and gas productivity in the GOM. As discussed in Section 4.3, these areas have generally been subject to limited oil and gas exploration activities and thus the relative importance of the closure areas is significantly uncertain.

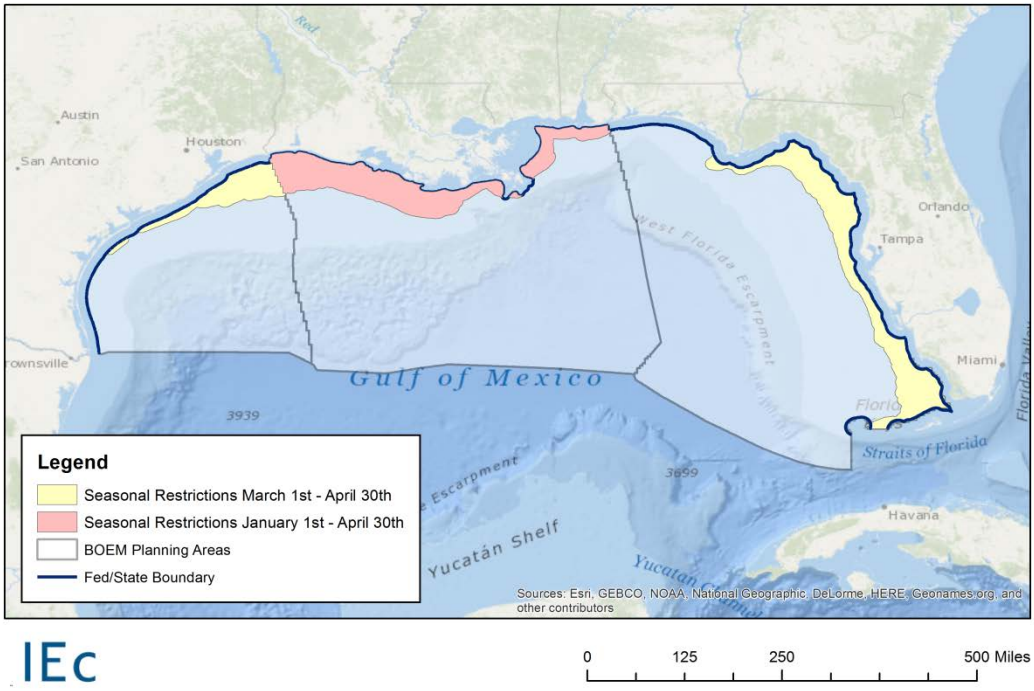
We note, however, that the closure areas under the Stay Agreement are less restrictive than the closure areas under the Proposed Rule, as the Stay Agreement includes exceptions to the G&G restriction for any portion of the area encompassed by EPA Lease Sale 226 and neighboring blocks adjacent to permitted survey areas but within an otherwise off-limit area. Our analysis in Section 4.3 regarding the Proposed Rule closure areas relative to the Pre-Stay Agreement Baseline is that there is some potential for

[4] Of note, the area of the seasonal restriction in the Stay Agreement was initially tied to UME. This area is still a seasonal restriction under the Stay Agreement although the UME has since ended.

effects on oil and gas productivity given delays in the ability to conduct seismic surveys in advance of the end of the existing GOMESA moratorium. As the Stay Agreement Baseline includes some level of restriction on G&G activity, we expect a lesser difference between the Stay Agreement and Proposed Rule with respect to oil and gas production effects. Thus, this analysis anticipates a low potential for the Proposed Rule to affect oil and gas development in the GOM as compared with the Stay Agreement Baseline.

The More Stringent Alternative, however, includes the additional Central Planning Closure Area, which is not included in the Stay Agreement. As discussed in Chapter 4, this area contains significant oil and gas activity expected to continue over the timeframe of the analysis, and year-round closure has the potential to delay or reduce oil and gas exploration and development activity in the GOM. Consequently, this closure area represents a potentially significant incremental burden of the More Stringent Alternative, for the reasons detailed in Chapter 4, as compared to the Stay Agreement Baseline.

EXHIBIT A-8. STAY AGREEMENT SEASONAL RESTRICTION AREAS



A.5 KEY UNCERTAINTIES AND LIMITATIONS

As discussed throughout this Appendix, several uncertainties affect the economic implications of the Proposed Rule relative to the Stay Agreement Baseline. The range of cost estimates reflect the uncertainty related to the direct compliance costs. Exhibit 4-43 in the main body of the report summarizes the major sources of uncertainty associated with the Proposed Rule cost analysis that are not reflected in the range of costs quantified. Exhibit A-9 describes additional sources of uncertainty that are specific to the analysis of the Proposed Rule relative to the Stay Agreement Baseline. The exhibit describes the

direction of any potential bias associated with each source of uncertainty and the likely significance with respect to impacts.

As part of the public comment period for the proposed rule, we request feedback on the data, assumptions, and uncertainties associated with this analysis, as characterized in Exhibit 4-43 and A-9. Following public comment, this analysis will integrate, as appropriate, any improvements or refinements to the data and assumptions.

EXHIBIT A-9. SOURCES OF UNCERTAINTY REGARDING COSTS OF THE PROPOSED RULE RELATIVE TO THE STAY AGREEMENT BASELINE

ASSUMPTION/SOURCE OF UNCERTAINTY	DIRECTION OF POTENTIAL BIAS ON QUANTIFIED IMPACTS	LIKELY SIGNIFICANCE WITH RESPECT TO CONCLUSIONS OF THIS ANALYSIS FOR THE PROPOSED RULE
DIRECT COMPLIANCE COSTS		
The analysis assumes that 65 percent of all deep penetration seismic surveys are affected by the minimum separation distance requirements	**Overestimate.** Analysis leads to a higher than expected cost estimate for this mitigation measure.	**Potentially major:** BOEM estimated the proportion of affected surveys based on a review of historical G&G permits. However, due to reduced G&G activity in recent years and four years of industry experience complying with the separation distances, costs of complying with the minimum separation distances may be declining. The avoided costs associated with the removal of the minimum separation distance requirements under the Proposed Rule relative to the Stay Agreement Baseline are the largest driver of total net costs. As a result, any change to this assumption could have a potentially major effect on the estimated net costs.
The analysis assumes that G&G vessels operate during reduced visibility conditions, and use PAM, for 12 hours per day on average.	**Unknown.** May overestimate or underestimate incremental impacts.	**Likely minor.** To the extent that this assumption overestimates the use of PAM in the baseline, the analysis underestimates the costs of 24 hour PAM under the Proposed Rule. These costs are relatively minor costs of compliance under the stay agreement baseline relative to the costs of minimum separation distances.

APPENDIX B | INITIAL REGULATORY FLEXIBILITY ANALYSIS

This Initial Regulatory Flexibility Analysis (IRFA) considers the extent to which the economic impacts resulting from the Proposed Rule may be borne by small entities. The analysis presented is conducted pursuant to the Regulatory Flexibility Act (RFA) as amended by the Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996. Information for this analysis was gathered from the Small Business Administration (SBA), Hoovers, Manta, and the RIA.

B.1 INTRODUCTION

First enacted in 1980, the RFA was designed to ensure that Federal Agencies consider the potential for its regulations to unduly inhibit the ability of small entities to compete. The goals of the RFA include increasing the government's awareness of the impact of regulations on small entities and to encourage agencies to exercise flexibility to provide regulatory relief to small entities.

When a Federal agency proposes regulations, the RFA requires the agency to prepare and make available for public comment an analysis that describes the effect of the rule on small entities (i.e., small businesses, small organizations, and small government jurisdictions).[5] For this rulemaking, this analysis takes the form of an IRFA. Under 5 U.S.C., Section 603(b) of the RFA, an IRFA is required to contain:

i. A description of the reasons why action by the agency is being considered;
ii. A succinct statement of the objectives of, and legal basis for, the Proposed Rule;
iii. A description of and, where feasible, an estimate of the number of small entities to which the Proposed Rule will apply;
iv. A description of the projected reporting, recordkeeping and other compliance requirements of the Proposed Rule, including an estimate of the classes of small entities which will be subject to the requirement and the type of professional skills necessary for preparation of the report or record;
v. Identification, to the extent practicable, of all relevant Federal rules which may duplicate, overlap or conflict with the Proposed Rule; and
vi. Each Initial Regulatory Flexibility Analysis shall also contain a description of any significant alternatives to the Proposed Rule that accomplish the stated objectives of applicable statutes and which minimize any significant economic impact of the Proposed Rule on small entities.

[5] 5 U.S.C. 601 et seq.

B.2 REASONS WHY ACTION IS BEING CONSIDERED, OBJECTIVES OF, AND LEGAL BASIS FOR THE PROPOSED RULE

B.2.1. REASONS WHY ACTION IS BEING CONSIDERED AND OBJECTIVES

The MMPA (16 U.S.C. 1371; 50 CFR Subpart 216) generally prohibits the taking of marine mammals, but also contains a number of exemptions and exceptions, including Section 101(a)(5)(A). On behalf of the oil and gas industry, BOEM has submitted a petition for regulations under Section 101(a)(5)(A) of the MMPA so that industry operators may conduct G&G activities in compliance with the MMPA. Ultimately the final MMPA rule would establish a framework for issuing letters of authorization for the take of marine mammals incidental to G&G activities related to oil and gas activities in GOM waters.

B.2.2. LEGAL BASIS FOR THE PROPOSED RULE

Over the past 15 years, BOEM and NMFS have been working cooperatively to develop regulations governing how G&G surveys should be carried out on the Outer Continental Shelf (OCS) in the GOM to ensure that these activities will have a negligible impact on marine mammals.[6] In 2002, the Minerals Management Service (MMS), a predecessor agency to BOEM, petitioned NMFS for MMPA incidental take authorization for sperm whales as a result of G&G surveys in the Gulf. In response to feedback from NMFS and the public, MMS revised the petition in 2004 to include all species of marine mammals; the petition was again revised to integrate updated information in 2011. Following the 2004 petition, NMFS began working to develop a National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS), with BOEM participating as a Cooperating Agency until 2008 and then as Co-Lead Agency afterward. Following the 2010 *Deepwater Horizon* oil spill, however, the Natural Resources Defense Council and other non-governmental organizations filed suit against the Department of the Interior alleging that BOEM violated NEPA when issuing G&G permits in the Gulf of Mexico before completing the EIS. Consistent with a 2013 settlement on this issue, BOEM is re-submitting a petition for the MMPA rulemaking and NMFS is developing a Proposed Rule, which is the subject of this RIA.

[6] "Negligible impact" is described in 50 CFR 216.103 as, "An impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

B.3 DESCRIPTION AND ESTIMATE OF THE NUMBER OF SMALL ENTITIES TO WHICH THE RULE APPLIES

B.3.1. DEFINITION OF A SMALL ENTITY

Three types of small entities are defined in the RFA:

- **Small Business.** Section 601(3) of the RFA defines a small business as having the same meaning as small business concern under section 3 of the Small Business Act. This includes any firm that is independently owned and operated and is not dominant in its field of operation. The U.S. SBA has developed size standards to carry out the purposes of the Small Business Act, which are generally based either on the number of employees or the annual revenues of particular entities (described in 13 CFR 121.201). The size standards are matched to North American Industry Classification System (NAICS) industries. The SBA definition of a small business applies to a firm's parent company and all affiliates as a single entity.
- **Small Governmental Jurisdiction.** Section 601(5) defines small governmental jurisdictions as governments of cities, counties, towns, townships, villages, school districts, or special districts with a population of less than 50,000. Special districts may include those servicing irrigation, ports, parks and recreation, sanitation, drainage, soil and water conservation, road assessment, etc. Most tribal governments will also meet this standard. When counties have populations greater than 50,000, those municipalities of fewer than 50,000 can be identified using population reports. Other types of small government entities are not as easily identified under this standard, as they are not typically classified by population.
- **Small Organization.** Section 601(4) defines a small organization as any not-for-profit enterprise that is independently owned and operated and not dominant in its field. Small organizations may include private hospitals, educational institutions, irrigation districts, public utilities, agricultural co-ops, etc. Depending upon state laws, it may be difficult to distinguish whether a small entity is a government or non-profit entity. For example, a water supply entity may be a cooperative owned by its members in one case and in another a publicly chartered small government with the assets owned publicly and officers elected at the same elections as other public officials.

B.3.2 DESCRIPTION OF SMALL ENTITIES TO WHICH THE RULE WILL APPLY

This IRFA focuses on identifying small businesses that would bear the incremental G&G survey costs quantified in this analysis. These may include entities undertaking, commissioning, or purchasing surveys. This analysis references information on G&G survey permit applicants for information on the types of entities engaged in G&G survey activity in the Gulf of Mexico. Potential indirect impacts to small business boat owners and operators, who are not typically permittees, but who may be involved in the implementation of G&G survey activities, are also discussed.

To identify entities that would likely be affected by this rule, we first reviewed ten years of G&G permit data (2006 to 2015). This dataset consisted of 879 applications to BOEM for G&G permits in the Gulf of Mexico during this time period.[7] We then eliminated applications for 141 non-acoustic surveys permits from the dataset, as those survey types are not anticipated to be affected by the Proposed Rule, as well as 33 surveys that occurred in the Atlantic OCS, which were permitted by the Gulf of Mexico Office; 21 surveys that were not related to exploration of oil, gas or sulphur; 29 surveys that were conducted for the purpose of scientific research and therefore are not included in the rule; and 37 surveys for permits that were later cancelled. For the remaining 618 acoustic survey permit applications, we conducted industry research to identify the parent companies for each permit applicant. Specifically, we used public merger and bankruptcy records, Bloomberg's information on acquisitions, and Hoover's family tree mapping to identify the ultimate parent companies of each permittee.[8] Four permittees involved parent companies that are bankrupt and no longer operate. Ultimately, we found that 82 independently owned companies had applied for 614 acoustic G&G permits during this period in 21 different industry NAICS codes. Of these 82 companies, 20 were found to be headquartered outside of the U.S., and are therefore not subject to consideration under SBREFA.[9] These foreign companies accounted for 54 percent of the acoustic G&G survey applications in our data (330 surveys). The remaining 62 U.S. based-companies applied for the remaining 284 acoustic G&G survey permits between 2006 and 2015.

Exhibit B-1 presents the primary industry NAICS codes listed for affected acoustic G&G permit applicants as identified in their permit applications as well as the SBA size standards for each. The SBA size standards indicate the annual receipts or employment maximum allowed for a concern and its affiliates to be considered small.

[7] BSEE Public Information Query for G&G. Accessed at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5.in August 2016.

[8] Manta Directory. Accessed at http://www.manta.com/ in November 2016; Hoovers, a D&B company. Accessed at http://www.hoovers.com/ on November 2016.

[9] Six industry NAICS codes were only reported for foreign applicants; these are presented separately in Exhibit A-1.

EXHIBIT B-1. INDUSTRIES THAT MAY BE DIRECTLY AFFECTED BY THE PROPOSED RULE

NAICS CODE	INDUSTRY AND DESCRIPTION	SBA SIZE STANDARD (MILLIONS OF DOLLARS IN ANNUAL RECEIPTS OR EMPLOYEES)	NUMBER OF SMALL BUSINESSES
211111	***Crude Petroleum and Natural Gas Extraction***. This U.S. industry comprises establishments primarily engaged in (1) the exploration, development and/or the production of petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques or (2) the production of crude petroleum from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids. Establishments in this industry operate oil and gas wells on their own account or for others on a contract or fee basis.	1,250 employees	16
212234	***Copper Ore and Nickel Ore Mining (Large only).*** This U.S. industry comprises establishments primarily engaged in: (1) developing the mine site, mining, and/or beneficiating (i.e., preparing) copper and/or nickel ores; and (2) recovering copper concentrates by the precipitation, leaching, or electrowinning of copper ore.	1,500 employees	
213111	***Drilling Oil and Gas Wells.*** This U.S. industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.	1,000 employees	1
213112	***Support Activities for Oil and Gas Operations***. This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.	$38.5 million	11
221118	***Other Electric Power Generation (Large only).*** This U.S. industry comprises establishments primarily engaged in operating electric power generation facilities (except hydroelectric, fossil fuel, nuclear, solar, wind, geothermal, biomass). These facilities convert other forms of energy, such as tidal power, into electric energy. The electric energy produced in these establishments is provided to electric power transmission systems or to electric power distribution systems.	250 employees	
221210	***Natural Gas Distribution (Large only).*** This industry comprises: (1) establishments primarily engaged in operating gas distribution systems (e.g., mains, meters); (2) establishments known as gas marketers that buy gas from the well and sell it to a distribution system; (3) establishments known as gas brokers or agents that arrange the sale of gas over gas distribution systems operated by others; and (4) establishments primarily engaged in transmitting and distributing gas to final consumers.	1,000 employees	

NAICS CODE	INDUSTRY AND DESCRIPTION	SBA SIZE STANDARD (MILLIONS OF DOLLARS IN ANNUAL RECEIPTS OR EMPLOYEES)	NUMBER OF SMALL BUSINESSES
237120	***Oil and Gas Pipeline and Related Structures Construction***. This industry comprises establishments primarily engaged in the construction of oil and gas lines, mains, refineries, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs.	$36.5 million	1
324110	***Petroleum Refineries (Large only).*** This industry comprises establishments primarily engaged in refining crude petroleum into refined petroleum. Petroleum refining involves one or more of the following activities: (1) fractionation; (2) straight distillation of crude oil; and (3) cracking.	1,500 employees	
424720	***Petroleum and Petroleum Products Merchant Wholesalers (except Bulk Stations and Terminals).*** This industry comprises establishments primarily engaged in the merchant wholesale distribution of petroleum and petroleum products (except from bulk liquid storage facilities).	200 employees	1
511210	***Software Publishers (Large only).*** This industry comprises establishments primarily engaged in computer software publishing or publishing and reproduction. Establishments in this industry carry out operations necessary for producing and distributing computer software, such as designing, providing documentation, assisting in installation, and providing support services to software purchasers. These establishments may design, develop, and publish, or publish only.	$38.5 million	
541330	***Engineering Services (Large only).*** This industry comprises establishments primarily engaged in applying physical laws and principles of engineering in the design, development, and utilization of machines, materials, instruments, structures, processes, and systems. The assignments undertaken by these establishments may involve any of the following activities: provision of advice, preparation of feasibility studies, preparation of preliminary and final plans and designs, provision of technical services during the construction or installation phase, inspection and evaluation of engineering projects, and related services.	$15 million	
541360[a]	***Geophysical Surveying and Mapping Services.*** This industry comprises establishments primarily engaged in gathering, interpreting, and mapping geophysical data. Establishments in this industry often specialize in locating and measuring the extent of subsurface resources, such as oil, gas, and minerals, but they may also conduct surveys for engineering purposes. Establishments in this industry use a variety of surveying techniques depending on the purpose of the survey, including magnetic surveys, gravity surveys, seismic surveys, or electrical and electromagnetic surveys	$15 million	

NAICS CODE	INDUSTRY AND DESCRIPTION	SBA SIZE STANDARD (MILLIONS OF DOLLARS IN ANNUAL RECEIPTS OR EMPLOYEES)	NUMBER OF SMALL BUSINESSES
541370	***Surveying and Mapping (except Geophysical) Services (Large only).*** This industry comprises establishments primarily engaged in performing surveying and mapping services of the surface of the earth, including the sea floor. These services may include surveying and mapping of areas above or below the surface of the earth, such as the creation of view easements or segregating rights in parcels of land by creating underground utility easements.	$15 million	
541620	***Environmental Consulting Services.*** This industry comprises establishments primarily engaged in providing advice and assistance to businesses and other organizations on environmental issues, such as the control of environmental contamination from pollutants, toxic substances, and hazardous materials. These establishments identify problems (e.g., inspect buildings for hazardous materials), measure and evaluate risks, and recommend solutions.	$15 million	2
541990	***All Other Professional, Scientific and Technical Services***. This industry comprises establishments primarily engaged in the provision of professional, scientific, or technical services (except legal services; accounting, tax preparation, bookkeeping, and related services; architectural, engineering, and related services; specialized design services; computer systems design and related services; management, scientific, and technical consulting services; scientific research and development services; advertising, public relations and related services; market research and public opinion polling; photographic services; translation and interpretation services; and veterinary services).	$15 million	2
561110	***Office Administrative Services (Large only).*** This industry comprises establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning; billing and recordkeeping; personnel; and physical distribution and logistics for others on a contract or fee basis. These establishments do not provide operating staff to carry out the complete operations of a business.	$7.5 million	

Sources: SBA table, review of G&G permit applications, 2006-2016.
Notes:
In addition to the NAICS codes included in this table, the permit history includes applicants categorized under six additional NAICS codes (331313, 447190, 523991, 525990, 551112, and 921130). However, all permit applicants within these categories were foreign businesses and therefore not relevant for the purposes of this SBREFA analysis.
[a] No businesses listed this NAICS code as the primary code when applying for G&G permits in the Gulf of Mexico in the 10-year period of data reviewed.

Additional Potentially Indirectly Affected Sectors: Contract Vessels

The Proposed Rule will not directly regulate businesses that operate vessels under contract by permit applicants. While it is possible that some portion of compliance costs associated with permitted activities would be expected to be incurred by contract vessels (e.g., actions that require additional time on board), generally, we expect the increased survey costs generated by the Proposed Rule will be borne by the entities either purchasing or commissioning the data. In some cases, this may be the permittee and in other cases the permittee may be commissioned by another entity. As such, increased compliance costs actually result in higher revenues for contract boats, all else being equal. However, to the extent that the overall number of G&G surveys is reduced by the Proposed Rule, businesses that operate these contract vessels could experience reduced revenues and associated employment demand. Because the current expectation is that the number of surveys that will be conducted in the next five years will not be materially affected by the Proposed Rule, indirect impacts to contract vessels are not addressed further in this analysis**.**

We reviewed a list of 87 vessels engaged in G&G permit activity in the Gulf developed by Continental Shelf Associates based on permits from the years 2012 to 2014. We then conducted research for each vessel and eliminated from this group those operated under non-U.S. flags (54 vessels). For 25 of the 33 vessels that operate under U.S. flags, we were able to identify the parent companies and primary NAICS codes under which these vessels operate. Exhibit B-2 presents a list of the NAICS codes for which contract boats reported G&G activity. Two industries (NAICS codes 213112 and 561110) are also reported by entities engaged directly in G&G permits.

EXHIBIT B-2. OTHER INDUSTRY SECTORS ANTICIPATED THAT MAY AFFECTED BY THE PROPOSED RULE

NAICS CODE	INDUSTRY	SBA SIZE STANDARD (MILLIONS OF DOLLARS IN ANNUAL RECEIPTS OR EMPLOYEES)
213112[a]	***Support Activities for Oil and Gas Operations.*** This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.	$38.5 million
441222	***Boat Dealers.*** This U.S. industry comprises establishments primarily engaged in (1) retailing new and/or used boats or retailing new boats in combination with activities, such as repair services and selling replacement parts and accessories, and/or (2) retailing new and/or used outboard motors, boat trailers, marine supplies, parts, and accessories.	$32.5 million
483113	***Coastal and Great Lakes Freight Transportation.*** This U.S. industry comprises establishments primarily engaged in providing water transportation of cargo in coastal waters, on the Great Lakes System, or deep seas between ports of the United States, Puerto Rico, and United States island possessions or protectorates. Marine transportation establishments using the facilities of the St. Lawrence Seaway Authority Commission are considered to be using the Great Lakes Water Transportation System. Establishments primarily engaged in providing coastal and/or Great Lakes barge transportation services are included in this industry.	700 employees
488330	***Navigational Services to Shipping.*** This industry comprises establishments primarily engaged in providing navigational services to shipping. Marine salvage establishments are included in this industry.	$38.5 million
541690	***Other Scientific and Technical Consulting Services.*** This industry comprises establishments primarily engaged in providing advice and assistance to businesses and other organizations on scientific and technical issues (except environmental).	$15 million
561110[a]	***Office Administrative Services.*** This industry comprises establishments primarily engaged in providing a range of day-to-day office administrative services, such as financial planning; billing and recordkeeping; personnel; and physical distribution and logistics for others on a contract or fee basis. These establishments do not provide operating staff to carry out the complete operations of a business.	$7.5 million

[a] NAICS codes 213112 and 561110 are also reported by entities engaged directly in G&G permits.

B.3.3. ESTIMATE OF THE NUMBER OF SMALL ENTITIES TO WHICH THE RULE WILL APPLY

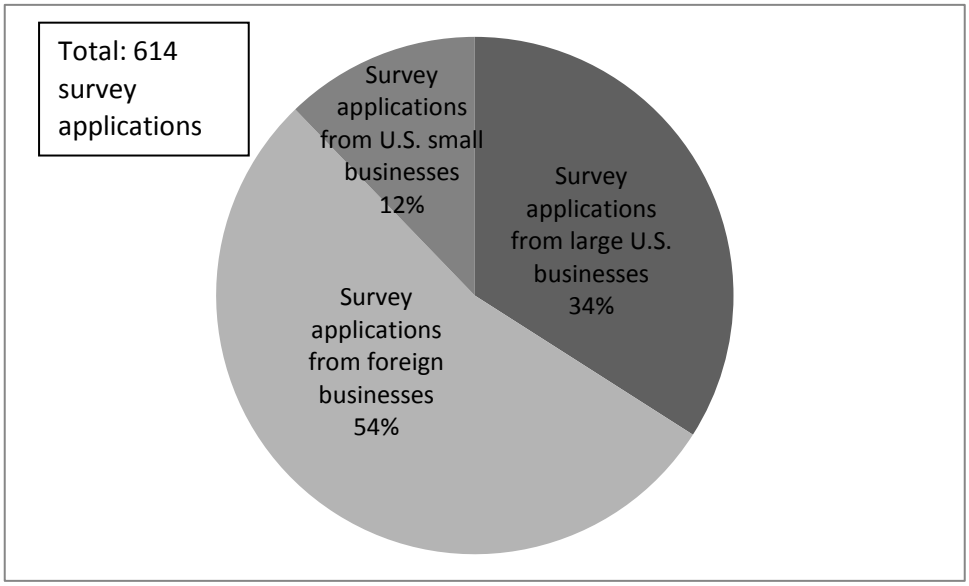
As discussed above, we analyzed permit applications between 2006 and 2015 to understand what industries were involved in G&G permit applications in the Gulf of Mexico. As we noted previously, however, while these reflect the best available data, it is not necessarily the permittees that undertake the surveys or bear the costs of the Proposed rule. After identifying the U.S.-based permit applicants for acoustic G&G permits, we established whether companies would be classified as small according to SBA definitions and the most recent revenue or employment data available via Hoovers or Manta.[10] The findings of this assessment are presented in Exhibits B-3 through B-5. As shown, of the total number of survey applications, 12 percent (75 applications) were put forth by small entities.

In total, 34 U.S.-based small businesses applied for acoustic G&G permits in the Gulf of Mexico between 2006 and 2015. While small businesses represent nearly half of the *entities* who applied for permits (41 percent of 82 entities), small businesses applied for only 12 percent of total permit *applications* (75 surveys out of 614). This means that foreign businesses and U.S.-based large businesses applied for more permits *per business* than small businesses. As shown in Exhibit B-6, foreign businesses and U.S.-based large entities put forth an average of 16.5 and 7.5 survey applications per entity, respectively, while U.S.-based small entities put forth 2.2 surveys per business between 2006 and 2015. Exhibit B-7 presents the industries represented by the small businesses that applied for G&G permits between 2006 and 2015. Companies involved in crude petroleum and natural gas extraction (NAICS 211111) and support activities for oil and gas (NAICS 213112) account for the majority of the permit applications by small companies (87 percent of companies).

While other industries do apply for permits, based on the profiles of businesses in these industries (as discussed in the next section), we expect it is unlikely they are ultimately bearing the costs of the surveys. We expect it is most likely that the companies commissioning the surveys or purchasing the data gathered will bear the increased cost; this is generally the oil and gas extraction industry. This analysis, however, profiles the various industries applying for G&G surveys in the GOM.

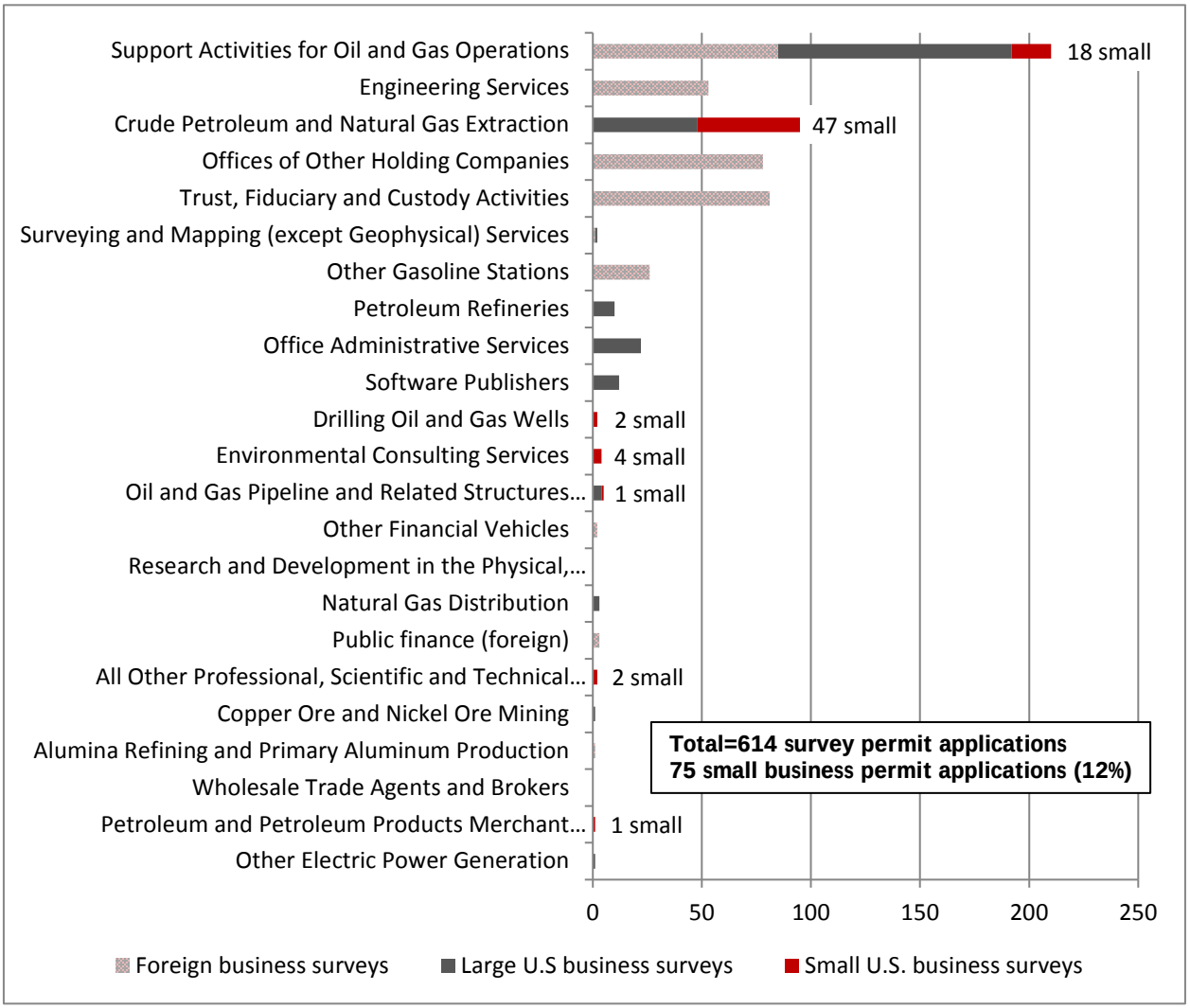
[10] Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

EXHIBIT B-3. APPLICATIONS FOR ACOUSTIC G&G SURVEY PERMITS IN THE GULF OF MEXICO, 2006 TO 2015



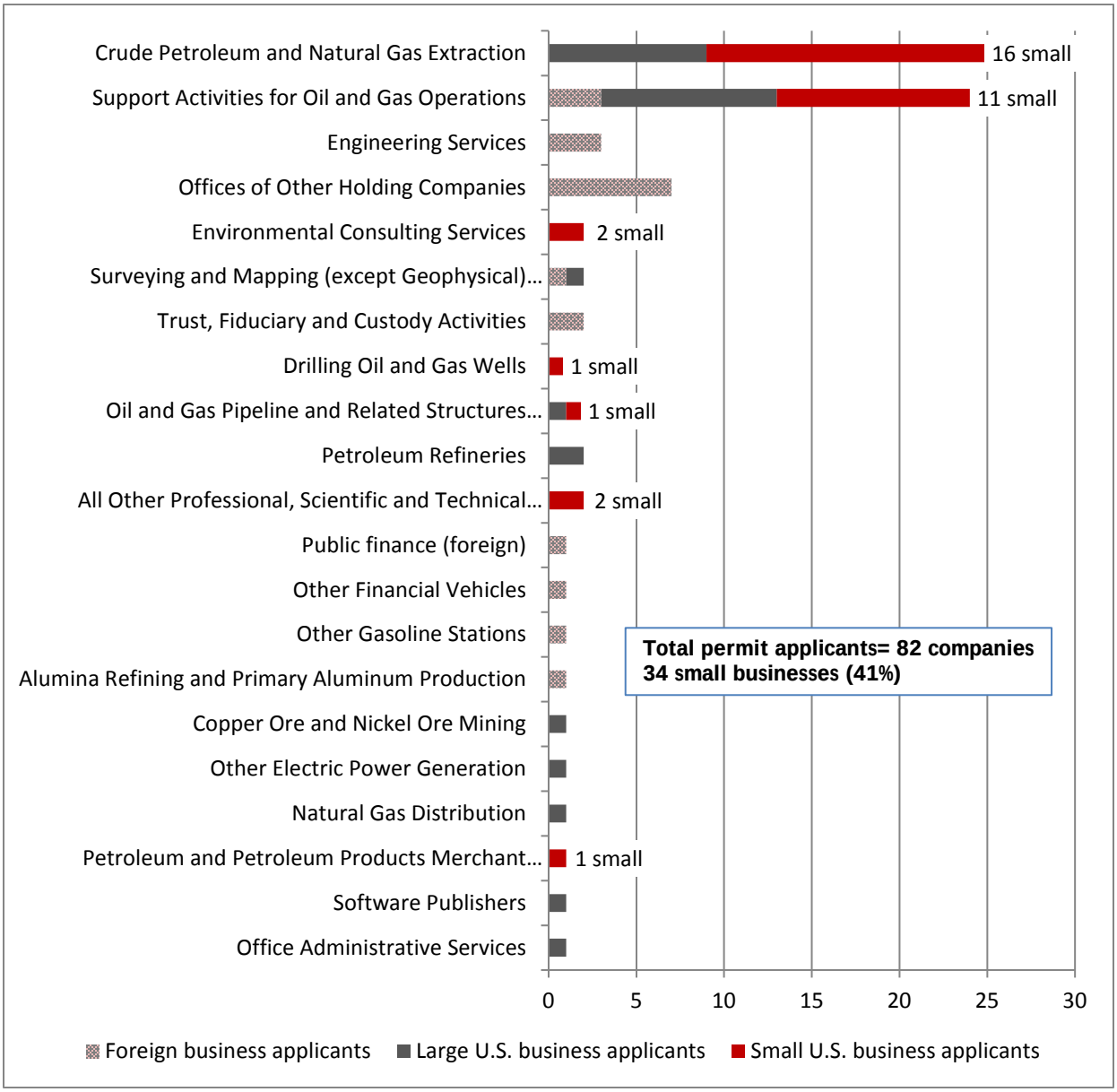
Source: BSEE Public Information Query for G&G, available at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5. Accessed August 2016.

EXHIBIT B-4. NUMBER OF ACOUSTIC G&G SURVEY PERMIT APPLICATIONS IN THE GULF OF MEXICO BY INDUSTRY, 2006 TO 2015



Source: BSEE Public Information Query for G&G, available at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5. Accessed August 2016; Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

EXHIBIT B-5. NUMBER OF COMPANIES THAT APPLIED FOR G&G SURVEY PERMITS IN THE GULF OF MEXICO BY INDUSTRY, 2006 TO 2015



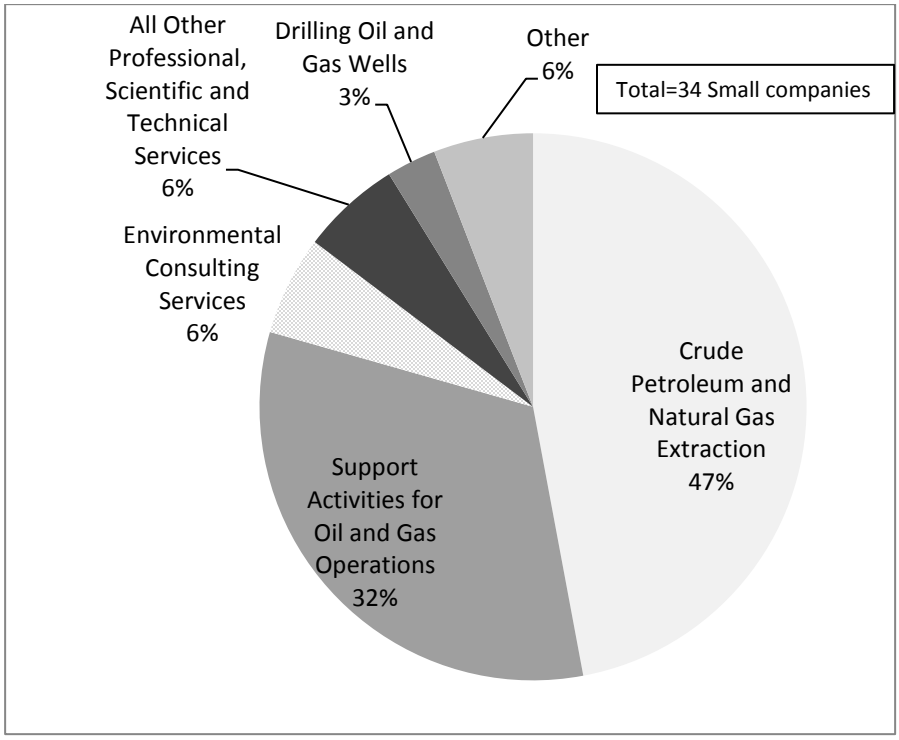
Source: BSEE Public Information Query for G&G, available at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5. Accessed August 2016; Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

EXHIBIT B-6 COMPARISON OF HISTORICAL G&G SURVEY RATES BY SIZE OF ENTITY, 2006-2015

	U.S. SMALL	U.S. LARGE	FOREIGN	ALL
Total number of applicant companies	34	28	20	82
Total number of survey permit applications	75	209	330	614
Number of surveys per company	2.2	7.5	16.5	7.5

BSEE Public Information Query for G&G, available at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5. Accessed August 2016; Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

EXHIBIT B-7 SMALL BUSINESSES APPLYING FOR G&G PERMITS BY INDUSTRY, 2006-2015



BSEE Public Information Query for G&G, available at https://www.data.bsee.gov/homepg/data_center/other/webstore/pimaster.asp?appid=5. Accessed August 2016; Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

Forecast Survey Activities by Small Entities

The RIA analysis forecasts the number of G&G surveys to be affected by the Proposed Rule over the next five years by survey type. These estimates are provided in Exhibit B-8. As shown, a total of 489 to 806 acoustic G&G surveys are anticipated to be permitted, or approximately 98 to 161 surveys annually in the Gulf of Mexico over the next five years.

EXHIBIT B-8. ACTIVITY FORECAST OF G&G SURVEYS SUBJECT TO THE PROPOSED RULE BY SURVEY TYPE, 2018-2022

YEAR	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBN	3D	3D-OBN	WAZ	TOTAL
2018	2 - 3.2	37.1 - 59.9	46 - 77	6 -12	0 - 2.7	<1	1.5 - 5	1.5 - 5	4 - 7	98 - 172
2019	2 - 3.3	38.0 - 61.8	37 - 65	5 -9	0 - 2.7	<1	1.5 - 4.5	1.5 - 4.5	4 - 9	89 - 160
2020	2 - 3.4	37.1 - 63.7	39 - 66	6-12	0 - 2.7	<1	1 - 4	1 - 4	3 - 7	89 - 163
2021	2.5 - 3.2	46.6 - 60.8	45 - 65	7 -13	0 - 2.7	<1	0 - 3.5	0 - 3.5	2 - 7	103 - 159
2022	2.8 - 3.4	52.3 - 64.6	45 - 59	5-9	0 - 2.7	<1	0.5 - 3.5	0.5 - 3.5	4 - 6	110 - 152
Total	11.1 - 16.4	210.9 -310.7	212 - 332	29-55	0 - 13.5	0 - 1.5	4.5 - 20.5	4.5 - 20.5	17 - 36	489 - 806
Estimated annual number of small business surveys*	**<1**	**5.4 - 9.2**	**0**	**0**	**<1**	**0**	**<1**	**<1**	**0**	7 - 11

Source: RIA. Note: WAZ, SWD, 2D-OBN, and VSP surveys are assumed not to involve small entities.
*Assumes historic distribution of survey type by industry.

Historically, small entities accounted for a larger percentage of HRG survey applications (airgun and non-airgun) than did businesses as a whole (85 percent of surveys applied for by small businesses were HRG, compared to 57 percent of surveys by all entities). Small businesses did not apply for WAZ, SWD, 2D-OBN, or VSP surveys according to the permit database reviewed.

By assuming that the same proportion of international, large, and small companies will undertake the surveys over the next five years as occurred during 2006 to 2015, we can anticipate the likely number of future surveys that will be include small entity applicants. Accordingly, we estimate that small entities would apply for approximately 33 to 57 surveys over the next five years, or approximately seven to 11 surveys annually. Historically, there was a ratio of approximately 2.2 surveys applied for per small entity. Using this ratio, we estimate that approximately 15 to 26 small companies will likely apply for acoustic G&G permits over the next five years, or approximately 3 to 5 small companies each year.

The future distribution of small G&G survey companies by industry is not known, but the historical pattern of surveys suggests that companies involved in crude petroleum and natural gas extraction (NAICS 211111) and support activities for oil and gas (213112) will account for the majority of the survey applications by small companies.

B.4 DESCRIPTION OF REPORTING, RECORD KEEPING EFFORTS, AND COMPLIANCE REQUIREMENTS

B.4.1. REPORTING AND RECORD KEEPING EFFORTS

The Proposed Rule is expected to add new information collection, recordkeeping, and reporting requirements for small entities. Specifically, the Proposed Rule includes three elements that require incremental information collection burden:

- PSOs will need to be present for non-airgun HRG surveys (which would not be required under the pre-stay agreement baseline). These PSOs will need to submit reports to BOEM approximately every 15 days.
- PSOs will need to be present for seismic airgun surveys occurring in water depths less than 200 meters (which would not be required under the pre-stay agreement baseline). These PSOs will need to submit reports to BOEM approximately every 15 days.
- PAM will be required to be used at all times for deep penetration airgun surveys in water depths greater than 100 meters, which represents an increase in use when compared with baseline requirements. PAM operators are required for these efforts. The Proposed Rule will require reports of marine mammal detections associated with this incremental usage of PAM.

Exhibit B-9 presents the average incremental labor hours and costs per survey associated with these requirements. These costs represent a subcomponent of the compliance costs presented in the next section.

EXHIBIT B-9. ESTIMATED INCREMENTAL DATA COLLECTION AND RECORDKEEPING BURDEN TO SMALL ENTITIES, AVERAGE HOURS AND COSTS PER SURVEY

SURVEY TYPE	WATER DEPTH	AVERAGE LABOR HOURS PER SURVEY (LOW)	AVERAGE LABOR HOURS PER SURVEY (HIGH)	AVERAGE COSTS PER SURVEY (LOW)	AVERAGE COSTS PER SURVEY (HIGH)
2D	Shallow	7,772	7,772	$239,000	$530,000
	Deep	3,548	3,548	$133,000	$266,000
2D-OBN	Shallow	6,246	18,739	$192,000	$1,280,000
	Deep	2,852	8,555	$107,000	$642,000
3D	Shallow	6,068	6,068	$186,000	$414,000
	Deep	2,770	2,770	$104,000	$208,000
3D-OBN	Shallow	6,246	18,739	$192,000	$1,280,000
	Deep	2,852	8,555	$107,000	$642,000
Airgun HRG	Shallow	228	228	$5,700	$14,300
	Deep	-	-	$0	$0
Non-airgun HRG	Shallow	-	-	$0	$0
	Deep	144	144	$3,590	$8,980

The Proposed Rule also has the potential to generate some cost savings to small entities due to reduced administrative effort required to obtain incidental take authorization. As discussed in Chapter 4, absent the rule, G&G surveys in the GOM would be required to apply for an Incidental Harassment Authorization (IHA). On the other hand, a Letter of Authorization (LOA) is required for harassment that is planned as part of future actions for up to five years (e.g., for a rulemaking). Under the Proposed Rule, NMFS would issue a LOA covering G&G surveys in the GOM that comply with the rule requirements, precluding the need for IHAs for each survey. In this way, the rule would reduce the administrative effort required of small entities to acquire the necessary authorization for incidental take of marine mammals over the five-year timeframe of the rule. The potential for this reduced administrative effort to result in cost savings would offset some of the additional information collection burden associated with the Proposed Rule. Absent information on the relative administrative effort for IHAs in the GOM versus an LOA for this rule, we do not quantify these potential cost savings but note that this contributes to an overall conservative estimate of the direct costs of the Proposed Rule.

B.4.2. ESTIMATE OF COMPLIANCE COSTS OF THE PROPOSED RULE

A review of the reported annual revenues for the 34 small entities that applied for G&G survey permits between 2006 and 2015 reveals a wide range, with the lowest revenues

reported to be $0.04 million and the highest revenues reported to be $1.9 billion.[11] Average revenues for the small entities who applied for G&G permits were $232 million, with median revenues of $12.26 million. We note, however, that the revenues and numbers of employees reported for many of these small companies appeared to be erroneous, at times including totals of two employees and in multiple instances reporting annual revenues significantly less than the costs of conducting even the lowest cost G&G surveys. For example, we identified one company that applied for a 3D OBN survey permit. The baseline cost for this type of survey is approximately $90 million, but the estimated annual revenues for this company were less than $1 million. As a result, these revenue estimates are likely to be inaccurate or, alternatively, permit applicants must pass survey costs on to the companies that purchase or commission the seismic data. Given that the oil and gas extraction companies are generally the entities purchasing the G&G data, we expect that it is most likely that G&G survey costs are ultimately borne by NAICS 211111 (crude petroleum and natural gas extraction), either as the permitees for the survey permit or because the other, smaller businesses pass these costs along in the data purchase price.

As discussed in the RIA, survey costs are anticipated to increase under the Proposed Rule, with specific incremental costs varying by survey type. Between 2006 and 2015, 85 percent of surveys applied for by small businesses were HRG surveys.[12] Incremental costs of the Proposed Rule for non-airgun surveys, which comprised most of the HRG surveys (95 percent are forecast to be non-airgun, as opposed to airgun, surveys), are anticipated to range from $5,100 to $11,300 per survey. Airgun HRG survey costs are anticipated to range from $6,600 to $17,200 per survey. Potential annual impacts to small entities by survey type are summarized in Exhibit B-10.

[11] Manta Directory, available at http://www.manta.com/, accessed November 2016; Hoovers, a D&B company, available at http://www.hoovers.com/, accessed November 2016.

Although revenues of $1.9 billion do not appear small, these revenues were reported for an entity whose reported employment was below the threshold for a small business by SBA standards.

[12] Excludes VSP and SWD surveys, which did not appear in our database of surveys.

EXHIBIT B-10. ESTIMATED ANNUAL INCREMENTAL COMPLIANCE COSTS TO SMALL ENTITIES, BY SURVEY AND ENTITY

SURVEY TYPE	INCREMENTAL COSTS OF PROPOSED RULE PER SURVEY*	
	LOW	HIGH
2D	$1,230,000	$1,860,000
2D-OBN	$1,230,000	$3,990,000
3D	$2,050,000	$5,440,000
3D-OBN	$1,840,000	$5,090,000
Airgun HRG	$6,630	$17,200
Non-airgun HRG	$5,100	$11,300

*Refer to the main text of the RIA for more detail about how these costs were estimated. As discussed above, small entities are estimated to engage in approximately 7 to 11 surveys per year across all types. Thus, each survey type may not engage a small entity every year.

Exhibit B-11 summarizes the small business size standards for the NAICS codes with small entity applicants for G&G permits. However, as discussed above, while the crude petroleum and natural gas extraction industry (NAICS 211111) accounts for 63 percent of the permit applications from small entities, we expect that the other small entities applying for permits generally pass these costs on to the extraction industry as the industry that commissions the surveys or purchases the G&G data. Consequently, Exhibit B-12 summarizes the potential incremental impacts of the Proposed Rule on crude petroleum and natural gas extraction small entities as a percent of annual revenues by survey type. As noted above, a total of approximately five small entities may be involved in survey activities annually over the next five years. Impacts would not be universally experienced by all small entities, and would vary by the specific survey type. A small subset of entities would experience impacts described in Exhibit B-12 (i.e., up to five small extraction companies per year on average). As shown, incremental impacts for HRG surveys, which historically accounted for most small business surveys, are anticipated to increase costs to small entities by less than 0.1 percent of annual revenues on average. For those entities engaged in other types of surveys, costs range between 0.3 percent and 1.1 percent of annual revenues.

EXHIBIT B-11. SMALL BUSINESS SIZE STANDARDS BY INDUSTRY WITH SMALL BUSINESS APPLICANTS

NAICS CODE	PERCENT OF SMALL ENTITY APPLICANTS IN INDUSTRY*	PERCENT OF SMALL ENTITY APPLICATIONS IN INDUSTRY	ESTIMATE OF SMALL ENTITY SURVEY APPLICATIONS ANNUALLY	SMALL BUSINESS SIZE STANDARD IN MILLIONS OF DOLLARS	SMALL BUSINESS SIZE STANDARD IN NUMBER OF EMPLOYEES
211111	47%	63%	3.1 – 5.4	-	1,250
213111	3%	3%	<1	-	1,000
213112	32%	24%	2.2 – 3.7	$38.5	-
237120	3%	1%	<1	$36.5	-
424720	3%	1%	<1	-	200
541620	6%	5%	<1	$15.0	-
541990	6%	3%	<1	$15.0	-

EXHIBIT B-12. ESTIMATED INCREMENTAL COMPLIANCE COSTS TO SMALL ENTITIES AS PERCENT OF ANNUAL REVENUES

NAICS CODE	AVERAGE ANNUAL REVENUES PER SMALL ENTITY ($MILLIONS)*	INCREMENTAL COMPLIANCE COSTS PER SURVEY AS PERCENT OF ANNUAL SMALL BUSINESS REVENUES									
		AIRGUN HRG		NON-AIRGUN HRG		2D		3D		3D-OBN	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
211111	$482.0	<0.1%	<0.1%	<0.1%	<0.1%	0.3%	0.4%	0.4%	1.1%	0.4%	1.1%

*Based on 2015 revenues for small business applicants by G&G survey type. It is possible that one small entity may undertake more than one survey in a year, which would increase the percent revenue estimates in this exhibit. From 2006 to 2013, some small extraction companies undertook multiple HRG surveys in individual year. However, no small extraction company undertook multiple 2D, 3D, or 3D-OBN surveys in a single year over this time period. If a single small extraction company undertook five HRG surveys in a single year, incremental compliance costs would remain less than 0.1 percent of revenues on average.

In summary, this IRFA finds:

1. In the majority of cases (88 percent), survey permit applicants are large businesses.
2. When the permit applicants are small businesses, the majority of the time (63 percent) they are oil and gas extractors (NAICS 211111).
3. Together these permits (for large businesses and small businesses with high annual revenues for which rule costs are a small fraction) account for 96 percent of the permits for G&G surveys.
4. While small entities in other industries occasionally apply for permits (four percent historically), these businesses are quite small, with average annual revenues in the millions or even less. Given their size, it is unlikely that these permit applicants bear G&G survey costs; otherwise it would be reflected in their annual revenues (i.e., their revenues on average would reflect that they recover their costs). Accordingly, we expect it is most likely the survey costs are passed on to oil and gas extraction companies who commission the surveys or purchase the data.
5. Overall, up to five small businesses (NAICS 211111) per year may experience increased costs of between 0.1 and 1.1 percent of average annual revenues.

B.5 IDENTIFICATION OF RELEVANT FEDERAL RULES THAT MAY DUPLICATE, OVERLAP, OR CONFLICT WITH THE PROPOSED RULE

This rule does not conflict with other rulemakings in the GOM by NOAA, BOEM, U.S. Coast Guard, or other federal agencies**.**

B.6 DESCRIPTION OF ALTERNATIVES TO THE PROPOSED RULE THAT WOULD MINIMIZE SIGNIFICANT ECONOMIC IMPACTS ON SMALL ENTITIES

As described above, a relatively small portion of total G&G survey activities are undertaken by small entities.

The potential harassment risks to marine mammals are not necessarily lower for small entities than large entities. Adverse consequences to marine mammals in the event of harassment or an incidental taking are the same, regardless of operator size. Whether small or large entities are conducting survey activities on the OCS, the Proposed Rule aims to provide the same degree of protection to all marine mammals.

The RIA describes costs by planning area to provide information on costs at a more refined spatial scale. In addition, the analysis presents information on costs by type of survey and by mitigation requirement. This IRFA demonstrates that small businesses are generally affected by increasing the costs of a subset of survey types (airgun HRG, non-airgun HRG, 2D, 3D, and 3D-OBN). The analysis is accordingly designed to allow NMFS to consider multiple combinations of mitigation requirements by survey type and geographic area as alternatives to the Proposed Rule.

In addition, the RIA considers costs and benefits of the More Stringent Alternative, for which total costs of mitigation are approximately 20 percent greater at the high end than for the Proposed Rule. The additional costs primarily reflect additional shut down

requirements for sperm whale observations outside of the exclusion zone, and unquantified additional costs associated with year-round area closures in the Central Planning Area. Given the greater cost relative to the Proposed Rule, the More Stringent Alternative is not considered an alternative designed to minimize economic impacts on small entities.

NMFS is requesting comment on the costs of these proposed incidental take regulations on small entities, with the goal of ensuring a thorough consideration and discussion at the final rule stage. We request comments on the analysis of entities affected, as well as information on regulatory alternatives that would simultaneously reduce the burden on small entities and afford the level of protection to marine mammals required by the MMPA.

APPENDIX C. OTHER COMPLIANCE REQUIREMENTS

As required by applicable statutes and executive orders, this section summarizes analyses of equity considerations and other regulatory concerns associated with the Proposed Rule. This section assesses potential impacts, with respect to the following issues:

- **Energy Impacts:** examines the impacts of the Proposed Rule on energy use, supply, and distribution as mandated under Executive Order 13211 (66 FR 28355, May 22, 2001);
- **Paperwork reduction**: examines the requirements of the Proposed Rule for paperwork collections as required by the PRA;
- **Unfunded mandates:** examines the implications of the Proposed Rule with respect to unfunded mandates as required by the Unfunded Mandates Reform Act (UMRA);
- **Environmental justice:** considers potential issues for minority and low-income populations as required under E.O. 12898;
- **Children's health protection:** examines the potential impact of the Proposed Rule on the health of children in order to comply with E.O. 13045;
- **Tribal governments:** extends the discussion of federal unfunded mandates to include impacts on Native American tribal governments and their communities as mandated under E.O. 13175, “Consultation and Coordination With Indian Tribal Governments” (May 14, 1998);
- **Federalism:** considers potential issues related to state sovereignty as required under E.O. 13132; and
- **Cumulative Impacts:** considers the cumulative impacts of regulations, specifically costs, as required under E.O 12866 and E.O. 13563.

C.1 EFFECTS ON THE NATION’S ENERGY SUPPLY (EXECUTIVE ORDER 13211) ACTIONS CONCERNING REGULATIONS THAT SIGNIFICANTLY AFFECT ENERGY SUPPLY, DISTRIBUTION, OR USE.

Under E.O. 13211 (66 FR 28355, May 22, 2001), agencies are required to prepare and submit to OMB a Statement of Energy Effects for significant energy actions. This should include a detailed statement of any adverse effects on energy supply, distribution, or use (including a shortfall in supply, price increases, and increased use of foreign supplies) expected to result from the action and a discussion of reasonable alternatives and their effects.

The Office of Management and Budget provides guidance for implementing this Executive Order, outlining outcomes that may constitute "a significant adverse effect" when compared with the regulatory action under consideration:

- Reductions in crude oil supply in excess of 10,000 barrels per day (bbls);
- Reductions in fuel production in excess of 4,000 barrels per day;
- Reductions in coal production in excess of five million tons per year;
- Reductions in natural gas production in excess of 25 million Mcf per year;
- Reductions in electricity production in excess of one billion kilowatts-hours per year or in excess of 500 megawatts of installed capacity;
- Increases in energy use required by the regulatory action that exceed the thresholds above;
- Increases in the cost of energy production in excess of one percent;
- Increases in the cost of energy distribution in excess of one percent; or
- Other similarly adverse outcomes.

Or if the regulation:

- Adversely affects in a material way the productivity, competition, or prices in the energy sector;
- Adversely affects in a material way productivity, competition or prices within a region;
- Creates a serious inconsistency or otherwise interferes with an action taken or planned by another agency regarding energy; or
- Raises novel legal or policy issues adversely affecting the supply, distribution or use of energy arising out of legal mandates, the President's priorities, or the principles set forth in Executive Orders 12866 and 13211.[13]

The MMPA Rule governing G&G activities in the GOM, as described in Chapter 1 of this analysis, would require additional mitigation measures protecting marine mammals as part of seismic surveys for oil and gas exploration and development. Specifically, for seismic airgun surveys, the MMPA rule prescribes use of 24-hour Passive Acoustic Monitoring (PAM) in waters deeper than 100 meters. In addition, for non-airgun HRG surveys, the MMPA rule requires PSO monitoring and a pre-survey clearance period of 30 minutes (i.e., no marine mammals except bow-riding dolphins within 30 minutes of start-up or shut-down).

As detailed in Chapter 4, the annualized direct compliance costs range from $49 million to $182 million over the rule's five-year timeframe (assuming a seven percent discount

[13] OMB. 2001. Memorandum For Heads of Executive Department Agencies, and Independent Regulatory Agencies, Guidance For Implementing E.O. 13211, M-01-27. http://www.whitehouse.gov/omb/memoranda/m01-27.html

rate).[14] Total present value costs over the five-year timeframe range from $215 million to $797 million (assuming a seven percent discount rate). The expected increase in the direct cost of G&G surveys under the Proposed Rule and More Stringent Alternative, however, is unlikely to materially reduce the level of oil and gas development in the Gulf of Mexico, given that the costs of G&G activities are relatively minor compared to expenditures on drilling, engineering, installation of platforms, and production operations. For instance, Quest Offshore (2014) estimates that G&G activities would account for only three percent of total spending on oil and gas activities in the Eastern Gulf over a 19 year timeframe if the current moratorium were lifted.[15,16] Consequently, a 14 percent increase in G&G costs, as estimated under the Proposed Rule for some surveys, would represent only a 0.4 percent increase in oil and gas development costs overall.[17] Personal communication with IAGC and API confirmed that the direct compliance costs of the regulatory requirements are unlikely to result in materially reduced oil and gas activities in the Gulf of Mexico.[18]

While the increases in G&G survey costs under the Proposed Rule are unlikely to materially affect the level of oil and gas development activity in the GOM, the seasonal and year-round area closures have the potential to generate reductions in leasing, exploration, and subsequent development activity. While the timeframe of this rule covers just five years (2018-2022), any reductions in seismic data gathering during that five-year period could result in delayed development of oil and gas resources beyond that five-year timeframe. That is, limiting where G&G surveys can occur over the next five years can have implications on oil and gas development activity in the following years.

The likelihood of the seasonal restrictions and area closures affecting G&G survey levels and, ultimately, oil and gas production is dependent on the factors outlined below. Each of these factors is subject to substantial uncertainty. It would therefore be speculative to draw definitive conclusions regarding the economic impacts of proposed seasonal restrictions and area closures.

- **Oil and gas market conditions:** Demand for G&G data is driven by demand for oil and gas. As described in Chapter 2, recent years have seen a reduction in demand due to relatively low oil prices. Because the oil market tends to be somewhat cyclical, the forecast for future G&G activity reflects the assumption

[14] All monetized cost estimates are presented in 2016 US dollars.

[15] Quest Offshore. (2014). " The Economic Benefits of Increasing U.S. Access to Offshore Oil and Natural Gas Resources in the Eastern Gulf of Mexico." Prepared for the American Petroleum Institute (API) and the National Ocean Industries Association (NOIA).

[16] Quest Offshore project spending for each of the following activity types: Seismic (G&G), SURF, Platforms, Installation, Drilling, Engineering, and Operating Expenditures.

[17] For instance, Exhibit 4-2 shows that the baseline high-end total cost for a WAZ survey is $171,000,000, and Exhibit 4-11 shows that the incremental compliance cost for a WAZ survey under the Proposed Rule is up to $22,000,000. This represents a 13 percent increase in total survey costs. All other survey types under the Proposed Rule see lower percent cost increases.

[18] Personal communication between IEc, IAGC, and API. December 15, 2016.

that production of GOM oil and gas will rise in the future with increases in the price of oil, though the timing for this is highly uncertain. In other words, production of oil and gas from the GOM over the narrow timeframe of this analysis is not known with reasonable precision to quantify potential impacts.

- **Relative importance of the area closures to oil and gas production:** The economic implications of seasonal restrictions and area closures depend most directly on the level of activity that would overlap these areas, within the context of broader GOM G&G activity, absent the rule. The forecast of G&G activity levels is not spatially precise within GOM Planning Areas. However, as an indicator of the relative importance of these GOM areas to oil and gas production in the past, the discussion Section 4.3 of this analysis provides recent historical information on the relative levels of exploration, development and production.
- **The state of existing G&G data covering the areas:** Importantly, the seasonal restrictions and area closures do not directly restrict other offshore oil and gas exploration and development activities, only seismic surveys. Seismic data do exist for the area closures; however, we understand that some of the data are dated and therefore new surveys are required to facilitate efficient exploration and development decisions in these areas. Information specifying the vintage of current seismic data for the closure areas is not available. Therefore, whether existing data are sufficient, or whether exploration, development and ultimate oil and gas production would be delayed in these areas due to restrictions on G&G activities over the next five years is uncertain.

In summary, quantifying the impacts of precluding G&G surveys in the Proposed Rule closure areas over the timeframe of the rule would be speculative in light of the layered uncertainties described above. In particular, demand for new survey data for affected areas in the Eastern Planning Area, while likely to increase over the timeframe of this analysis, is uncertain. In recent history, these areas have not been the target of the oil and gas industry, in particular, due to the moratorium established under the Gulf of Mexico Energy Security Act of 2006 (GOMESA). Oil and gas development has occurred primarily in the Central and Western Planning Areas of the GOM. As these areas become developed, however, the industry is likely to expand into the Eastern Planning Area given the estimated UTRR. Whether that is likely to happen within the timeframe of this analysis or the five to ten years following is a function of the fluctuations of the broader oil and gas market, itself likewise uncertain. Overall, however, within the five-year timeframe of the analysis, the Proposed Rule is not expected to constitute a significant adverse effect on energy supply, distribution or use according to the thresholds described above, given the overlapping moratorium covering the Eastern Planning Area and that the direct compliance costs represent a small fraction (on the order of less than one percent) of the total costs of exploration and development in the GOM.

C.2 PAPERWORK REDUCTION ACT

The Paperwork Reduction Act (PRA) and its implementing regulations require OMB clearance for any planned information collections. The PRA of 1995 requires that agencies obtain OMB approval before requesting most types of information from the

public. “Information collections” include forms, interviews, record-keeping requirements, and a wide variety of other instances. In the PRA the term “persons” includes more than individual people: corporations, universities, state and local agencies, associations, etc., as well as individuals.

This submission requests clearance to impose new recordkeeping and reporting requirements contained in the Proposed Rule. These requirements are associated with existing requirements that have previously been cleared under 0648-0151 (Applications and Reporting Requirements for the Incidental Take of Marine Mammals by Specified Activities (other than Commercial Fishing operations) under the Marine Mammal Protection Act), approved in March 2014. The new information collection adds recordkeeping and reporting requirements pursuant to the collection of information by PSOs for particular survey types (non-airgun HRG surveys), as well as collection and reporting of PAM information. These additional requirements are required by statute to assist in minimization of unintentional take of marine mammals incidental to G&G activities in GOM waters.

INFORMATION REQUESTED

This section describes the incremental information collection requirements applicable to entities that will be affected by the Proposed Rule.

IDENTIFYING THE RESPONDENT UNIVERSE

The potentially regulated universe includes companies conducting acoustic G&G surveys in the Gulf of Mexico during the time period for the analysis. As presented elsewhere, this analysis forecasts that 98 to 161 G&G surveys will take place annually on average over the next five years that would be subject to potential paperwork requirements. Appendix B details characteristics of these entities in more detail.

ESTIMATING THE HOUR AND COST BURDEN OF THE COLLECTION

In this section, we estimate the total average annual respondent and government agency hour and cost burden for all information collection requirements covered in this PRA for the first five years after the implementation of the rule. The PRA presents the cost burden for both the respondent universe and implementing government agencies on an annual basis. Exhibits C-1 through C-4 provide estimates of the respondents’ burden and Agency review hour and cost burden associated with these information collection and recordkeeping requirements.

The Proposed Rule is anticipated to include three elements that would require incremental information collection burden:

- PSOs will need to be present for non-airgun HRG surveys (which would not be required under the baseline). These PSOs will need to develop and submit reports to BOEM;
- PSOs will need to be present for seismic airgun surveys occurring in water depths less than 200 meters (which would not be required under the pre-stay agreement baseline). These PSOs will need to develop and submit reports to BOEM.

- PAM will be required to be used at all times for deep penetration airgun surveys in water depths greater than 100 meters, which represents an increase in use when compared with baseline requirements. PAM operators are required for these efforts. The Proposed Rule will require reports of marine mammal detections associated with this incremental usage of PAM.

The Proposed Rule also has the potential to generate some cost savings due to reduced administrative effort required to obtain incidental take authorization. As discussed in Chapter 4, absent the rule, G&G surveys in the GOM would be required to apply for an Incidental Harassment Authorization (IHA). On the other hand, a Letter of Authorization (LOA) is required for harassment that is planned as part of future actions for up to five years (e.g., for a rulemaking). Under the Proposed Rule, NMFS would issue a LOA covering G&G surveys in the GOM that comply with the rule requirements, precluding the need for IHAs for each survey. In this way, the rule would reduce the administrative effort required of industry and regulatory agencies to acquire the necessary authorization for incidental take of marine mammals over the five-year timeframe of the rule. The potential for this reduced administrative effort to result in cost savings would offset some of the additional information collection burden associated with the Proposed Rule. Absent information on the relative administrative effort for IHAs in the GOM versus an LOA for this rule, we do not quantify these potential cost savings but note that this contributes to an overall conservative estimate of the direct costs of the Proposed Rule.

Industry Costs

For purposes of this analysis, we assume the following costs will be borne by the G&G industry:

- PSO rates are assumed to range from $200-$500 per day (or $25 to $63 per hour).
- A day rate for a PAM operator is assumed to range from $300-$600 per hour (or $38 to $75 per hour).

Government Costs

- We assume that incremental government agency review will require 1/2 hour of GS-13 level time.[19]
- We assume that government agency review of additional PSO reports will require one hour of GS-13 level time per report.[20]
- We assume that government agency review of additional PAM reporting will require 0.5 hours of GS-13 level time per report.[21]

---

[19] Government wage rate is a Basic, Step 5, GS-13 rate multiplied by 1.526 to reflect fringe benefits and overhead. GS rate Accessed https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2017/GS_h.pdf on April 6, 2017.

[20] Government wage rate is a Basic, Step 5, GS-13 rate multiplied by 1.526 to reflect fringe benefits and overhead. GS rate Accessed https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2017/GS_h.pdf on April 6, 2017.

- We assume that PAM/PSO reports will be prepared.
- This may overstate actual review time for individual reports but provides an approximate estimate of the increased level of government time required.

Using these assumptions, the PRA estimates the average annual industry burden for all surveys will be $1.5 million to $17.0 million. Total government burden will be $6,000 to $14,000 (undiscounted dollars). Total additional information collection costs are estimated to be approximately be $1.5 million to $17.0 million annually (undiscounted dollars), or $1.4 million to $16.4 million when discounted at a 3 percent rate, or $1.4 million to $15.9 million when discounted at a 7 percent rate.

[21] Government wage rate is a Basic, Step 5, GS-13 rate multiplied by 1.526 to reflect fringe benefits and overhead. GS rate Accessed https://www.opm.gov/policy-data-oversight/pay-leave/salaries-wages/salary-tables/pdf/2017/GS_h.pdf on April 6, 2017.

EXHIBIT C-1. EXPECTED INCREMENTAL INDUSTRY DATA COLLECTION BURDEN, AVERAGE ANNUAL HOURS, 2018-2023

SURVEY TYPE	WATER DEPTH	NUMBER OF SURVEYS (AVERAGE ANNUAL)[1]		INCREMENTAL NUMBER OF PSOS/PAM OPERATORS PER VESSEL[2]		NUMBER OF VESSELS PER SURVEY		DURATION ON WATER (DAYS)[3]	INCREMENTAL PAM/PSO INFORMATION COLLECTION HOURS (AVERAGE ANNUAL)[4]	
		LOW	HIGH	PSO	PAM	LOW	HIGH		LOW	HIGH
Non-airgun HRG	Shallow	14	23	0.0	0.0	1	1	18	-	-
	Deep	28	39	1.0	0.0	1	1	18	4,014	5,653
2D	Shallow	0	0	3.0	2.5	1	1	176	-	-
	Deep	0	3	0.0	2.5	1	1	176	-	9,565
2D-OBN	Shallow	0	0	3.0	2.5	1	3	141	-	-
	Deep	0	<1	0.0	2.5	1	3	141	-	2,604
3D	Shallow	0	1	3.0	2.5	1	1	137	-	7,281
	Deep	1	3	0.0	2.5	1	1	137	2,493	8,033
3D-OBN	Shallow	0	1	3.0	2.5	1	3	141	-	22,486
	Deep	1	3	0.0	2.5	1	3	141	2,566	24,808
WAZ	Shallow	0	<1	3.0	2.5	2	5	178	-	15,703
	Deep	3	7	0.0	2.5	2	5	178	24,374	121,871
Airgun HRG	Shallow	1	1	3.0	0.0	1	1	10	171	274
	Deep	1	2	0.0	0.0	1	1	10	-	-
VSP	Shallow	11	18	3.0	2.5	1	1	7	3,277	5,441
	Deep	32	49	0.0	2.5	1	1	7	4,488	6,887
SWD	Shallow	0	0	3.0	2.5	1	1	7	-	-
	Deep	6	11	0.0	2.5	1	1	7	818	1,552
Annual Incremental PRA Burden (Industry)		**98**	**161**	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**	**42,202**	**232,157**

[1] Refer to Section 4.2.2 and Exhibit 4-17 for additional details about the forecasts for the number of surveys that are anticipated.
[2] Assumes that 74 percent of airgun surveys had two PAM operators on board in the baseline. Under the Proposed Rule, deep penetration airgun surveys need 4 PAM operators on board. Thus on average, each deep penetration airgun survey requires an additional 2.5 PAM operators (2.5 = 4 – 2 × 0.74). Airgun surveys in shallow waters require 3 PSOs in addition to these PAM operators.
[3] Refer to Section 4.2 and Exhibit 4-2 for additional details about the average duration on water.
[4] Assumes 8 hours per day of data collection and reporting per PSO/PAM Operator.

EXHIBIT C-2 EXPECTED INCREMENTAL INDUSTRY DATA COLLECTION BURDEN RELATED TO PSO REQUIREMENTS, AVERAGE ANNUAL HOURS AND COSTS, 2018-2023

SURVEY TYPE	WATER DEPTH	HOURS (AVERAGE ANNUAL)[1]		PSO WAGE/HOUR[2]		PRA COSTS (AVERAGE ANNUAL)[3]	
		LOW	HIGH	LOW	HIGH	LOW	HIGH
Non-airgun HRG	Shallow	-	-	$25	$63	$0	$0
	Deep	4,014	5,653	$25	$63	$100,000	$353,000
2D	Shallow	-	-	$25	$63	$0	$0
	Deep	-	-	$25	$63	$0	$0
2D-OBN	Shallow	-	-	$25	$63	$0	$0
	Deep	-	-	$25	$63	$0	$0
3D	Shallow	-	3,957	$25	$63	$0	$247,000
	Deep	-	-	$25	$63	$0	$0
3D-OBN	Shallow	-	12,221	$25	$63	$0	$764,000
	Deep	-	-	$25	$63	$0	$0
WAZ	Shallow	-	8,534	$25	$63	$0	$533,000
	Deep	-	-	$25	$63	$0	$0
Airgun HRG	Shallow	171	274	$25	$63	$4,280	$17,100
	Deep	-	-	$25	$63	$0	$0
VSP	Shallow	1,781	2,957	$25	$63	$44,500	$185,000
	Deep	-	-	$25	$63	$0	$0
SWD	Shallow	-	-	$25	$63	$0	$0
	Deep	-	-	$25	$63	$0	$0
Total Annual PRA Burden (Industry)		**5,966**	**33,595**	**n/a**	**n/a**	**$149,000**	**$2,100,000**

[1] See previous exhibit for calculations of these hours.
[2] Hourly wage rates are calculated from daily wage rates of $300 to $600 per day for PAM operators, and $200 to $500 per day for PSOs.
[3] These costs are also reported as components of compliance costs estimates provided in the main body of the report.

EXHIBIT C-3 EXPECTED INCREMENTAL INDUSTRY DATA COLLECTION BURDEN RELATED TO PAM REQUIREMENTS, AVERAGE ANNUAL HOURS AND COSTS, 2018-2023

SURVEY TYPE	WATER DEPTH	HOURS (AVERAGE ANNUAL)[1]		PAM OPERATOR WAGE/HOUR[2]		PRA COSTS (AVERAGE ANNUAL)[3]	
		LOW	HIGH	LOW	HIGH	LOW	HIGH
Non-airgun HRG	Shallow	-	-	$38	$75	$0	$0
	Deep	-	-	$38	$75	$0	$0
2D	Shallow	-	-	$38	$75	$0	$0
	Deep	-	9,565	$38	$75	$0	$717,000
2D-OBN	Shallow	-	-	$38	$75	$0	$0
	Deep	-	2,604	$38	$75	$0	$195,000
3D	Shallow	-	3,324	$38	$75	$0	$249,000
	Deep	2,493	8,033	$38	$75	$93,500	$602,000
3D-OBN	Shallow	-	10,265	$38	$75	$0	$770,000
	Deep	2,566	24,808	$38	$75	$96,200	$1,860,000
WAZ	Shallow	-	7,169	$38	$75	$0	$538,000
	Deep	24,374	121,871	$38	$75	$914,000	$9,140,000
Airgun HRG	Shallow	-	-	$38	$75	$0	$0
	Deep	-	-	$38	$75	$0	$0
VSP	Shallow	1,496	2,484	$38	$75	$56,100	$186,000
	Deep	4,488	6,887	$38	$75	$168,000	$516,000
SWD	Shallow	-	-	$38	$75	$0	$0
	Deep	818	1,552	$38	$75	$30,700	$116,000
Total Annual PRA Burden (Industry)		**36,236**	**198,562**	**n/a**	**n/a**	**$1,360,000**	**$14,900,000**

[1] See previous exhibit for calculations of these hours.
[2] Hourly wage rates are calculated from daily wage rates of $300 to $600 per day for PAM operators, and $200 to $500 per day for PSOs.
[3] These costs are also reported as components of compliance costs estimates provided in the main body of the report.

EXHIBIT C-4. EXPECTED INCREMENTAL GOVERNMENT DATA COLLECTION BURDEN, AVERAGE ANNUAL HOURS AND COSTS, 2018-2023

SURVEY TYPE	WATER DEPTH	NUMBER OF SURVEYS (AVERAGE ANNUAL) [1]		NUMBER OF REPORTS PER SURVEY[2]	GOVERNMENT REVIEW (HOURS PER REPORT) [3]	TOTAL INCREMENTAL GOVERNMENT REVIEW HOURS (AVERAGE ANNUAL)		GOVERNMENT COST PER HOUR (GS RATE)[1]	TOTAL INCREMENTAL GOVERNMENT PRA COSTS (AVERAGE ANNUAL)	
		LOW	HIGH			LOW	HIGH		LOW	HIGH
Non-airgun HRG	Shallow	14	23	n/a	n/a	0	0	$61.80	$0	$0
	Deep	28	39	1	1	28	39	$61.80	$1,730	$2,430
2D	Shallow	0	0	12	1.5	0	0	$61.80	$0	$0
	Deep	0	3	12	0.5	0	16	$61.80	$0	$977
2D-OBN	Shallow	0	0	9	1.5	0	0	$61.80	$0	$0
	Deep	0	<1	9	0.5	0	1	$61.80	$0	$89
3D	Shallow	0	1	9	1.5	0	16	$61.80	$0	$1,020
	Deep	1	3	9	0.5	4	13	$61.80	$255	$821
3D-OBN	Shallow	0	1	9	1.5	0	17	$61.80	$0	$1,050
	Deep	1	3	9	0.5	4	14	$61.80	$262	$845
WAZ	Shallow	0	<1	12	1.5	0	7	$61.80	$0	$440
	Deep	3	7	12	0.5	20	40	$61.80	$1,250	$2,490
Airgun HRG	Shallow	1	1	1	1	0	1	$61.80	$29	$47
	Deep	1	2	1	n/a	0	0	$61.80	$0	$0
VSP	Shallow	11	18	1	1.5	16	26	$61.80	$983	$1,630
	Deep	32	49	1	0.5	16	24	$61.80	$983	$1,510
SWD	Shallow	0	0	1	1.5	0	0	$61.80	$0	$0
	Deep	6	11	1	0.5	3	6	$61.80	$179	$340
Total Annual PRA Burden (Govt)		**98**	**161**	**n/a**	**n/a**	**92**	**221**	**n/a**	**$5,660**	**$13,700**

[1] Refer to Section 4.2.2 and Exhibit 4-17 for additional details about the forecasts for the number of surveys that are anticipated.

[2] Assumes that a bi-weekly report will be prepared by PSOs. This column reflects the number of these reports that would be prepared given each survey duration.

[3] Assumes that government agency review will be required for all survey reports. Assumes 0.5 incremental hours for review of new PAM records, and 1.0 hours for review of PSO reports.

EXHIBIT C-5 TOTAL EXPECTED PAPERWORK BURDEN (INDUSTRY AND GOVERNMENT)

SURVEY TYPE	WATER DEPTH	AVERAGE ANNUAL HOURS		AVERAGE ANNUAL PRA COSTS		EXPECTED PRA COSTS, ANNUALIZED (3 PERCENT)		EXPECTED PRA COSTS, ANNUALIZED (7 PERCENT)	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Non-airgun HRG	Shallow	0	0	$0	$0	$0	$0	$0	$0
	Deep	4,042	5,692	$102,000	$356,000	$96,600	$342,000	$91,900	$327,000
2D	Shallow	0	0	$0	$0	$0	$0	$0	$0
	Deep	0	9,580	$0	$718,000	$0	$696,000	$0	$670,000
2D-OBN	Shallow	0	0	$0	$0	$0	$0	$0	$0
	Deep	0	2,605	$0	$195,000	$0	$190,000	$0	$182,000
3D	Shallow	0	7,298	$0	$498,000	$0	$483,000	$0	$467,000
	Deep	2,497	8,046	$93,700	$603,000	$92,900	$589,000	$92,000	$572,000
3D-OBN	Shallow	0	22,503	$0	$1,530,000	$0	$1,490,000	$0	$1,440,000
	Deep	2,571	24,822	$96,500	$1,860,000	$95,600	$1,820,000	$94,700	$1,770,000
WAZ	Shallow	0	15,710	$0	$1,070,000	$0	$1,040,000	$0	$999,000
	Deep	24,394	121,912	$915,000	$9,140,000	$891,000	$8,900,000	$861,000	$8,610,000
Airgun HRG	Shallow	171	274	$4,300	$17,100	$4,160	$16,700	$4,010	$16,100
	Deep	0	0	$0	$0	$0	$0	$0	$0
VSP	Shallow	3,293	5,467	$102,000	$373,000	$68,900	$242,000	$66,300	$234,000
	Deep	4,504	6,911	$169,000	$518,000	$163,000	$503,000	$157,000	$486,000
SWD	Shallow	0	0	$0	$0	$0	$0	$0	$0
	Deep	821	1,558	$30,900	$117,000	$29,800	$113,000	$28,700	$109,000
Total Annual PRA Burden (Govt + Industry)		**42,293**	**232,378**	**$1,510,000**	**$17,000,000**	**$1,440,000**	**$16,400,000**	**$1,400,000**	**$15,900,000**

BURDEN STATEMENT

This rule contains a collection-of-information requirement subject to the Paperwork Reduction Act (PRA) and which has been approved by OMB under control number (*0648*-0151). The public reporting burden for this Proposed Rule is estimated to include PSO time and PAM operator time collecting data, as well as an average *approximately four hours per survey*, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding this burden estimate, or any other aspect of this data collection, including suggestions for reducing the burden, to NMFS (see ADDRESSEES) and by e-mail to OIRA_Submission@omb.eop.gov , or fax to (202) 395-5806.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number. All currently approved NOAA collections of information may be viewed at: http://www.cio.noaa.gov/services_programs/prasubs.html

C.3 UNFUNDED MANDATES REFORM ACT

Signed into law on March 22, 1995, Unfunded Mandates Reform Act (UMRA) (2 USC 1501 et seq.) places certain requirements on federal agencies that issue significant regulations that generate unfunded mandates. These include the preparation of a statement supporting the need to issue the regulation, and a description of prior consultation with representatives of affected state, local, and tribal governments. Requirements in the UMRA apply only to those federal regulations containing a "significant unfunded mandate." The UMRA defines a significant unfunded mandate as a federal rule that either:

- Results in estimated costs to state, local, and tribal governments, in aggregate, of $100 million or more in any one year; or
- Results in estimated annual costs to the private sector of $100 million or more in any one year.

Federal rules are exempt from the UMRA requirements if:

- The rule implements requirements specifically set forth in law; or
- Compliance with the rule is voluntary for state and local governmental entities.

Based on these criteria set forth by the UMRA, we do not expect the Proposed Rule to generate a significant unfunded mandate. The rule does not have a significant or unique effect on State, local or Tribal governments, or the private sector. As such, a statement containing the information required by UMRA (2 U.S.C. §§ 1531et seq.) is not required.

C.4 ENVIRONMENTAL JUSTICE ANALYSIS

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (February 11, 1994), requires federal agencies

to identify disproportionately large and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations.[22,23] Among other actions, agencies are directed to improve research and data collection regarding health and environmental effects in minority and low-income communities. BOEM provides this analysis in the FEIS.

C.5 PROPERTY TAKINGS (EXECUTIVE ORDER 12630)

Executive Order 12630 states that governmental officials should be sensitive to and anticipate, and account for obligations imposed by the Just Compensation Clause of the Fifth Amendment in planning and carrying out government actions. Actions which result in a physical invasion or occupancy of private property may constitute a taking of property, even if that invasion is temporary. Because the area to be affected by this Proposed Rule is Federal waters, no property takings is anticipated.

C.6 CHILDREN'S HEALTH PROTECTION

Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks" (April 21, 1997), directs federal agencies and departments to evaluate the health effects of health-related or risk-related regulations on children.[24] For economically significant rules concerning an environmental health or safety risk that may disproportionately affect children, Executive Order 13045 also requires an explanation as to why the planned regulation is preferable to other potentially effective and feasible alternatives.[25] The Proposed Rule is not subject to E.O. 13045 because it does not involve decisions on environmental health or safety risks that may disproportionately affect children**.**

C.7 TRIBAL GOVERNMENT ANALYSIS

Executive Order 13175: Consultation and Coordination with Indian Tribal Governments (65 FR 67249, November 9, 2000), requires NMFS to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." Because this rule will be implemented in Federal waters, NMFS believes that it does not have tribal implications and therefore is not further evaluated.

---

[22] As stated in Executive Order 12898, a minority is an individual who is a member of one of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic.

[23] As stated in Executive Order 12898, low-income populations are identified using the annual statistical poverty thresholds from the Census Bureau's Current Population Reports on Income and Poverty.

[24] In addition, two separate directives issued by EPA, "Policy on Evaluating Health Risks to Children" (October 1995) and "National Agenda to Protect Children's Health from Environmental Threats" (October 1996), call for consideration of children's health within risk assessments and other components of regulatory analyses.

[25] As defined in Executive Order 13045, an economically significant rule is any rulemaking that has an annual effect on the economy of $100 million or more, or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local or tribal governments or communities.

C.8 FEDERALISM ANALYSIS

Executive Order 13132, entitled "Federalism" (64 FR 43255, August 10, 1999), requires NMFS to develop a process to ensure "meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications." Policies that have federalism implications are defined in the Executive Order to include regulations that have "substantial direct effects on the States [in terms of compliance costs], on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government." In addition, policies have federalism implications if they preempt State law. In terms of compliance costs, the Federal government must provide the necessary funds to pay the direct costs incurred by State and local governments in complying with the regulation if the rule:

1. Results in direct expenditures to state and local governments in aggregate of $25 million in any one year; or
2. Results in expenditures greater to state and local governments greater than one percent of their annual revenues in any one year

We do not anticipate that this rule will result in significantly greater compliance costs for the States above the thresholds listed above. We also do not expect this rule to impact the relationship between the Federal government and the States or on the distribution of power and responsibilities among the various levels of government, as specified in the Order. Thus, Executive Order 13132 does not apply to this rule.

C.9 CUMULATIVE IMPACTS ANALYSIS

Executive Order 12866, entitled "Regulatory Planning and Review" (October 4, 1993), and Executive Order 13563, entitled "Improving Regulation and Regulatory Review" (January 21, 2011), require NMFS to "tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations." For a more detailed assessment of the cumulative impacts of alternative rule elements considered in the development of the Proposed Rule, please refer to the EIS.

APPENDIX D | INDUSTRY COMPLIANCE COST RESULTS USING THE THREE PERCENT SOCIAL DISCOUNT RATE

This appendix presents the results of the industry compliance cost analysis using the three percent social discount rate. Exhibits D-1 through D-3 present results relative to the pre-stay agreement baseline and Exhibits D-4 through D-6 present results relative to the stay agreement baseline.

EXHIBIT D-1. PRESENT VALUE COSTS BY SURVEY TYPE, INCREMENTAL TO PRE-STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.03 - $0.11	$0.63 - $2.0	$4.2 - $11.9	$0.56 - $1.92	$0.00 - $18.5	$0.00 - $4.39	$7.7 - $94.5	$6.9 - $82.9	$228 - $705	$248 - $921
More Stringent Alternative	$0.06 - $0.17	$0.63 - $2.0	$4.6 - $13.7	$0.62 - $2.21	$0.00 - $22.1	$0.00 - $5.65	$12.0 - $116	$10.7 - $107.2	$364 - $835	$393 - $1,110

Notes:
Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.

EXHIBIT D-2. ANNUALIZED COSTS BY SURVEY TYPE, INCREMENTAL TO PRE-STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.01 - $0.02	$0.13 - $0.42	$0.88 - $2.53	$0.12 - $0.41	$0.00 - $3.92	$0.00 - $0.93	$1.63 - $20.0	$1.45 - $17.6	$48.4 - $149	$53 - $195
More Stringent Alternative	$0.01 - $0.04	$0.13 - $0.42	$0.98 - $2.91	$0.13 - $0.47	$0.00 - $4.68	$0.00 - $1.20	$2.54 - $24.7	$2.26 - $22.7	$77.2 - $177	$83 - $234

Notes:
Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.

EXHIBIT D-3. ANNUALIZED COSTS BY SURVEY TYPE AND PLANNING AREA, INCREMENTAL TO PRE-STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.00	$0.01 - $0.05	$0.22 - $0.69	$0.00 - $0.07	$0.00 - $1.31	$0.00 - $0.31	$0.00 - $3.42	$0.00 - $2.99	$5.7 - $41.1	$5.9 - $50.0
	Central	$0.01 - $0.02	$0.12 - $0.35	$0.66 - $1.77	$0.12 - $0.33	$0.00 - $1.31	$0.00 - $0.31	$1.63 - $14.3	$1.45 - $12.6	$42.7 - $104	$46.7 - $135
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.07	$0.00 - $0.00	$0.00 - $1.31	$0.00 - $0.31	$0.00 - $2.37	$0.00 - $2.02	$0.00 - $3.99	$0.00 - $10.1
More Stringent Alternative	Western	$0.00 - $0.00	$0.01 - $0.05	$0.24 - $0.80	$0.00 - $0.09	$0.00 - $1.56	$0.00 - $0.40	$0.00 - $4.21	$0.00 - $3.87	$9.0 - $48.8	$9.3 - $59.8
	Central	$0.01 - $0.03	$0.12 - $0.35	$0.74 - $2.03	$0.13 - $0.38	$0.00 - $1.56	$0.00 - $0.40	$2.54 - $17.5	$2.26 - $16.2	$68.1 - $124	$74.0 - $162
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - $0.08	$0.00 - $0.00	$0.00 - $1.56	$0.00 - $0.40	$0.00 - $2.94	$0.00 - $2.65	$0.00 - $4.74	$0.00 - $12.4

Notes:
Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.

EXHIBIT D-4. PRESENT VALUE COSTS BY SURVEY TYPE, INCREMENTAL TO STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.01 - $0.04	$0.63 - $1.97	($1.64) - ($18.6)	($0.22) - ($3.07)	$0.00 - ($21.2)	$0.00 - ($14.1)	($7.60) - ($72.5)	($18.8) - ($275)	($26.5) - ($343)	($54.1) - ($745)
More Stringent Alternative	$0.04 - $0.09	$0.63 - $1.97	($1.15) - ($16.8)	($0.16) - ($2.78)	$0.00 - ($17.6)	$0.00 - ($12.8)	($3.27) - ($50.6)	($14.9) - ($251)	$109 - ($212)	$90.3 - ($562)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.

EXHIBIT D-5. ANNUALIZED COSTS BY SURVEY TYPE, INCREMENTAL TO STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	SURVEY TYPE									
	AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	$0.00 - $0.01	$0.13 - $0.42	($0.35) - ($3.94)	($0.05) - ($0.65)	$0.00 - ($4.49)	$0.00 - ($2.99)	($1.61) - ($15.4)	($3.98) - ($58.3)	($5.63) - ($72.7)	($11.5) - ($158)
More Stringent Alternative	$0.01 - $0.02	$0.13 - $0.42	($0.24) - ($3.56)	($0.03) - ($0.59)	$0.00 - ($3.73)	$0.00 - ($2.72)	($0.69) - ($10.7)	($3.17) - ($53.1)	$23.1 - ($45.0)	$19.1 - ($119)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.

EXHIBIT D-6. ANNUALIZED COSTS BY SURVEY TYPE AND PLANNING AREA, INCREMENTAL TO STAY AGREEMENT BASELINE, 2018-2022 (MILLION 2016$, 3% DISCOUNT RATE)

SCENARIO	PLANNING AREA	SURVEY TYPE									
		AIRGUN HRG	NON-AIRGUN HRG	VSP	SWD	2D	2D-OBS	3D	3D-OBS	WAZ	TOTAL
Proposed Rule	Western	$0.00 - $0.00	$0.01 - $0.05	($0.09) - ($1.09)	$0.00 - ($0.12)	$0.00 - ($1.50)	$0.00 - ($1.00)	$0.00 - ($2.62)	$0.00 - ($9.94)	($0.66) - ($20.1)	($0.73) - ($36.3)
	Central	$0.00 - $0.01	$0.12 - $0.35	($0.26) - ($2.74)	($0.05) - ($0.53)	$0.00 - ($1.50)	$0.00 - ($1.00)	($1.61) - ($10.9)	($3.98) - ($41.3)	($4.97) - ($50.6)	($10.7) - ($108)
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - ($0.11)	$0.00 - $0.00	$0.00 - ($1.50)	$0.00 - ($1.00)	$0.00 - ($1.86)	$0.00 - ($7.07)	$0.00 - ($1.95)	$0.00 - ($13.5)
More Stringent Alternative	Western	$0.00 - $0.00	$0.01 - $0.05	($0.06) - ($0.99)	$0.00 - ($0.11)	$0.00 - ($1.24)	$0.00 - ($0.91)	$0.00 - ($1.83)	$0.00 - ($9.06)	$2.71 - ($12.5)	$2.66 - ($26.5)
	Central	$0.01 - $0.02	$0.12 - $0.35	($0.18) - ($2.48)	($0.03) - ($0.48)	$0.00 - ($1.24)	$0.00 - ($0.91)	($0.69) - ($7.60)	($3.17) - ($37.6)	$20.4 - ($31.4)	$16.48 - ($81.3)
	Eastern	$0.00 - $0.00	$0.00 - $0.01	$0.00 - ($0.10)	$0.00 - $0.00	$0.00 - ($1.24)	$0.00 - ($0.91)	$0.00 - ($1.30)	$0.00 - ($6.44)	$0.00 - ($1.21)	$0.00 - ($11.2)

Notes:
1. Estimates within parentheses indicate negative costs, or cost savings.
2. Estimates are rounded to three significant digits and may not sum to totals reported due to rounding error. Estimates are also reported to two decimal places. Costs totaling less than $5,000 are therefore reported as $0.