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Draft Programmatic Environmental Impact Statement

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Bureau of Ocean Energy Management

Appendix

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Appendix A: Impacts Not Expected to Be Significant

In this appendix, the Bureau of Ocean Energy Management (BOEM) addresses impacts that are not expected to be significant and provides a rationale for that determination.

Section 1502.1 of the Council on Environmental Quality (CEQ) regulations implementing the National Environmental Policy Act directs Federal agencies to "focus on significant environmental issues." The scoping process, including early public involvement and opportunity to comment, aids in identifying these significant environmental issues. Section 1500.4(g) of the CEQ regulations states that scoping should be completed "…not only to identify significant environmental issues deserving of study, but also to deemphasize insignificant issues."

For the purposes of this analysis, impacts on affected resources by impact-producing factors (IPFs) are categorized as defined in **Table A-1**.

Table A-1. Definitions and examples of direct and indirect effects of IPFs on resources

Impact	Definition	Example	Refer to
Potentially significant	An IPF may affect the particular resource in question and is generally considered to be unavoidable. This category includes impacts that are potentially irreversible but may be removed or reduced through mitigation, regulation, or remedial action. This assessment considers impacts on individual animals (Endangered Species Act-listed species), as well as populations, as appropriate.	I.1 **NOISE** and R.9 **MARINE MAMMALS**	Sections 4.1.3 and 4.1.6–4.1.9
Not expected to be significant	An IPF interacts with a resource but is not expected to affect the particular resource in question, or, if impacts do occur, the resource would most likely recover without mitigation once the impacting factor is removed.	I.1 **NOISE** and R.4 **MARINE BENTHIC COMMUNITIES**	Appendix A
Does not interact	An IPF does not interact with a specific resource.	I.1 **NOISE** and R.1 **AIR QUALITY**	n/a

BOEM's determinations in the draft programmatic environmental impact statement (Draft Programmatic EIS) regarding potentially significant impacts are based on evaluations in previous Bureau environmental documents, public scoping information, and the professional judgment of BOEM subject matter experts who applied and interpreted current scientific and technical information. **Section 1.6** describes how BOEM addressed incomplete and unavailable information in this document.

This Draft Programmatic EIS considers the potential for significance at a broad geographic scale, as appropriate for the scope of a national leasing program. BOEM prepares more detailed lease sale and site-specific environmental documents to evaluate potential impacts at each subsequent stage of the leasing process. These subsequent environmental reviews address any new or additional information available at those stages and evaluate appropriate protective measures.

This appendix is organized first by IPFs and then by resources. The discussion provides the rationale for IPF/resource combinations that are not expected to be significant. For potentially significant impacts, see **Chapter 4**. Unless indicated otherwise, the determinations in this appendix apply to all Outer Continental Shelf (OCS) regions or planning areas. The numbering of the IPFs and resources is consistent with the rest of the Draft Programmatic EIS for easy identification.

I.1 NOISE

R.1 **AIR QUALITY:** Noise does not interact with air quality.

R.2 **WATER QUALITY:** Noise does not interact with water quality.

R.3 **PELAGIC COMMUNITIES:** Noise is not expected to significantly impact pelagic communities, particularly planktonic organisms. Little research has been conducted on the physiological impacts of noise to eggs, zooplankton, and fish larvae. While it is possible that high-intensity noises could irreversibly damage internal anatomy and physiology of planktonic organisms if they are close enough to a sound source (de Soto et al. 2013; Govoni et al. 2003; Govoni et al. 2008) or such noises may cause them to swim out of harm’s way (Dalen and Knutsen 1987), most of the work that has been done on small spatial scales (i.e., 10s of meters) has shown minimal effects at these distances (Bolle et al. 2012; Booman et al. 1996; Govoni et al. 2008; Holliday et al. 1987; Kostyuchenko 1973; Pearson et al. 1994; Saetre and Ona 1996). McCauley et al. (2017) sampled zooplankton in the vicinity of the track of a seismic airgun and demonstrated elevated mortality rates at much larger distances than previous studies had shown (> 3,280 ft [1,000 m]). A follow-up modeling study found that, even if such high mortality rates were to occur, zooplankton populations would recover quickly, due to a combination of rapid turnover and natural mixing from ocean circulation (Richardson et al. 2017). More recently, Fields et al. (2019) showed an increase in mortality for copepods that were exposed to an airgun at distances up to 32.8 ft (10 m) but not at a distance of 65.6 ft (20 m), a stark contrast to McCauley et al. (2017). The discrepancy between these findings underscores the need for additional research in this area. Taken together, the results from research in this area indicates that seismic airguns may affect plankton on very small spatial scales and would not significantly increase mortality rates in planktonic organisms, which already have very high natural levels of mortality.

Behavioral impacts from low-intensity sound sources (e.g., distant vessels, construction) may also be possible but would likely occur over small spatial scales and therefore have no or insignificant impacts. For example, some fish larvae use acoustic signals to maintain group cohesion (Staaterman et al. 2014b) or to navigate toward appropriate settlement habitat (Montgomery and Coombs 2011; Montgomery et al. 2006; Radford et al. 2011; Simpson et al. 2005). Therefore, some continuous sounds from drilling or vessel transit, for example, could mask biologically relevant sounds (Holles et al. 2013), but these effects would be transient and localized in nature and are unlikely to have long-term, population-level effects.

R.4 MARINE BENTHIC COMMUNITIES: Noise is not expected to significantly impact marine benthic communities, particularly invertebrates. Invertebrate bioacoustics is a rapidly expanding field of research (Mooney et al. 2016; Normandeau Associates Inc. 2012; Popper and Hawkins 2018). It is generally understood that marine invertebrates are sensitive to particle motion and not acoustic pressure. For information about hearing in marine invertebrates, see **Appendix B** and Popper and Hawkins (2018). Impacts are expected to occur within a few wavelengths of a sound source, where the particle motion component of a sound wave is dominant, but not be significant (Kalmijn 1988; Popper and Hawkins 2018; Urick 1983). In addition to water-borne particle motion, noise from seismic airguns, drilling, or trenching may propagate through the substrate and could also affect some burrowing invertebrates (Roberts and Elliott 2017; Solan et al. 2016). Several studies have examined impacts of high-intensity sounds on benthic invertebrates and have generally found sublethal effects. Day et al. (2017) found that airgun exposure changed blood chemistry and altered normal behaviors in burrowing scallops within several hundred meters of the source. Rock lobsters exposed to seismic airguns exhibited reflex impairment, long-term statocyst (balance sensory receptor) damage, and changes in blood chemistry, but mass mortality did not occur (Day et al. 2016; Day et al. 2019). Payne et al. (2007) observed sublethal effects to blood biochemistry in American lobster exposed to airguns but no obvious mortality or physiological changes. Alarm and startle responses have been observed in squid (Fewtrell and McCauley 2012; Jones et al. 2021) and cuttlefish (Samson et al. 2014), and increased vessel noise has increased metabolic rates in shore crabs (Wale et al. 2013). A series of field studies on adult snow crabs showed no serious impacts on behavior or health when exposed to seismic airguns (Christian et al. 2003; Cote et al. 2020; Morris et al. 2020). Taken together, this research suggests that marine benthic organisms could experience some behavioral or sublethal physiological effects when exposed to noise from seismic airguns, but wide-scale mortality is not expected. Because results thus far have shown differing effects across species, noise impacts on marine mammals continues to be an important area of scientific research.

R.5 COASTAL & ESTUARINE HABITATS: Noise is potentially significant for coastal and estuarine habitats in some Alaska planning areas where caribou are present (**Section 4.1**). Noise is not expected to significantly impact coastal and estuarine habitats in other regions or the remaining Alaska planning areas, largely because of the physics of sound propagation in shallow waters. In coastal areas, noise could be produced as a byproduct of onshore construction, pipeline trenching, or vessel traffic. Impacts are expected to be highly localized because low-frequency sounds do not propagate well through shallow water (low-frequency cutoff) (Urick 1983). The most common species in coastal areas (such as crabs, oysters, mussels, and shrimp) are capable of perceiving the particle motion component (**Appendix B**) of low-frequency sounds (Charifi et al. 2017; de Soto et al. 2013; Roberts et al. 2015). Larval stages of some estuarine species may use acoustic cues to navigate toward appropriate settlement habitat or to initiate metamorphosis (Lillis et al. 2015; Lillis et al. 2013; Stanley et al. 2015). Although these animals may use natural acoustic cues for basic life functions, the particle motion signal from anthropogenic noise sources would propagate only a few wavelengths from the sound source and therefore would not likely affect the majority of coastal and estuarine species (Kalmijn 1988; Popper and Hawkins 2018; Urick 1983).

R.6 **FISH & ESSENTIAL FISH HABITAT:** Noise is potentially significant for fish and essential fish habitat (EFH) in all planning areas (**Section 4.1**).

R.7 **BIRDS:** Noise is not expected to significantly impact birds. Birds have a relatively restricted hearing range for airborne noise. Hearing sensitivity seems most acute in the range of 1 to 5 kHz (Dooling and Popper 2007). These data, albeit limited, suggest that seabirds are not particularly sensitive to sounds below 1 kHz, the frequency range in which the most acute OCS-associated noise occurs (**Appendix B**). Despite this low sensitivity, birds could detect and be disturbed by some OCS-related noise. Noise from seismic surveys could temporarily disturb or displace pelagic diving birds from foraging habitat (Pichegru et al. 2017). Underwater noise from seismic surveys, drilling, production, trenching, or vessel traffic could affect seabirds and waterfowl that dive below the water surface to forage or escape predators. Other underwater sounds (e.g., vessel noise) also have dominant acoustic energy below the hearing range of diving birds; therefore, impacts from these sources would be minimal and would only occur very close to the source. Although drilling and production operations generate noise, some seabirds are attracted to offshore structures and use them for resting or foraging (Baird 1990; Montevecchi 2006; Russell 2005; Tasker et al. 1986).

Species that are in close proximity to platforms may experience disturbance or possible temporary displacement from airborne sounds around the platforms (Russell 2005; Tasker et al. 1986). Aircraft noise would be short term with transient effects. Studies of birds exposed to frequent, low-level military jet aircraft overflights and simulated mid- to high-altitude sonic booms have shown some short-term behavioral responses but little effect on reproductive success (Ellis et al. 1991). Additionally, birds have been shown to return to pre-disturbance behavior within 5 minutes of aircraft disturbance (Komenda-Zehnder et al. 2003).

Finally, noise from onshore construction and other OCS activities could temporarily mask bird vocalization and communication and cause localized disturbance and temporary displacement of some species from the immediate area of activity. Some species may avoid the noisy area but return to the area after construction ends, while others may become acclimatized to the noise. In general, impacts could be avoided or minimized onshore through careful placement of facilities, such as by locating pipeline corridors and construction projects away from nesting aggregations or by scheduling activities to avoid the nesting period.

R.8 **SEA TURTLES:** Noise is potentially significant for sea turtles in the Pacific, Gulf of Mexico (GOM), and Atlantic Regions—and in the Gulf of Alaska Planning Area when sea turtles occur there (**Section 4.1**). Noise is not expected to be significant for sea turtles in the remaining Alaska planning areas, where sea turtles are not present.

R.9 **MARINE MAMMALS:** Noise is potentially significant for marine mammals in all planning areas (**Section 4.1**).

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Noise is not expected to significantly impact commercial and recreational fisheries. Research on the impacts of seismic airguns on commercial catch rates generally have focused on short-term impacts and have shown that some fish species do vacate areas during and immediately following seismic surveys, but the fish usually return within hours to days (Engas et al. 1996; Hirst and Rodhouse 2000; Lokkeborg and Soldal 1993). Although catch rates may be temporarily affected by a displacement of animals, it is unlikely to have long-lasting impacts on an entire fishery. Other noise sources from OCS activity are not expected to have significant impacts on fisheries. Ship noise may cause localized, temporary behavioral disturbance or masking of biologically important sounds (impacts of acoustic masking are discussed in **Section 4.1**). Unless masking persistently occurs at the site and timing of a key spawning aggregation, it is unlikely to have a significant impact on fisheries. Similarly, drilling and trenching noise are transient in nature and are not expected to displace fishing activity or significantly impact this resource. Overall, although individuals of some economically important target species may be affected by noise, the impacted fish would constitute an immeasurably small portion of potential landings.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Noise does not interact with archaeological and cultural resources.

R.12 **LAND USE:** Noise is not expected to significantly impact land use. Onshore noise impacts from construction (e.g., new landfalls, port expansion) are anticipated to be temporary. Noise impacts relating to marine seismic surveys and geohazard surveys; vessel noise (e.g., propeller cavitation, propeller singing, propulsion); drilling and production operations; offshore construction; and platform removal would be restricted to the offshore environment.

R.13 **CULTURE:** Noise is potentially significant for culture in the Alaska, Atlantic, and Pacific Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, noise is not expected to have a significant impact on culture, because the additional OCS oil and gas activity would not have a noticeable effect on baseline noise levels. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected. Noise from aircraft and ships is short term and transient.

R.14 **VULNERABLE COASTAL COMMUNITIES:** Noise is potentially significant for vulnerable coastal communities in the Alaska, Atlantic, and Pacific Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, noise is not expected to have a significant impact on vulnerable coastal communities because the additional OCS oil and gas activity would not have a noticeable effect on baseline noise levels. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected. Noise from aircraft and ships is short term and transient.

R.15 **RECREATION & TOURISM:** Noise is potentially significant for recreation and tourism in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Noise impacts on recreation and tourism from OCS-related oil and gas activities are not expected to be significant in the Western and Central GOM Planning Areas due to the baseline level of industrial noise that already exists in these areas. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

I.2 TRAFFIC

R.1 **AIR QUALITY:** Traffic does not interact with air quality, because this IPF considers only the physical presence of aircraft, vessel, and onshore traffic, not the emissions they produce.

R.2 **WATER QUALITY:** Traffic is not expected to significantly impact water quality. Vessel wake, propeller “wash,” bottom scour from ship or vessel traffic, and channel dredging may lead to temporary and localized increases in turbidity, but these potential impacts are not expected to be significant due to their localized and temporary nature.

R.3 **PELAGIC COMMUNITIES:** Traffic is not expected to significantly impact pelagic communities. Aircraft would have no effect on pelagic communities. Ship traffic transiting through an area may affect local circulation and increase turbulence (e.g., ship wake), which may cause mortality or injury to some planktonic organisms in close proximity to the moving vessels (Bickel et al. 2011). However, this impact would not be significant because of the naturally high rates of mortality and growth in planktonic organisms and the localized nature of ship wakes.

R.4 **MARINE BENTHIC COMMUNITIES:** Traffic is not expected to significantly impact marine benthic communities. Traffic can interact with marine benthic communities, particularly in shallower waters, as a result of vessel wake, propeller “wash,” bottom scour from ships or vessels, and channel dredging to allow for ships and vessels to pass through. These potential impacts are not expected to be significant due to the short-duration and/or small, localized footprints of these occurrences, should they occur.

R.5 **COASTAL & ESTUARINE HABITATS:** Vessel and onshore traffic may significantly impact coastal and estuarine habitats in all planning areas (**Section 4.1**).

R.6 **FISH & ESSENTIAL FISH HABITAT:** Traffic is not expected to significantly impact fish and EFH. Traffic can interact with fish and EFH, particularly in shallower waters, as a result of vessel wake, propeller “wash,” bottom scour from ships or vessels, and channel dredging to allow for ships and vessels to pass through; traffic may potentially disrupt, injure, or destroy these resources. These potential impacts are not expected to be significant due to the short-duration and/or small, localized footprints of these occurrences.

R.7 **BIRDS:** Traffic may significantly impact birds in all planning areas (**Section 4.1**).

R.8 **SEA TURTLES:** Vessel traffic may significantly impact sea turtles in the Pacific, GOM, and Atlantic Regions—and in the Gulf of Alaska Planning Area when sea turtles occur there (**Section 4.1**). Traffic is not expected to be significant for sea turtles in the remaining Alaska planning areas, where sea turtles are not present.

R.9 **MARINE MAMMALS:** Traffic may significantly impact marine mammals in all planning areas (**Section 4.1**).

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Traffic is not expected to significantly impact commercial or recreational fisheries. Although traffic may cause commercial and recreational fishing vessels to change their course or speed while traveling to or from fishing grounds or while fishing, standard maritime communication and well-established planning processes easily resolve any chance overlap of traffic with fisheries activities. Vessel traffic may also damage fishing gear, although these incidences are expected to be isolated.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Traffic does not interact with archaeological and cultural resources.

R.12 **LAND USE:** Traffic may significantly impact land use in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, traffic would not have a significant impact on land use, because the traffic increase likely would not be measurably different from the baseline due to the current level of oil and gas activity. Some coastal lands have already been converted to support offshore oil and gas activity, and an incremental addition of activities from additional OCS oil and gas activity is not likely to change established traffic patterns and levels. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.13 **CULTURE:** Traffic may significantly impact culture in the Alaska, Atlantic, and Pacific Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, traffic is not expected to have a significant impact on regional culture because the traffic increase would not be measurably different than the baseline of current oil and gas activity. The incremental addition of activities from OCS oil and gas activity is not likely to change established traffic patterns and levels. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.14 **VULNERABLE COASTAL COMMUNITIES:** Traffic may significantly impact vulnerable coastal communities in the Alaska, Atlantic, and Pacific Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, traffic is not expected to have a significant impact on vulnerable coastal communities because traffic increase would not be measurably different than the baseline of current oil and gas activity. The incremental addition of activities from OCS oil and gas activity is not likely to change established traffic patterns and levels. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.15 **RECREATION & TOURISM:** Traffic is not expected to have a significant impact on recreation and tourism in any planning area. Increased road, air, or marine traffic could occur but would be temporary in nature or have a small or insignificant incremental contribution to existing traffic.

I.3 ROUTINE DISCHARGES

R.1 AIR QUALITY: Routine discharges do not interact with air quality.

R.2 WATER QUALITY: Routine discharges may significantly impact water quality in all planning areas (**Section 4.1**).

R.3 PELAGIC COMMUNITIES: Routine discharges are not expected to significantly impact pelagic communities. Elevated turbidity may reduce the amount of light available for photosynthesis by phytoplankton and may impair feeding opportunities for visual-foraging zooplankton (including larval fishes). In addition, suspended material in the water may clog and abrade appendages and feeding structures on some zooplankton species (Kjelland et al. 2015; Wilber and Clarke 2001). However, impacts from routine discharges would not significantly impact pelagic communities, because routine discharges would be localized, minimal, and rapidly dispersed and diluted. Additionally, compliance with National Pollution Discharge Elimination System (NPDES) permit requirements would reduce or prevent most impacts on nearby waters.

R.4 MARINE BENTHIC COMMUNITIES: Routine discharges may significantly impact marine benthic communities in all planning areas (**Section 4.1**).

R.5 COASTAL & ESTUARINE HABITATS: Routine discharges do not interact with coastal and estuarine habitats.

R.6 FISH & ESSENTIAL FISH HABITAT: Routine discharges are not expected to significantly impact fish and EFH. Permitted routine discharges, such as produced water, are not expected to persist in the water column after discharge. Discharged muds and cuttings settle or disperse rapidly. Cuttings discharged at the surface spread over a greater area than those shunted to the seafloor, but protective buffers are used to distance drilling activities from potentially sensitive habitat and/or fish communities. Site-specific reviews would be conducted, and additional mitigations could be applied as appropriate. Routine discharges that affect the seafloor may have similar effects as those from bottom/land disturbance (**Section 4.1**).

R.7 BIRDS: Routine discharges are potentially significant for birds in the Alaska Region (**Section 4.1**). In all other regions, routine discharges are not expected to significantly impact birds. Operational discharges that produce oil sheens (e.g., produced water) may impact seabirds through contact with feathers at sea (Fraser et al. 2006). However, the impact of routine discharges on birds is not expected to be significant, because compliance with NPDES permit requirements and U.S. Coast Guard (USCG) regulations should reduce or prevent most impacts. Permitted routine discharges are not expected to persist in the water column after discharge. Depending upon the habitat type at the drill site, there may be some temporary loss of benthic foraging habitat from permitted drilling muds and cutting discharges.

R.8 SEA TURTLES: Routine discharges are not expected to significantly impact sea turtles, because compliance with NPDES permit requirements and USCG regulations should reduce or prevent most impacts. These permitted discharges may be localized in areas not often frequented by sea turtles and likely would not persist long enough to have a measurable effect on these animals.

R.9 **MARINE MAMMALS:** Routine discharges may significantly impact marine mammals in the Alaska Region (**Section 4.1**). In all other regions, benthic-feeding marine mammals do not occur in, or their foraging areas do not overlap with, the expected areas of OCS activity. For example, in the Pacific Region, sea otters forage in nearshore benthic habitats, typically in waters 65 ft (20 m) in depth or less (Bodkin et al. 2004), and northern elephant seals forage in deep waters off the continental margin (Le Boeuf et al. 2000). Gray whales do not feed during their annual migration along the Pacific Coast. In the Atlantic and GOM Regions, the only benthic-feeding marine mammal is the West Indian manatee, which forages very close to shore. Furthermore, compliance with NPDES permit requirements and USCG regulations during normal operations may reduce or prevent most impacts.

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Routine discharges are not expected to significantly impact commercial and recreational fisheries due to existing discharge water quality regulations in place to uphold water quality standards (EPA 2019). Existing NPDES permit requirements and USCG regulations are designed to minimize potential impacts on water quality. Depending upon the habitat type at the drill site, there may be some temporary loss of benthic foraging habitat until re-colonization occurs.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Most routine discharges, such as produced water, are not expected to significantly impact archaeological and cultural resources. Drilling muds and cuttings may impact archaeological sites, either directly or by hindering detection of sites due to magnetic interference. However, known archaeological and cultural resources are likely to be avoided, and potential impacts are not expected to be significant.

R.12 **LAND USE:** Routine discharges are potentially significant for land use in the Eastern GOM Planning Area, Pacific Region (except for the Southern California Planning Area), Alaska Region (except for the Beaufort Sea and Cook Inlet Planning Areas), and Atlantic Region (**Section 4.1**). Routine discharges are not expected to significantly impact areas currently producing oil and gas (Cook Inlet, Beaufort Sea, Southern California, Western GOM, and Central GOM Planning Areas), because operations requiring waste storage have already been permitted, and natural salt domes can be used for storage (Dismukes 2014). Some routine discharges are treated in the offshore environment through dilution or reinjection. Waste disposal is regulated by the U.S. Environmental Protection Agency (USEPA) and by individual state governments. Waste that cannot be diluted or reinjected must be processed onshore and land farmed, recycled, or landfilled in designated containment areas under ground (Dismukes 2011).

R.13 **CULTURE:** Routine discharges are potentially significant for culture in the Alaska Region and the Pacific Region (except for the Southern California Planning Area) (**Section 4.1**). In all other planning areas, routine discharges are not expected to be significant for culture.

R.14 **VULNERABLE COASTAL COMMUNITIES:** Routine discharges are potentially significant for vulnerable coastal communities in the Alaska Region and the Pacific Region (except for the Southern California

Planning Area) (**Section 4.1**). In all other planning areas, routine discharges are not expected to be significant for vulnerable coastal communities.

R.15 RECREATION & TOURISM: Routine discharges do not interact with recreation and tourism.

I.4 BOTTOM/LAND DISTURBANCE

R.1 AIR QUALITY: Bottom/land disturbance does not interact with air quality.

R.2 WATER QUALITY: Bottom/land disturbance is not expected to significantly impact water quality. Although impacts from bottom/land disturbance activities would likely increase turbidity within the area of disturbance, these impacts would be localized and temporary. Any suspended sediments, nutrients, or low-level concentrations of trace metals or other contaminants may be rapidly mixed and dispersed by prevailing ocean currents.

R.3 PELAGIC COMMUNITIES: Bottom/land disturbance is not expected to significantly impact pelagic communities. Although bottom/land disturbance may introduce turbidity, which may interfere with photosynthesis in phytoplankton and feeding and respiration in zooplankton, these impacts would be temporary and localized. The scale and frequency of disturbance would not significantly impact pelagic organisms at the population level.

R.4 MARINE BENTHIC COMMUNITIES: Bottom/land disturbance is potentially significantly for marine benthic communities in all planning areas (**Section 4.1**).

R.5 COASTAL & ESTUARINE HABITATS: Bottom/land disturbance is potentially significantly for coastal and estuarine habitats in all planning areas (**Section 4.1**).

R.6 FISH & ESSENTIAL FISH HABITAT: Bottom/land disturbance is not expected to significantly impact fish and EFH. Bottom/land disturbance may displace benthic fishes from areas used for foraging or resting; this displacement is expected to be localized and temporary. Disturbance is not expected to result in loss of habitat or other serious impact. Trenching, dredging, or other construction generate turbidity, which may impair respiration, feeding, or reproduction in individuals relying on visual cues (Kjelland et al. 2015; Wilber and Clarke 2001). Some fish simply move away from turbid waters. Small or less mobile species may be impaired by high turbidity, although effects vary by species (De Robertis et al. 2014). Such effects would likely be temporary (hours to days) and are not expected to have population-level effects. Onshore construction is not expected to impact this resource. Decommissioning may affect fish assemblages, some of which are commercially important and utilize these platforms as habitat (Carr et al. 2003); however, population-level effects are not expected (Gitschlag et al. 2000).

R.7 BIRDS: Bottom/land disturbance is potentially significant for birds in all planning areas (**Section 4.1**).

R.8 SEA TURTLES: Bottom/land disturbance is potentially significant for sea turtles in the GOM Region and Straits of Florida, South Atlantic, and Mid-Atlantic Planning Areas (**Section 4.1**) where sea turtles nest. Bottom/land disturbance is not expected to impact sea turtles in the remaining planning areas because they do not nest in those areas.

R.9 **MARINE MAMMALS:** Bottom disturbance is potentially significant for marine mammals in the Alaska and Atlantic Regions (**Section 4.1**). Bottom/land disturbance is not expected to significantly impact marine mammals in the Pacific and GOM Regions. Benthic-feeding marine mammals and marine mammals utilizing haul-out areas (e.g., seals and walrus) on shore may be significantly impacted. The GOM Region does not have benthic-feeding or semi-aquatic marine mammals, except for manatees, which feed very close to shore and therefore are not expected to be significantly impacted. In the Pacific Region, no benthic-feeding marine mammals forage in areas where OCS activities are expected to take place. Although the Pacific Coast is home to several large rookeries for semi-aquatic mammals (e.g., Steller sea lions, northern elephant seals, California sea lions, and Pacific harbor seals (NMFS 2011; NOAA Fisheries 2015a; 2015b; 2016d), most of these areas fall within national parks, monuments, or National Marine Sanctuaries and are not expected to be significantly impacted by OCS activity.

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Bottom/land disturbance is not expected to significantly impact commercial and recreational fisheries. Effects on fish are not expected, so changes in economically important fish abundance or distribution are not expected to affect fisheries effort or landings. Once a structure is in place, it could serve as additional habitat and open up opportunities for other fishing types (White et al. 2012). Removal of structures may then affect fishing activity, but impacts are expected to be highly localized. Seafloor or subsea structures have the potential to snag or damage fishing gear, but this impact is expected to affect only a small subset of fishermen.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Bottom/land disturbance may significantly impact archaeological and cultural resources in all planning areas (**Section 4.1**).

R.12 **LAND USE:** Bottom/land disturbance (particularly onshore construction) may significantly impact land use in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Impacts from drilling, infrastructure emplacement, anchoring, pipeline trenching, onshore construction, routine maintenance, and structure removal on land use would not be significant in the Western and Central GOM Planning Areas, where the incremental effect of additional OCS activities would not significantly alter the current baseline. Expected increases in OCS activities are not expected to impact onshore land use and infrastructure, as existing infrastructure in the Western and Central GOM Planning Areas would likely be able to accommodate additional needs. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.13 **CULTURE:** Bottom/land disturbance is potentially significant for culture in the Alaska and Atlantic Regions and the Washington/Oregon, Northern California, Central California, and Eastern GOM Planning Areas (**Section 4.1**). In all other planning areas, bottom/land disturbance is not expected to significantly impact culture, because onshore construction would not cause a measurable change in existing conditions.

R.14 **VULNERABLE COASTAL COMMUNITIES:** Bottom/land disturbance is potentially significant for vulnerable coastal communities in the Alaska and Atlantic Regions and the Washington/Oregon, Northern California, Central California, and Eastern GOM Planning Areas (**Section 4.1**). In all other planning areas, bottom/land disturbance is not expected to significantly impact vulnerable coastal communities because drilling and pipeline trenching would have localized impacts, and onshore construction would not cause a measurable change in existing conditions.

R.15 **RECREATION & TOURISM:** Bottom/land disturbance is not expected to significantly impact recreation and tourism. Offshore disturbance to shipwrecks used for recreational activities like scuba diving is possible, but highly unlikely. Water depth limits the number of sites available to scuba divers, and mitigations would be applied at most sites that are used. Onshore disturbance also may affect recreation and tourism but would depend on intensity, location, and timing of activities. In most cases, impacts from onshore construction would be localized and temporary in nature, and alternative recreational opportunities would be available. Recreation and tourism activities associated with wildlife viewing may be particularly sensitive to land disturbance, although impacts would depend on the extent of habitat alteration. These impacts should be evaluated in more detail when there is more information about the location and nature of proposed oil and gas activities.

I.5 EMISSIONS

R.1 **AIR QUALITY:** Emissions are potentially significant for air quality in the Southern California and Central GOM Planning Areas (**Section 4.1**). Emissions are not expected to significantly impact air quality in the Alaska and Atlantic Regions and the Washington/Oregon, Northern California, Central California, Eastern GOM, and Western GOM Planning Areas due to steady vertical and horizontal air motion throughout these areas (Wang and Angell 1999), which would rapidly disperse pollutants. The relatively few facilities and few new mobile sources that would support those facilities, as well as the new onshore facilities, are unlikely to contribute to excessive pollution in nearby Class I areas or result in new nonattainment areas.

R.2 **WATER QUALITY:** Emissions do not interact with water quality on the OCS.

R.3 **PELAGIC COMMUNITIES:** Emissions do not interact with pelagic communities.

R.4 **MARINE BENTHIC COMMUNITIES:** Emissions do not interact with marine benthic habitats.

R.5 **COASTAL & ESTUARINE HABITATS:** Emissions do not interact with coastal and estuarine communities.

R.6 **FISH & ESSENTIAL FISH HABITAT:** Emissions do not interact with fish or EFH.

R.7 **BIRDS:** Emissions are not expected to significantly impact bird species, because emissions would be localized and dissipate quickly.

R.8 **SEA TURTLES:** Emissions are not expected to significantly impact sea turtles because emissions would be localized and would dissipate quickly.

R.9 **MARINE MAMMALS:** Emissions are not expected to significantly impact marine mammals because emissions would be localized and would dissipate quickly.

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Emissions do not interact with commercial and recreational fisheries.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Emissions do not interact with archaeological and cultural resources.

R.12 **LAND USE:** Emissions are not expected to have a significant impact on how people use land onshore. Emissions may degrade materials of structures or alter how humans utilize land for activities such as agriculture. However, these impacts are dependent on where OCS oil and gas activities, including onshore support infrastructure, are located. Any potential impacts on land use should be evaluated in more detail when there is more information about the location and nature of proposed oil and gas activities.

R.13 **CULTURE:** Emissions are not expected to have a significant impact on culture because emissions would rapidly disperse. The relatively few facilities and few new mobile sources associated with OCS those facilities, as well as the new onshore facilities, are unlikely to contribute to excessive pollution in nearby communities or result in new nonattainment areas.

R.14 **VULNERABLE COASTAL COMMUNITIES:** Emissions are potentially significant for vulnerable coastal communities within and adjacent to the Southern California Planning Area (**Section 4.1**). Emissions are not expected to significantly impact vulnerable coastal communities in all other planning areas. Impacts from air pollution are expected to be site-specific and are subject to USEPA requirements for the National Ambient Air Quality Standards. Air emissions from routine operations are not expected to have a measurable impact on most vulnerable coastal communities due to geography or meteorological conditions. BOEM and USEPA regulate air emissions on the OCS. As lease-specific plans are submitted for review, and best available control technology could be put in place if needed to minimize air quality impacts from activities in the offshore environment. Although there is the potential for air quality impacts in the Central GOM Planning Area, it is not likely that those impacts would occur for vulnerable coastal communities. The main areas of concern in the Central GOM are impacts on Class I areas, which are not inhabited, and isolated portions of the Louisiana Coast, which would require lease sale information to determine impacts.

R.15 **RECREATION & TOURISM:** Emissions are not expected to significantly impact recreation or tourism. Emissions resulting from OCS oil and gas activities would be localized to the area of operations and are not anticipated to reduce air quality sufficiently to impact tourism and recreational industries.

I.6 LIGHTING

R.1 **AIR QUALITY:** Lighting does not interact with air quality.

R.2 **WATER QUALITY:** Lighting does not interact with water quality.

R.3 **PELAGIC COMMUNITIES:** Lighting is not expected to significantly impact pelagic communities because effects would be localized. Zooplankton, fish larvae, and some invertebrates are attracted to artificial lights directed toward the water's surface at night (Keenan et al. 2007). Plankton attracted to lights could be eaten by fish and other species like squid, which are also attracted to the lights. Because platforms only illuminate a small area of water around the structure, limited effects on planktonic organisms are expected.

R.4 **MARINE BENTHIC COMMUNITIES:** Lighting is not expected to significantly impact marine benthic communities. Most lighting associated with oil and gas activities occurs at or above the surface of the ocean—thus benthic communities, especially in deep water, would not generally be exposed to lighting. One exception is lighting that occurs as a result of underwater maintenance activities, which include the use of submersibles or other equipment with lighting. These activities may occur at or near the seafloor and therefore may potentially affect marine benthic communities; however, these impacts are not expected to be significant because they are limited in duration and the size of area impacted is minimal.

R.5 **COASTAL & ESTUARINE HABITATS:** Lighting does not interact with coastal and estuarine habitats. Coastal species (e.g., birds, sea turtles) that may be significantly impacted from lighting are analyzed separately.

R.6 **FISH & ESSENTIAL FISH HABITAT:** Lighting is not expected to significantly impact fish and EFH. Small areas of marine surface waters may be exposed to facility or vessel lighting. Some fish species are attracted to lights at night (Keenan et al. 2007), but because the effects would be confined to a small geographic area, few fishes are expected to be impacted with no population-level effects.

R.7 **BIRDS:** Lighting is potentially significant for birds in all planning areas (**Section 4.1**).

R.8 **SEA TURTLES:** Lighting is potentially significant for sea turtles in the GOM Region and Straits of Florida, South Atlantic, and Mid-Atlantic Planning Areas (**Section 4.1**), where sea turtles nest. Lighting is not expected to impact sea turtles in the remaining planning areas because they do not nest in those areas.

R.9 **MARINE MAMMALS:** Lighting is not expected to significantly impact marine mammals. Lighting is not expected to significantly impact the migratory, feeding, and breeding behaviors of cetaceans because they depend on acoustic rather than visual cues. Artificial light may increase the visibility of semi-aquatic marine mammals, such as seals and sea lions, to potential predators at night (Greer et al. 2010). However, the effects of facility or vessel lighting would be confined to a small area of marine surface water or coastal habitat, and population-level effects to marine mammals are not expected.

R.10 **COMMERCIAL & RECREATIONAL FISHERIES:** Lighting is not expected to significantly impact commercial and recreational fisheries. Some fish may be attracted to offshore surface lighting, resulting in congregations that may benefit some fishermen. Overall, effort and landings are not expected to change.

R.11 **ARCHAEOLOGICAL & CULTURAL RESOURCES:** Lighting does not interact with archaeological and cultural resources.

R.12 **LAND USE:** Lighting is not expected to have significant effects on land use in any planning area. Lighting from onshore facilities (e.g., ports, construction facilities, transportation facilities, processing facilities) would be localized and probably would be located in areas with existing industrial lighting effects. Lighting from offshore facilities (e.g., platform lighting, construction lighting, MODU) would mostly impact nighttime views as discussed in the visible infrastructure analysis of **Section 4.1**.

R.13 **CULTURE** and R.14 **VULNERABLE COASTAL COMMUNITIES:** Lighting may significantly impact culture and vulnerable coastal communities in the Alaska Region (except for the Cook Inlet Planning Area), Pacific Region (except for the Southern California Planning Area) and Atlantic Region (**Section 4.1**). Lighting is not expected to have significant impacts on cultural norms or vulnerable coastal communities in the GOM Region and the Cook Inlet and Southern California Planning Areas because of the amount of existing industrialization. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.15 **RECREATION & TOURISM:** Lighting may significantly impact recreation and tourism in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Lighting is not expected to have significant impacts on recreation and tourism in the Western and Central GOM Planning Areas because of the incremental contribution to the existing baseline of oil and gas activities. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

I.7 VISIBLE INFRASTRUCTURE

R.1 **AIR QUALITY:** Visible infrastructure does not interact with air quality.

R.2 **WATER QUALITY:** Visible infrastructure does not interact with water quality.

R.3 **PELAGIC COMMUNITIES:** Visible infrastructure does not interact with pelagic communities.

R.4 **MARINE BENTHIC COMMUNITIES:** Visible infrastructure does not interact with marine benthic communities.

R.5 **COASTAL & ESTUARINE HABITATS:** Visible infrastructure does not interact with coastal and estuarine habitats.

R.6 **FISH & ESSENTIAL FISH HABITAT:** Visible infrastructure does not interact with fish or EFH.

R.7 **BIRDS:** Visible infrastructure does not interact with birds.

R.8 **SEA TURTLES:** Visible infrastructure does not interact with sea turtles.

R.9 **MARINE MAMMALS:** Visible infrastructure does not interact with marine mammals.

R.10 COMMERCIAL & RECREATIONAL FISHERIES: Visible infrastructure does not interact with commercial and recreational fisheries.

R.11 ARCHAEOLOGICAL & CULTURAL RESOURCES: Visible infrastructure may significantly impact archaeological and cultural resources (e.g., onshore historic properties or Traditional Cultural Properties) in all planning areas except the Western and Central GOM Planning Areas (**Section 4.1**). In the Western and Central GOM Planning Areas, visible infrastructure from additional offshore facilities is not likely to have a significant impact because of the number of existing facilities and their distance from shore, and it is unlikely that an onshore historic property would be significantly impacted (e.g., lose its *National Register* eligibility or be substantially altered). Additional OCS activities are also not expected to significantly alter the current baseline of onshore infrastructure. Existing infrastructure in the Western and Central GOM would likely be able to accommodate additional needs. Significant impacts that may already exist may be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.12 LAND USE: Visible infrastructure may significantly impact land use in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Based on existing levels of oil and gas activities in the Western and Central GOM Planning Areas, visible infrastructure is not expected to have a significant impact on land use. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.13 CULTURE and **R.14 VULNERABLE COASTAL COMMUNITIES:** Visible infrastructure may significantly impact culture and vulnerable coastal communities in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Onshore visible infrastructure has existed in the Western and Central GOM Planning Areas for many years, and any additional oil and gas development is expected to tie into existing offshore visible infrastructure and therefore is not expected to significantly impact culture and vulnerable coastal communities. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.15 RECREATION & TOURISM: Visible infrastructure may potentially impact tourism in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). In the Western and Central GOM Planning Areas, visible infrastructure is not expected to have significant impacts on recreation and tourism given that the recreation and tourism industry has coexisted with an extensive and widespread OCS oil- and gas-related industry. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

I.8 SPACE-USE CONFLICTS

R.1 AIR QUALITY: Space-use conflicts do not interact with air quality.

R.2 WATER QUALITY: Space-use conflicts do not interact with water quality.

R.3 PELAGIC COMMUNITIES: Space-use conflicts do not interact with pelagic communities.

R.4 MARINE BENTHIC COMMUNITIES: Space-use conflicts do not interact with marine benthic communities.

R.5 COASTAL & ESTUARINE HABITATS: Space-use conflicts do not interact with coastal and estuarine habitats.

R.6 FISH & ESSENTIAL FISH HABITAT: Space-use conflicts do not interact with fish or EFH.

R.7 BIRDS: Space-use conflicts do not interact with birds.

R.8 SEA TURTLES: Space-use conflicts do not interact with sea turtles.

R.9 MARINE MAMMALS: Space-use conflicts do not interact with marine mammals.

R.10 COMMERCIAL & RECREATIONAL FISHERIES: Space-use conflicts may significantly impact commercial and recreational fisheries in all planning areas except in the Beaufort and Chukchi Seas Planning Areas (**Section 4.1**). Space-use conflicts are not expected to impact commercial and recreational fishing in the Beaufort and Chukchi Seas Planning Areas. In these areas, commercial fishing is currently prohibited. There is a relatively small amount of recreational fishing in the Beaufort and Chukchi Seas Planning Areas, and impacts on recreational fisheries from space-use conflicts are not expected.

R.11 ARCHAEOLOGICAL & CULTURAL RESOURCES: Space-use conflicts do not interact with archaeological and cultural resources.

R.12 LAND USE: Space-use conflicts may significantly impact land use in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Given the history of oil and gas leasing activities in the Western and Central GOM Planning Areas and the well-established network of facilities to support OCS oil and gas activities, impacts on land use from space-use conflicts onshore and offshore are not expected to be significant. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.13 CULTURE: Space-use conflicts may significantly impact culture in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area (**Section 4.1**). Existing nearshore and offshore infrastructure in the Western and Central GOM Planning Areas makes it unlikely that there would be a noticeable change in social norms; therefore, impacts on culture are not expected to be significant. The impacts of onshore facilities in the Western and Central GOM would be localized near existing industrial areas and would not result in a significant impact to culture. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.14 VULNERABLE COASTAL COMMUNITIES: Space-use conflicts may significantly impact vulnerable coastal communities in the Alaska, Pacific, and Atlantic Regions and the Eastern GOM Planning Area

(**Section 4.1**). Existing nearshore and offshore infrastructure in the Western and Central GOM Planning Areas makes it unlikely that there would be a noticeable impact on vulnerable coastal communities in this area. The impacts of onshore facilities in the Western and Central GOM would be localized near existing industrial areas and would not result in significant impacts on vulnerable coastal communities. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

R.15 **RECREATION & TOURISM:** Space-use conflicts may significantly impact recreation and tourism for all planning areas except the Western and Central GOM Planning Areas (**Section 4.1**). Recreation and tourism activities are not expected to be significantly impacted by new leasing in the Western and Central GOM Planning Areas, where these industries have coexisted for many years. Significant impacts that may already exist could be prolonged by any activities authorized under the 2023–2028 Program, but additional impacts are not expected.

Appendix B: Acoustics

B.1 INTRODUCTION

Marine species live in an environment that is ideally suited for acoustic communication. Sound travels nearly five times faster in water than it does in air (Urick 1983). Most of the ocean is dark, and most marine organisms perceive their world through auditory cues.

Ocean sounds originate from a variety of sources. Some come from non-biological sources, such as wind and waves, while others come from the movements or vocalizations of marine life (Duarte et al. 2021). In addition, humans introduce sound into the ocean through activities like oil and gas exploration, construction, military sonars, and vessel traffic (Duarte et al. 2021). The acoustic environment or "soundscape" of a given ecosystem comprises all such sounds—biological, non-biological, and anthropogenic (Pijanowski et al. 2011). Soundscapes are highly variable across space, time, and water depth due to the properties of sound transmission and the types of sound sources present in each area. A soundscape may also be called an "acoustic habitat," as it is a vital attribute of a given area (i.e., habitat) where an animal may live (Hatch et al. 2016).

B.2 PHYSICAL PROPERTIES OF SOUND

This section briefly describes physical properties and transmission of sounds in the ocean. More detailed information can be found in Urick (1983) and Popper and Hawkins (2018).

B.2.1 Components of a Sound Wave

Sounds are created by the vibration of an object within its medium (**Figure B-1**). This movement generates kinetic energy, which travels as a propagating wave away from the sound source. As this wave moves through the medium, the particles undergo tiny back-and-forth movements ("particle motion") along the axis of propagation, but the particles themselves do not travel with the wave. Instead, the vibration is transferred to adjacent particles, which are pushed into areas of high pressure (compression) and low pressure (rarefaction). Acoustic pressure is a non-directional (scalar) quantity, whereas particle motion is an inherently directional quantity (a vector) taking place in the axis of sound transmission. The total energy of the sound wave includes the potential energy associated with the sound pressure as well as the kinetic energy from particle motion.

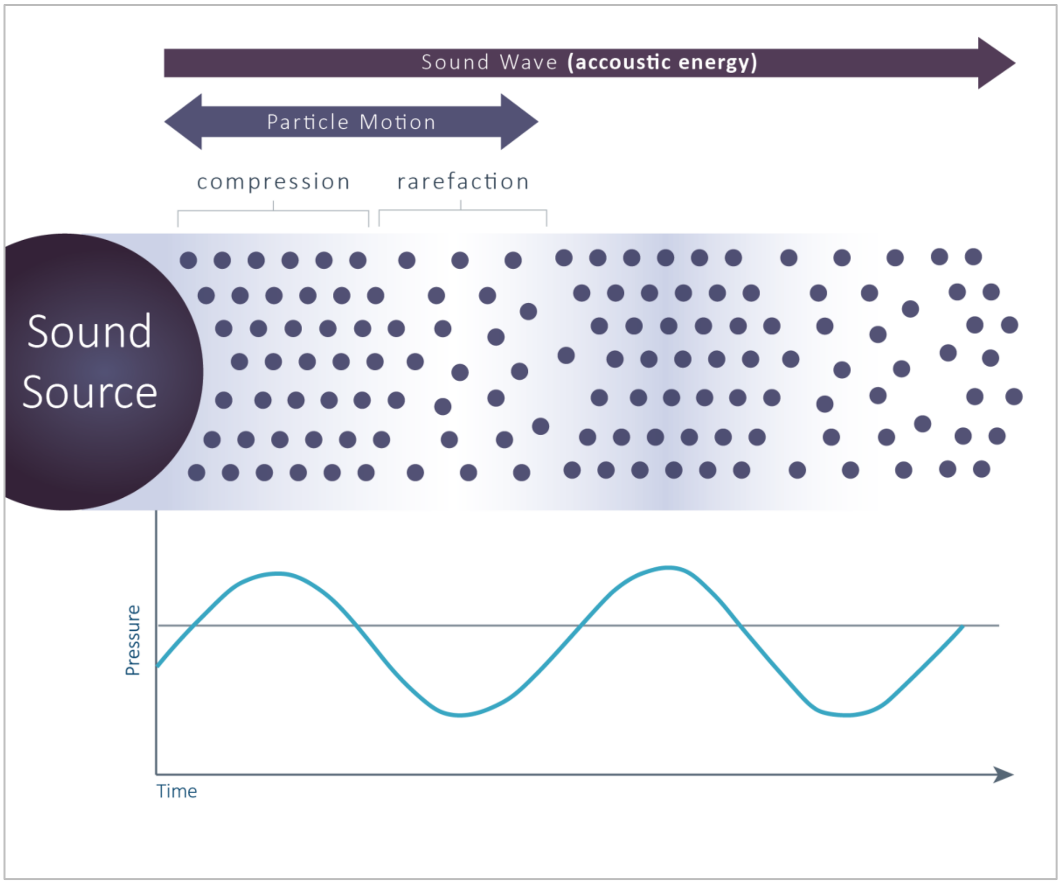

Figure B-1. Basic mechanics of a sound wave
Although acoustic energy travels in the form of a propagating sound wave away from the source, the particles of water or air move back and forth along the axis of sound propagation. Acoustic pressure is a non-directional quantity that changes over time or distance, depicted here as a sinusoidal wave; pressure is greatest when particles are compressed and lowest when they are spread out.

Although the physical properties of sound waves are well understood, most recordings of underwater sounds have measured acoustic pressure rather than particle motion, mainly because (1) it is easier to measure pressure with hydrophones (underwater microphones), and (2) particle motion is a relatively short-ranged cue (10s to 100s of meters). In addition, most of the research on effects of noise on wildlife have focused on animals that detect acoustic pressure (i.e., marine mammals; see section below on *Animal Hearing*). However, as researchers have learned more about the hearing sensitivity of fish and invertebrates (which primarily detect particle motion), more work has begun to measure particle motion from natural and anthropogenic sources and consider potential impacts from this component of sound.

B.2.2 Units of Measurement

Many metrics can be used to describe acoustic signals, and several metrics are defined in the glossary (**Appendix I**). For definitions and acoustic metrics not discussed in this document, see BOEM (2016d), Erbe et al. (2016), Southall et al. (2017), and ISO (2017). Briefly, the most relevant perceptual cues are listed below:

- **Amplitude:** perceptual meaning is “loudness”
- **Frequency:** perceptual meaning is “pitch”
- **Duration:** length of a signal
- **Energy:** total energy of an acoustic wave (kinetic energy + potential energy)

B.2.3 Propagation of Sound in the Ocean

Sound speed in water increases with increasing temperature, salinity, and pressure. When sound waves travel through the water, they encounter areas with different physical properties and are refracted, bending toward areas with lower speeds (Urick 1983). Due to higher temperatures near the ocean’s surface, sound speeds are relatively fast, but as temperature decreases with depth, sound speeds decrease. Ocean sound speeds are slowest at mid-latitude depths of about 1,000 m; sounds originating in this layer can travel great distances. Sounds can also be trapped in the mixed layer near the ocean’s surface (Urick 1983). Latitude, weather, and local circulation patterns influence the depth of the mixed layer, and the propagation of sounds near the surface is highly variable and difficult to predict.

At the boundaries near the sea surface and the sea floor, acoustic energy can be scattered, reflected, or attenuated. Fine-grain sediments tend to absorb sounds well, while hard bottom substrates reflect much of the acoustic energy back into the water column. The presence of ice on the ocean’s surface can either dampen sound levels when there is a continuous ice sheet that blocks surface winds, or increase sound levels when pieces of ice scrape together (Urick 1983). Therefore, as sound waves move from a source to a receiver (i.e., an animal), they can travel on direct, reflected, and refracted pathways, creating a complex pattern of transmission across range and depth. The patterns become even more complicated in shallow waters due to repeated interactions with the surface and the bottom. These variables contribute to the difficulty in predicting the soundscape of a given marine environment at any particular time.

B.3 OCEAN SOUND TYPES

B.3.1 Non-Biological Sounds

The types of sounds present in different areas of the ocean drives the site-specific nature of marine soundscapes. For example, near the surface, sound levels increase with increasing wind speed and wave height. Rain and thunderstorms can also elevate sound levels. In geologically active areas, noise from earthquakes, undersea volcanoes, and hydrothermal vent activity can contribute significant amounts of low-frequency energy to marine soundscapes (Hildebrand 2009; Wenz 1962). In coastal channels and estuaries, noise from water movement generated by tides, such as the sound of waves breaking on the shore, can be substantial (Cotter 2008). Although each of these non-biological sources contribute to marine soundscapes, it is important to note that they each have a distinct frequency composition, which means that they may be perceived differently by different types of animals. In addition, some of these sound sources have regular, periodic variations (e.g., tidal noise), while others are more irregular and unpredictable (e.g., volcanic explosions) (Wenz 1961; 1962).

B.3.2 Biological Sounds

Biological sounds are important components of most marine soundscapes. Some sounds are produced simply as a byproduct of animal movement (Coquereau et al. 2016; Di Iorio et al. 2012; Radford et al. 2008), while others are more deliberately produced for communication, foraging, or navigational purposes. For example, snapping shrimp (crustaceans that live in the structured bottoms of coastal ecosystems) produce a “snap” sound to stun prey, and the snapping of entire colonies creates a loud “crackling” sound present in many coastal habitats. In fact, much of the site-specific variability in coastal soundscapes is attributed to snapping shrimp, and crackling levels vary depending on time of day, season, tidal phase, and even habitat health (Butler et al. 2016; Kennedy et al. 2010; Lillis et al. 2014; Lillis and Mooney 2018; Ricci et al. 2016; Staaterman et al. 2014a).

Many fishes produce sounds for territory defense or for mate attraction (Kasumyan 2009; Lobel et al. 2010; Winn 1964). For example, male toadfish occupy nests in hard bottom habitats (e.g., the Gulf toadfish in the Gulf of Mexico [GOM]) and produce “hums” to attract females; these sounds are a key component of nighttime soundscapes in this region (Thorson and Fine 2002). Other fish like Atlantic cod (Hernandez et al. 2013), black drum (Rice et al. 2017), Gulf corvina (Erisman and Rowell 2017), Goliath grouper (Mann et al. 2009), and several croaker species (Luczkovich et al. 2008) generate sounds to coordinate spawning activities when they gather in large aggregations. Many of these activities occur on a lunar cycle, and fish sounds tend to dominate marine soundscapes during peak activity times (Cato and McCauley 2002; Rice et al. 2014).

Marine mammals also produce sounds for a variety of natural behaviors over a range of acoustic frequencies (Richardson et al. 1995). Seals, sea lions, and walrus produce sounds both in air and water; these sounds usually occur during the breeding season and are associated with territorial and mating behaviors. Bearded seals, for example, produce frequency-modulated trills, which are a major component of Arctic soundscapes in the spring (Richardson et al. 1995). Toothed whales use higher frequency echolocation clicks to navigate and track prey, as well as a variety of whistle types during social interactions (Richardson et al. 1995). Baleen whales produce low-frequency reproductive and social calls that can travel great distances, even across ocean basins (Clark and Gagnon 2002). Humpback whales, for example, sing complex songs that differ across oceans and evolve from year to year (Garland et al. 2017).

B.3.3 Anthropogenic Sounds

Noise generated by human activities (**Figure B-2B**) may serve a specific purpose, such as navigational sonar and seismic exploration, or may result as an indirect byproduct of activities such as shipping or construction. In the pelagic zone, shipping noise is the main anthropogenic component of marine soundscapes in low frequencies (Frisk 2012; Hildebrand 2009; McKenna et al. 2013; National Research Council 2003b), the range in which most baleen whales communicate (Richardson et al. 1995). In shallow coastal waters, the sounds of distant ships are not as far-reaching, because a large portion of the sound's intensity is absorbed by sands and mud on the seafloor, but small boat traffic can elevate local sound levels (Hermannsen et al. 2019). Marine geophysical surveys use a variety of tools and techniques to identify shallow hazards or characteristics of the seafloor as well as the geology below the seabed. For example, 2-D and 3-D deep-penetration seismic surveys repeatedly produce high-energy, low-frequency, short-duration sounds to search for petroleum deposits below the seafloor, while sub-bottom profilers and side-scan sonars generally produce high-frequency sounds to locate geohazards or archaeological resources on the seabed. Sounds from seismic airguns are a major component of marine soundscapes where higher levels of oil and gas exploration exist, such as in the Western and Central GOM Planning Areas (Estabrook et al. 2016; Hildebrand 2009; Wiggins et al. 2016). Other anthropogenic sound sources include dynamic positioning systems, dredging and drilling operations, construction activities, fishing vessels, recreational vessels, and military preparedness exercises (e.g., sonar signals).

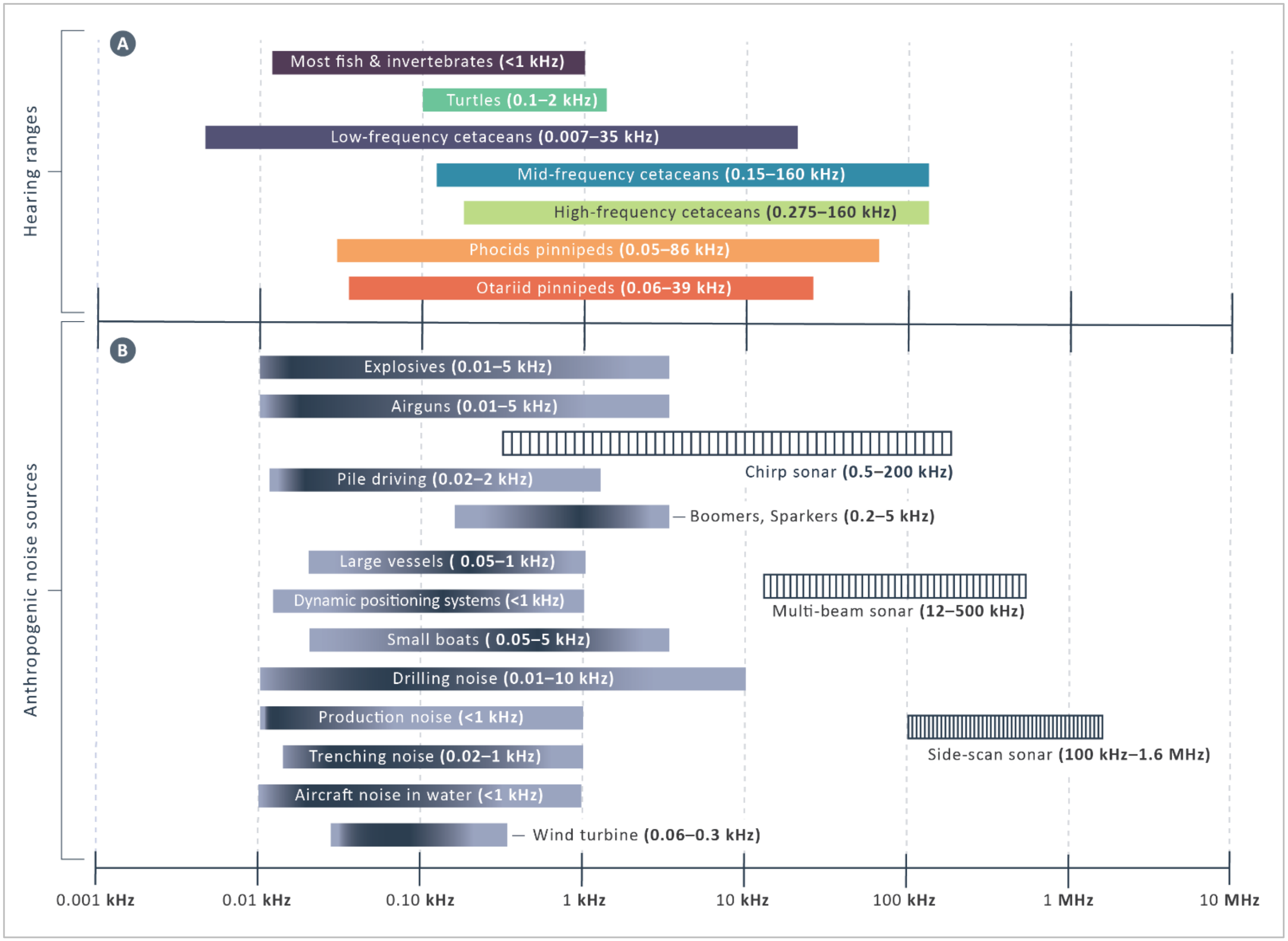

Figure B-2. A) Approximate hearing ranges of marine species; B) Frequency ranges of various anthropogenic sources

These ranges represent approximately 90% of the acoustic energy, and color shading roughly corresponds to the dominant energy band of each source. Dashed lines represent broadband sonars to depict the multi-frequency nature of these sounds. The frequency axis of both plots shows kHz in a logarithmic scale.

Sources: Popper et al. (2014), Richardson et al. (1995), and NMFS (2018a).

B.4 ANIMAL HEARING

Most of the ocean is dark, and because sound travels particularly well through water, it is reasonable to assume that all marine organisms can detect and use sounds for a variety of purposes. Detection of auditory cues is critically important for marine animals for navigating through the marine environment, maintaining vigilance against predators, and interacting with members of the same species. Sound-production mechanisms and hearing capabilities vary widely across taxonomic groups (Duarte et al. 2021). Different taxa have evolved mechanisms for sound detection that are suited to their environment and the type of acoustic signals they need to detect (Fay 2009). Salient perceptual cues include amplitude (loudness), frequency (pitch), and duration. Animals likely hear best within the same frequency range as their vocalizations.

A hearing "threshold" is the lowest amplitude sound that an animal can detect and is frequency dependent; when a series of hearing thresholds are plotted together as a function of frequency, they typically form a U-shaped curve called an audiogram. To measure hearing thresholds, investigators may use psychological methods, wherein they train captive animals and "ask" them whether they can detect a sound, much like an audiologist does for humans. Operant and Pavlovian conditioning techniques have been used to test hearing abilities of various fishes (Popper 1971) and marine mammals (Gales 1982). Alternatively, electrodes may be harmlessly placed on the skull (for mammals) or directly on the auditory nerves (for fish) so that neurological activity can be measured when a sound is detected. This method is only feasible for animals that can be trained and/or kept in captivity; as a result, there is a fundamental lack of understanding of hearing levels for many marine species.

B.4.1 Fish and Invertebrates

The most basic form of hearing—detection of particle motion—is evident in fish and invertebrates (**Figure B-2A**); for further detail, see Popper and Fay (2011), Popper and Hawkins (2018), and NMFS (2019a). All fishes have inner ears with three bony structures (otoliths) that act like 3-D accelerometers. The density of a fish's body is similar to that of water, but its otoliths are denser. When a sound wave passes, the body of the fish moves back and forth with particle motion, but the denser otoliths lag behind. This lag generates a shearing force between the sensory epithelium and the otoliths, sending a signal to the brain. Because of the orientation of the otoliths and epithelia, fish can detect particle motion in three axes. Crustaceans and squid detect particle motion through their statocysts (internal organs with sensory hairs resembling the hair cells in vertebrate ears), while other marine invertebrates have other specialized hearing organs, or mechanoreceptors, on the outside of their body. Some fish invertebrates, especially those that live on or in the benthos, may also detect vibrations that travel through the sediment (Popper and Fay 2011; Popper and Hawkins 2018). Most fish and invertebrates can detect sounds below 1 kHz.

Fish that are limited to particle motion detection typically are referred to as "hearing generalists," but a more advanced form of hearing is also possible for fish that have a swimbladder. In this case, when the sound wave passes, it causes vibration in the swimbladder, generating particle motion inside the body of the fish. For fish with a swimbladder that is in close proximity to the ear, this signal can be substantial and essentially enables an entirely new mechanism of hearing. These fish are called "hearing specialists." Hearing specialists usually can detect higher acoustic frequencies than generalists and may be able to detect sounds at a greater distance from the source (Popper and Fay 2011; Popper and Hawkins 2018; Wiernicki et al. 2020). A handful of herring-like fishes can even detect ultrasonic frequencies (above 20 kHz) (Higgs 2004; Mann et al. 1997).

Hearing specialists may be susceptible to behavioral disturbance or acoustic masking over larger spatial scales than hearing generalists. Fish with swimbladders are also more susceptible to barotrauma (tissue damage and auditory injury caused by sudden changes in pressure) from impulsive sources like pile driving, seismic airguns, or explosions. In fact, Goertner (1978) showed that the range from an explosive event in which damage may occur to a swimbladder fish is approximately 100 times greater than that for non-swimbladder fish.

B.4.2 Marine Mammals

The hearing structures of marine mammals are fundamentally similar to those of terrestrial mammals, but their hearing range is usually wider (National Research Council 2003b) (**Figure B-2A**). Mooney et al. (2012), NMFS (2018a), and Southall et al. (2019) reviewed marine mammal hearing in detail. Marine mammals are capable of detecting acoustic pressure. The outer ear collects sound, the middle ear filters and amplifies acoustic energy to the inner ear, and the inner ear converts acoustic energy to neural signals. The cochlea is the key organ in the inner ear that is tuned to vibrate at particular frequencies; this tuning determines an animal's hearing range. Marine mammals can hear sounds over a wider frequency range than fishes, invertebrates, or birds, but hearing sensitivity varies by species. For example, semi-aquatic mammals (pinnipeds) can detect sounds in air and water, as well as a broader range of frequencies in water. Fully aquatic mammals (cetaceans and manatees) have additional adaptations. They have no external ear, and their ear canals are plugged with wax and are not functional. It is believed that sounds are transmitted from the water to the inner ear through specialized fats in the jaw or cheekbones (Mooney et al. 2012). In addition, some cetaceans have sophisticated mechanisms for beam forming and sound localization (also called echolocation), which they utilize for hunting prey. Based on these differences in auditory physiology, it is now generally accepted that there are six marine mammal functional hearing groups: low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, sirenians, phocid carnivores (in water and air), and other marine carnivores (in water and air) (Southall et al. 2019).

B.4.3 Sea Turtles

Sea turtles are sensitive to acoustic pressure. Their ear resembles most reptiles' ears, but with a few underwater specializations (Popper et al. 2014). They have no outer ear; the opening of their ear is covered by a thick skin with a fatty layer underneath. As in marine mammals, this fatty layer helps conduct sound to the middle and inner ear. There is relatively little data on sea turtle hearing; the current understanding is that their underwater hearing range is generally constrained to frequencies < 2 kHz (**Figure B-2A**), with a narrower frequency range in air (Bartol et al. 1999; Piniak et al. 2012; Popper et al. 2014). Compared to most fish and marine mammals, they have relatively low hearing sensitivity (Martin et al. 2012; Popper et al. 2014).

B.5 PREDICTING IMPACTS OF NOISE ON MARINE LIFE

Whether a particular sound is a noise or a meaningful signal is a matter of perspective. “Sounds” and “noise” represent the same physical phenomena and have the same units of measurement, but what is sound to one animal could be noise to another. For example, the crackling sounds of a coral reef may serve as an important navigational cue for larval organisms (Simpson et al. 2005; Vermeij et al. 2010), but these same sounds could be “noise” to a dolphin that is trying to communicate with its social group. Likewise, the sounds from seismic airguns provide important information for seismic operators looking for oil beneath the seabed, but these sounds could be unwanted “noise” for marine animals that use low-frequency signals to communicate.

The degree of impact of a sound depends on the hearing capabilities of a given species, qualities of the sound, and propagation of the sound from the source (**Figure B-3**). See **Section 4.1** for the description of the nature of potential impacts on marine organisms nationally and regionally. Additional detail can also be found in Appendices I and J in BOEM (2014) and BOEM (2017d).

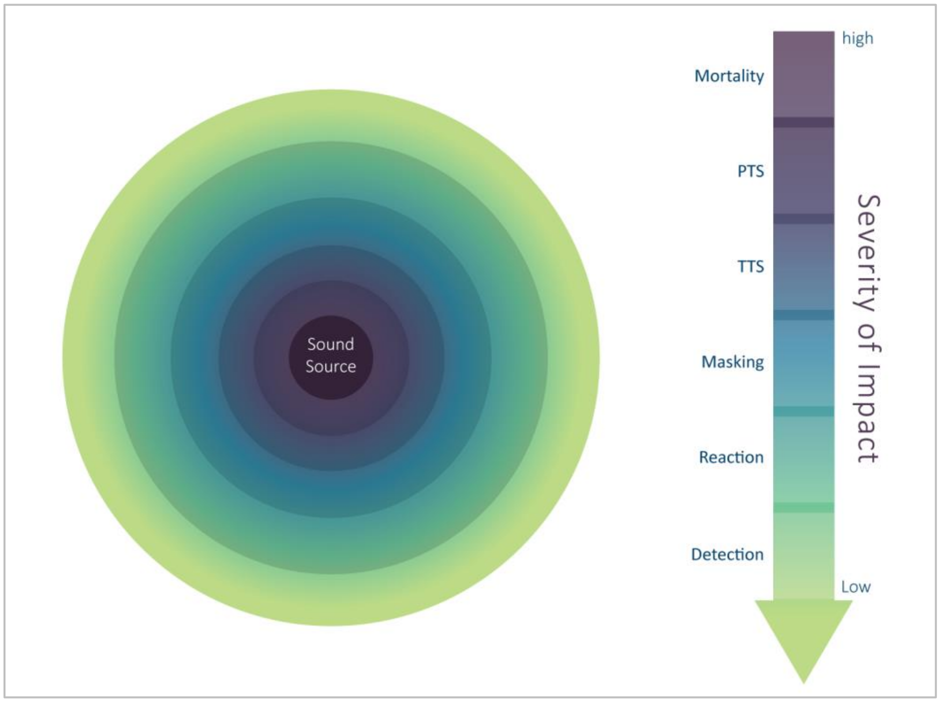

Figure B-3. Ways that noise can affect marine organisms
Physical properties of the environment—as well as the amplitude, duration, and frequency content of a signal—affect the propagation of a sound from the source. An animal’s perception depends upon its hearing abilities, its prior exposure, and the behavior in which an animal is engaged. The severity of impact ranges from simple detection (least impact) to mortality (most severe but least likely impact). Physical effects (e.g., permanent threshold shift [PTS] or temporary threshold shift [TTS]) generally occur closest to the source, and behavioral effects occur farther away.

To best protect marine life from potentially dangerous loud sounds, scientists and regulators have developed “acoustic criteria,” i.e., sound levels above which an animal should not be exposed. These criteria are derived from experimental work that exposes available species to varying sound levels. The National Marine Fisheries Service (NMFS) *2018 Revision to: Technical Guidance for Assessing the Effects* *of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0)* (NMFS 2018a) outlines the acoustic criteria for five functional groups of marine mammals and is the standard used to protect marine mammals from auditory injury under the Marine Mammal Protection Act. It should be noted that there are still significant knowledge gaps in the field of marine mammal bioacoustics (e.g., hearing capabilities of baleen whales). In fact, Southall et al. (2019) revisited the existing data and reclassified some hearing groups, though the acoustic thresholds do not differ from the 2018 NMFS Guidance. Although not officially accepted as "acoustic criteria," Popper et al. (2014) completed a similar set of sound exposure guidelines on the sound levels at which auditory injury could occur for fish and sea turtles.

During later analyses (e.g., Endangered Species Act and Marine Mammal Protection Act) that may happen as a result of the 2023–2028 Program, BOEM will consult with NMFS and the U.S. Fish and Wildlife Service, as applicable, and may employ acoustic modeling and other methods to predict the number of acoustic exposures for different marine mammal species. An overview of the modeling process is explained in a BOEM video on acoustics (www.youtube.com/watch?v=ubgmZ6iTz80). This type of work looks at the overlap between the sound field (through acoustic propagation modeling), abundance of a given species in the affected area, and hearing capabilities of the species. This process utilizes the NMFS 2018 technical guidance (NMFS 2018a). In this way, it is possible to predict the number of individuals that may be affected. The next step is to integrate information about the species' life history and the status of the population to better interpret the severity of potential impacts.

In 2020, BOEM launched the Center for Marine Acoustics, which aims to advance methods in modeling, improve estimates of animal density, interpret behavioral reactions to sound, and broaden the understanding of hearing thresholds. Over the last several decades, BOEM's science program has supported scientific studies to fill key knowledge gaps in the field of marine acoustics. As new scientific data have become available, BOEM has been revising its approach for estimating acoustic exposures and is moving toward a more sophisticated risk assessment framework in the near future. For examples of this work, see Appendix D of BOEM (2017d) and Appendix E of BOEM (2014); for acoustic-based studies supported by BOEM, see www.boem.gov/sites/default/files/documents//Marine-Acoustics-Managing-Impacts.pdf.

Appendix C: Emissions

C.1 CRITERIA AND PRECURSOR POLLUTANTS

The Bureau of Ocean Energy Management (BOEM) estimates air emissions that may be released as a result of Outer Continental Shelf (OCS) activities expected to occur from the 2023–2028 National OCS Oil and Gas Leasing Program (2023–2028 Program) and from the substituted sources of energy should no leasing occur.

The air pollutants presented comprise two different pollution classes:

- **National Ambient Air Quality Standards (NAAQS) criteria pollutants** are identified and regulated by the U.S. Environmental Protection Agency under the Clean Air Act**.** The relevant directly emitted criteria pollutants are the following:
    - Nitrogen dioxide (NO_2)
    - Sulfur dioxide (SO_2)
    - Coarse particulate matter (PM_{10})
    - Fine particulate matter ($PM_{2.5}$)
    - Carbon monoxide (CO)
- **NAAQS precursor pollutants** form NAAQS criteria pollutants through photochemical reactions after release into the atmosphere, including ozone. For more about the NAAQS precursor and criteria pollutants, see **Chapter 2**. The relevant precursor pollutants are:
    - Volatile organic compounds (VOCs)

Tables C-1 to C-3 present the estimated offshore air emissions resulting from the 2023–2028 Program and substitute energy sources in the absence of a 2023–2028 Program. The substitution estimates assume that current patterns of energy consumption will continue. However, this assumption is questionable given the national commitment to greenhouse gas (GHG) emissions reductions for 2030 and net zero for 2050. If the U.S. makes progress towards reducing its overall use of fossil fuels by replacing them with lower emitting sources of energy, then substitute sources of energy for OCS oil and gas production would also shift. This shift is anticipated to result in emissions that are lower than from the OCS oil and gas substitutions in **Tables C-1 to C-3**, which present the “business as usual” substitute emissions estimates. The criteria pollutant emissions listed in these tables are generated through the same combustion processes generating CO_2, and requirements reducing CO_2 emissions are likely to also reduce these pollutants as well. Hence these estimates are uncertain. The tables provide the estimates for different activity cases (high, mid, and low) as discussed in the *Draft Economic Analysis Methodology for the 2023–2028 National Outer Continental Shelf Oil and Gas Leasing Program* (BOEM 2022b). Most emissions from substituted sources would occur outside the OCS but are listed by planning area to show the lease sales being replaced. The Offshore Environmental Cost Model (OECM) generated this data as part of the overall cost-benefit analysis of the 2023–2028 Program. For more information on the OECM and cost-benefit analysis, see Chapter 5 in the Proposed Program (BOEM 2022a).

Table C-1. Estimated air emissions from the 2023–2028 Program and substituted energy sources in the absence of a 2023–2028 Program (high activity case) in thousands of short tons

	2023–2028 Program						Substituted Energy Sources					
Planning Area	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC
Atlantic Region												
North Atlantic	60.77	3.98	1.40	1.35	18.23	13.47	4.70	0.62	0.15	0.14	0.72	0.10
Mid-Atlantic	105.68	7.40	2.61	2.51	31.49	23.33	9.40	1.23	0.29	0.27	1.44	0.20
South Atlantic	61.43	3.61	1.44	1.39	19.51	14.25	*	*	*	*	*	*
Straits of Florida	0.37	0.05	0.01	0.01	0.06	0.01	*	*	*	*	*	*
Gulf of Mexico (GOM) Region												
Eastern GOM	85.89	9.28	2.43	2.31	20.64	13.46	9.53	1.25	0.30	0.29	1.51	0.49
Central GOM and Western GOM	508.49	50.00	14.76	14.05	114.00	76.32	41.81	3.08	1.10	1.05	13.17	9.34
Pacific Region												
Southern California	78.83	5.30	1.81	1.73	28.98	20.96	17.56	0.63	0.34	0.33	8.28	6.61
Central California	31.32	1.85	0.68	0.66	12.48	9.35	0.74	0.10	0.02	0.02	0.11	0.02
Northern California	30.85	1.42	0.64	0.62	13.44	10.38	0.74	0.10	0.02	0.02	0.11	0.02
Washington/ Oregon	19.04	0.81	0.37	0.36	8.68	6.87	*	*	*	*	*	*
Alaska Region												
Gulf of Alaska	19.04	1.13	0.43	0.42	9.42	15.08	0.15	*	*	*	0.03	0.01
Cook Inlet	81.62	2.29	1.38	1.34	36.72	40.51	15.74	0.22	0.26	0.25	8.12	6.77
Kodiak	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
Shumagin	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
Aleutian Arc	0.05	*	*	*	0.01	*	*	*	*	*	*	*
St. George Basin	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
St. Matthew-Hall	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Bowers Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Aleutian Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Navarin Basin	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
Norton Basin	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
Hope Basin	0.15	*	*	*	0.03	0.01	0.05	*	*	*	0.01	*
Chukchi Sea	19.04	1.13	0.43	0.42	9.42	15.08	0.15	*	*	*	0.03	0.01
Beaufort Sea	81.62	2.29	1.38	1.34	36.72	40.51	15.74	0.22	0.26	0.25	8.12	6.77

Note: * = negligible

Table C-2. Estimated air emissions from the 2023–2028 Program and substituted energy sources in the absence of a 2023–2028 Program (mid activity case) in thousands of short tons

	2023–2028 Program						Substituted Energy Sources					
Planning Area	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC
Atlantic Region												
North Atlantic	36.04	2.15	0.87	0.84	13.40	9.54	76.33	2.95	1.34	0.87	7.49	80.46
Mid-Atlantic	91.62	6.65	2.30	2.21	26.11	19.13	223.80	9.07	4.13	2.59	22.05	238.29
South Atlantic	38.07	2.11	0.90	0.87	11.79	8.94	60.89	2.50	1.15	0.71	6.01	64.88
Straits of Florida	*	*	*	*	*	*	*	*	*	*	*	*
GOM Region												
Eastern GOM	37.78	4.01	1.10	1.04	8.77	4.84	36.49	1.55	0.47	0.39	3.59	41.50
Central GOM and Western GOM	216.12	20.86	6.27	5.97	51.28	32.71	360.30	14.49	4.82	3.85	35.33	399.48
Pacific Region												
Southern California	63.80	4.18	1.45	1.39	23.88	17.54	96.03	3.98	1.23	1.02	9.43	108.19
Central California	22.41	1.34	0.49	0.47	8.87	6.64	21.99	0.87	0.29	0.23	2.15	24.29
Northern California	22.11	1.12	0.47	0.46	9.22	6.97	16.95	0.67	0.23	0.18	1.66	18.63
Washington/ Oregon	10.34	0.51	0.21	0.20	4.46	3.46	5.88	0.23	0.08	0.06	0.58	6.50
Alaska Region												
Gulf of Alaska	19.69	0.68	0.34	0.33	7.88	10.52	9.97	0.45	0.13	0.11	0.99	11.62
Cook Inlet	65.67	2.07	1.12	1.09	28.36	33.55	27.77	1.19	0.36	0.30	2.73	31.67
Kodiak	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
Shumagin	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
Aleutian Arc	*	*	*	*	*	*	*	*	*	*	*	*
St. George Basin	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
St. Matthew-Hall	*	*	*	*	*	*	*	*	*	*	*	*
Bowers Basin	*	*	*	*	*	*	*	*	*	*	*	*
Aleutian Basin	*	*	*	*	*	*	*	*	*	*	*	*
Navarin Basin	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
Norton Basin	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
Hope Basin	0.10	*	*	*	0.02	0.01	*	*	*	*	*	*
Chukchi Sea	568.84	10.80	25.98	23.41	218.30	117.84	167.80	6.57	2.19	1.78	16.41	184.41
Beaufort Sea	289.06	5.03	13.34	12.01	112.80	55.65	67.16	2.91	0.86	0.71	6.62	76.92

Note: * = negligible

Table C-3. Estimated air emissions from the 2023–2028 Program and substituted energy sources in the absence of a 2023–2028 Program (low activity case) (in thousands of short tons)

	2023–2028 Program						Substituted Energy Sources					
Planning Area	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC	NO_2	SO_2	PM_{10}	$PM_{2.5}$	CO	VOC
Atlantic Region												
North Atlantic	4.70	0.62	0.15	0.14	0.72	0.10	*	*	*	*	*	*
Mid-Atlantic	9.40	1.23	0.29	0.27	1.44	0.20	*	*	*	*	*	*
South Atlantic	*	*	*	*	*	*	*	*	*	*	*	*
Straits of Florida	*	*	*	*	*	*	*	*	*	*	*	*
GOM Region												
Eastern GOM	9.53	1.25	0.30	0.29	1.51	0.49	12.33	0. 41	0.16	0.13	1.20	13.04
Central GOM and Western GOM	41.81	3.08	1.10	1.05	13.17	9.34	58.98	2.51	0.91	0.65	5.84	66.57
Pacific Region												
Southern California	17.56	0.63	0.34	0.33	8.28	6.61	11.47	0.43	0.16	0.12	1.12	12.48
Central California	0.74	0.10	0.02	0.02	0.11	0.02	*	*	*	*	*	*
Northern California	0.74	0.10	0.02	0.02	0.11	0.02	*	*	*	*	*	*
Washington/ Oregon	*	*	*	*	*	*	*	*	*	*	*	*
Alaska Region												
Gulf of Alaska	0.15	*	*	*	0.03	0.01	*	*	*	*	*	*
Cook Inlet	15.74	0.22	0.26	0.25	8.12	6.77	5.40	0.18	0.07	0.06	0.52	5.70
Kodiak	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Shumagin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Aleutian Arc	*	*	*	*	*	*	*	*	*	*	*	*
St. George Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
St. Matthew-Hall	*	*	*	*	*	*	*	*	*	*	*	*
Bowers Basin	*	*	*	*	*	*	*	*	*	*	*	*
Aleutian Basin	*	*	*	*	*	*	*	*	*	*	*	*
Navarin Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Norton Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Hope Basin	0.05	*	*	*	0.01	*	*	*	*	*	*	*
Chukchi Sea	2.91	*	0.15	0.13	1.08	0.22	*	*	*	*	*	*
Beaufort Sea	3.39	0.01	0.17	0.15	1.26	0.26	*	*	*	*	*	*

Note: * = negligible

C.2 GHG POLLUTANTS

C.2.1 Introduction to Life Cycle GHG Emissions and Models

BOEM's life cycle GHG analysis relies on three BOEM models to estimate results: the Market Simulation Model (MarketSim) (Industrial Economics Inc. 2021), OECM (Industrial Economics Inc. and SC&A 2018a; 2018b), and Greenhouse Gas Life Cycle Energy Emissions Model (GLEEM) (Wolvovsky 2021). The term "life cycle" refers to emissions from all activities related to the exploration, development, production, and consumption of hydrocarbon resources. This analysis looks at two scenarios, "Leasing" (which analyzes new leasing reflected the Draft Proposal for the 2023–2028 Program) and "No Leasing" (which analyzes the scenario based on no additional leasing in the 2023–2028 Program).

The activities often are grouped into three stages: upstream (e.g., exploration, development, production, and decommissioning), midstream (e.g., refining, storage, and distribution systems), and downstream (e.g., consumption). **Figure C-1** illustrates BOEM's application of the models and related steps.

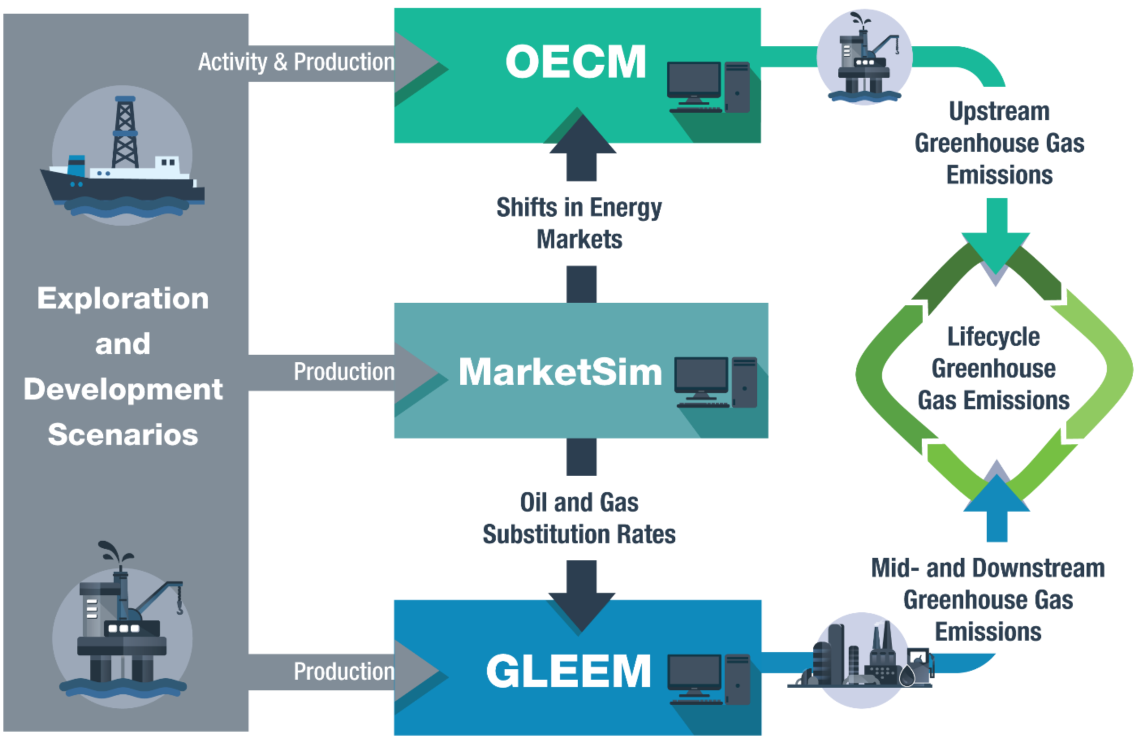

Figure C-1. Illustration of BOEM's models and methodology

C.2.2 GHG Emissions Methodology and Results

BOEM's methodology consists of estimating the incremental GHG emissions attributable to the Leasing scenario relative to the No Leasing scenario. Under the No Leasing scenario, oil and gas demand would not simply disappear, although it might diminish. Rather, alternative sources would be consumed, which BOEM refers to as "substitute" sources. The emissions analysis can be categorized into two components.

The first part estimates GHG emissions resulting from domestically produced or consumed fuels; the second includes emissions when considering the shift in foreign oil consumption.

When estimating emissions, these models quantify the three main GHGs: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). To provide a single metric for estimating an action alternative's emissions profiles, BOEM provides combined totals of all three GHG emissions in CO_2 equivalent (CO_2e). This approach allows for a direct, aggregate comparison among emissions of different pollutants that have different atmospheric lifespans and vary in their ability to trap heat in the atmosphere. For example, emission of one metric ton of CH_4 has an impact equivalent to 25 metric tons of CO_2. This analysis uses the Environmental Protection Agency conversion factors (EPA 2021b) for 100-year global warming potential (**Table C-4**).

Table C-4. Global warming potential (in metric tons)

Greenhouse Gas	Global Warming Potential (CO_{2e})
CO_2	1
CH_4	25
N_2O	298

Source: EPA (2021b)

C.2.2.1 Modeling Inputs

Two key elements are needed for the OECM and GLEEM to estimate the life cycle emissions: 1) anticipated OCS activity and production and 2) the energy market substitutions, including reduced consumption, if new OCS activity and production were not to occur. Anticipated production can be found in the Proposed Program (BOEM 2022a). MarketSim estimates the substitutions for offshore oil and gas production that could occur in the absence of lease sales in each of the planning areas; a full explanation is provided in the Proposed Program (BOEM 2022a). MarketSim's estimates assume current patterns of energy consumption and are based on current policies and laws, but do not include the overarching national policy to achieve net-zero GHG emissions by 2050 (see discussion below). Implementing that policy would require significant changes not accounted for by MarketSim, and therefore the model's substitution emission estimates overall should be understood to be uncertain and potentially significantly higher than if new requirements were set to achieve the 2050 net-zero target. The estimates below are presented with this qualification. If the U.S. makes progress towards reducing its overall use of fossil fuels by replacing them with lower emitting sources of energy, then substitute sources of energy for OCS oil and gas production would also shift. This shift is anticipated to result in emissions that are lower than from the OCS oil and gas substitutions presented in this appendix, i.e., "business as usual" substitute emissions estimates.

To run GLEEM and estimate midstream and downstream emissions, substitutions are needed separately for oil and gas (**Table C-5**).

Table C-5. Substitute energy results for the No Leasing scenario for the low, mid, and high level of activity

	Oil			Gas		
Substituting Energy Sector	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**
Onshore Production	17%	16%	16%	63%	61%	60%
Onshore Oil	15%	14%	14%	1%	1%	1%
Onshore Gas	2%	2%	2%	62%	60%	59%
Imports	1%	*	*	*	*	*
Oil Imports	67%	68%	68%	8%	8%	8%
Gas Imports	67%	68%	68%	6%	6%	6%
Production from Existing Offshore Leases	*	*	*	2%	2%	2%
Coal	*	*	*	2%	2%	2%
Electricity from Other Sources***	1%	1%	1%	5%	7%	7%
Other Energy Sources**	9%	8%	8%	1%	1%	1%
Reduced Demand/Consumption	6%	6%	6%	63%	61%	60%

Notes: * = These substitution rates are less than 0.5%.
**= The "Other" substitution category includes biofuels, other natural gas, and other oil. Other oil is by far the largest component and comprises refinery processing gain, product stock withdrawal, natural gas plant liquids, and liquids from coal. Roughly 80% of the other oil category is natural gas plant liquids.
***includes nuclear

C.2.2.2 Domestic Life Cycle GHG Emissions Methodology and Results

The domestic component quantifies full life cycle GHG emissions (which includes upstream, midstream, and downstream as shown in **Figure C-2**) associated with fuels produced or consumed domestically for both the Leasing and No Leasing scenarios. Estimated OCS upstream emissions are less than upstream emissions for their substitutes, although it should be noted that a portion of the upstream emissions in the No Leasing scenario would occur outside of the U.S. However, estimated midstream and downstream emissions stemming from OCS energy development are greater than the substitutes replacing OCS oil and gas in the No Leasing scenario.

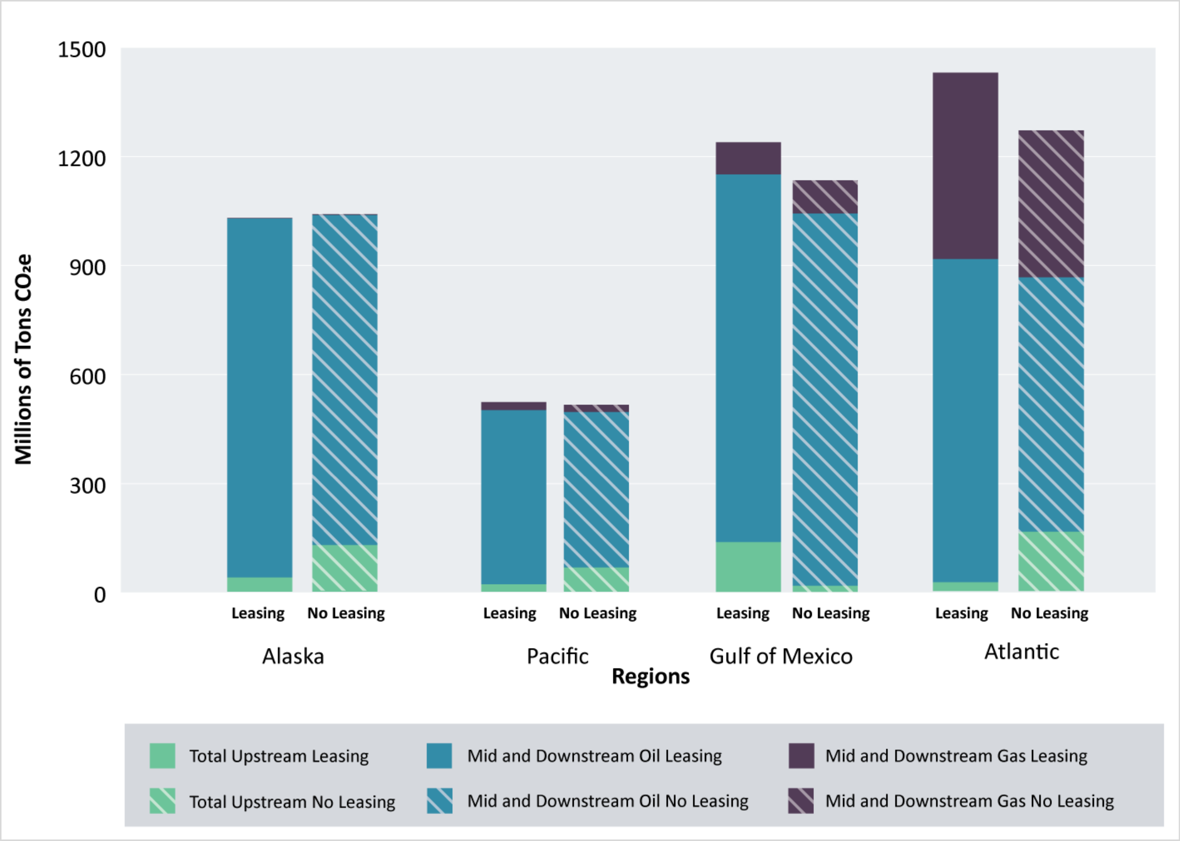

Figure C-2. Upstream, midstream, and downstream emissions under the Leasing and No Leasing scenarios by region

Upstream GHG Emissions

The OECM estimates the upstream emissions associated with both OCS production and energy substitutes. For energy substitutes, the OECM estimates GHG emissions associated with the international production of oil and natural gas imports to the U.S. and the transport of these sources via tanker. The model also calculates emissions for the increase in domestic onshore production of oil, natural gas, and coal. The OECM does not include emissions estimates associated with pipelines, changes in coal imports, or construction of renewable energy projects.

Table C-6 presents the estimated upstream emissions from the Leasing and No Leasing scenarios. When compared to emissions resulting from leasing, the expected substitute energy sources result in greater upstream emissions than those estimated from the anticipated OCS production. This trend applies for all three activity levels in all planning areas, except Mid-Atlantic, and Cook Inlet under a low activity scenario.

Table C-6. Upstream emissions by activity level (CO_{2e}, in millions of metric tons)

	Leasing			No Leasing			Net		
Planning Area	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**
Atlantic Region									
North Atlantic	10	5	*	54	33	0	-44	-28	*
Mid-Atlantic	15	13	1	115	102	0	-100	-89	1
South Atlantic	10	6	0	54	28	0	-44	-22	0
GOM Region									
GOM Program Area 1	49	21	5	387	166	29	-337	-144	-24
GOM Program Area 2	8	4	1	51	18	5	-43	-14	-4
Pacific Region									
Southern California	12	10	3	54	45	5	-42	-36	-2
Central California	5	4	*	14	10	0	-9	-7	*
Northern California	5	4	*	10	8	0	-4	-4	*
Washington/ Oregon	3	2	0	4	3	0	-1	-1	0
Alaska Region									
Gulf of Alaska	4	3	*	9	5	0	-6	-2	*
Cook Inlet	15	12	3	16	14	2	-1	-2	1
Chukchi Sea	23	16	*	116	76	0	-93	-60	*
Beaufort Sea	20	8	*	63	33	0	-43	-25	*

Notes: The following planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.
***** = emissions that are between 500,000 and negative 500,000 metric tons but are not zero.

Midstream and Downstream Emissions

Midstream and downstream emissions are not directly tied to production activity on the OCS but are assigned to the planning areas based on their anticipated oil and gas production. In the case of the No Leasing scenario, estimated emissions are based on substitute sources of energy.

Table C-7 shows the estimated midstream and downstream emissions for the Leasing and No Leasing scenarios. Midstream and downstream emissions resulting from the Leasing scenario are higher than those estimated for the No Leasing scenario for all planning areas at all three activity levels.

Table C-7. Midstream and downstream emissions by activity level (CO_{2e}, in millions of metric tons)

	Leasing			No Leasing			Net		
Planning Area	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**
Atlantic Region									
North Atlantic	464	282	0	361	222	0	104	60	0
Mid-Atlantic	997	876	0	779	687	0	218	189	0
South Atlantic	462	244	0	362	195	0	100	49	0
GOM Region									
GOM Program Area 1	3,025	1,274	231	2,664	1,124	204	360	150	27
GOM Program Area 2	386	132	36	322	110	30	65	22	6
Pacific Region									
Southern California	409	345	38	371	313	34	39	32	4
Central California	106	77	0	94	68	0	12	9	0
Northern California	75	59	0	65	51	0	10	7	0
Washington/ Oregon	30	20	0	25	16	0	6	4	0
Alaska Region									
Gulf of Alaska	70	47	0	65	43	0	6	4	0
Cook Inlet	119	104	15	105	95	11	14	10	4
Chukchi Sea	902	585	0	830	539	0	72	46	0
Beaufort Sea	482	253	0	443	233	0	38	20	0

Notes: The following planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.

Life Cycle GHG Emissions

BOEM combines the domestic upstream, midstream, and downstream life cycle estimates of GHG emissions to calculate the estimates of domestic full life cycle GHG emissions. **Table C-8** presents these GHG emission estimates for each activity level.

For most planning areas, total estimated domestic emissions over the life cycle of producing and consuming oil and gas products under the Leasing scenario are very similar to those expected to be produced under the No Leasing scenario. The estimated emissions from most OCS-produced oil and gas are slightly higher than the estimated life cycle emissions from substituted sources, although for certain planning areas, the reverse is true, such as for high and mid activity in Southern California, Beaufort Sea, and Chukchi Sea Planning Areas.

This overall difference between oil versus gas emissions is caused by differing rates of substitution and associated emissions for the two fuels. In the No Leasing scenario, emissions from natural gas substitutes are significantly lower than the emissions associated with OCS gas production. When combined with reduced energy demand (resulting from lower supply and higher prices), the result is potentially fewer midstream and downstream emissions.

Although an emissions reduction is expected to occur under the No Leasing scenario for oil as well, the reduction would be much smaller, in part due to more GHG-intensive substitutes. When combined with the increased emissions from upstream activities, life cycle oil substitutes would have higher emissions than OCS oil production, while natural gas substitutes would have lower emissions than OCS gas production (**Figure C-2**). Thus, the oil-to-gas ratio in each planning area is a key determinant of whether substitutes or OCS production result in higher emissions.

The differences in full life cycle GHG emissions from the Leasing and the No Leasing scenarios are very small for the Alaska, Pacific, and GOM planning areas, and slightly different assumptions from the models could yield reversed results. For the Atlantic Region, emissions estimates for the No Leasing scenario are significantly lower than the estimates for the Leasing scenario, in large part due to the potential for significant natural gas resource development in the Mid-Atlantic Planning Area (**Figure C-2**).

Table C-8. Domestic full life cycle GHG emissions for Leasing and No Leasing scenarios at the mid activity level (CO_2e, in millions of metric tons) for domestic production and consumption only

	Leasing			No Leasing			Net		
Planning Area	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**	**High**	**Mid**	**Low**
Atlantic Region									
North Atlantic	474	288	*	415	256	0	60	32	*
Mid-Atlantic	1,012	889	1	894	789	0	118	100	0
South Atlantic	472	250	0	416	223	0	56	27	0
GOM Region									
GOM Program Area 1	3,074	1,295	236	3,051	1,290	233	23	5	3
GOM Program Area 2	395	135	36	373	128	35	22	7	2
Pacific Region									
Southern California	421	355	41	424	358	41	-4	-3	3
Central California	111	80	*	108	78	0	3	2	*
Northern California	80	62	*	75	59	0	5	3	*
Washington/ Oregon	34	22	0	29	19	0	5	3	0
Alaska Region									
Gulf of Alaska	74	50	*	74	48	0	0	2	*
Cook Inlet	134	116	18	121	108	13	13	7	5
Chukchi Sea	925	601	*	946	615	0	-21	-14	*
Beaufort Sea	501	261	*	506	266	0	-5	-5	*

Notes: The following planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.
Negative values in the Net column indicate that emissions are estimated to be lower from leasing than in the absence of leasing. Positive values in the Net column indicate that emissions are estimated to be lower when there is No Leasing. No Leasing includes upstream overseas emissions for fuels produced for the U.S. market. For example, emissions from imports are included in the No Leasing scenario.

C.2.2.3 Foreign GHG Emissions

BOEM can model domestic energy markets with sufficient reliability to estimate the energy substitutes consumed or produced domestically. Although BOEM is unable to model global energy markets with the same level of detail as the domestic energy market, BOEM's GHG analysis does include a quantitative analysis of the Leasing scenario's impact on foreign oil consumption and the resulting GHG emissions.

BOEM's foreign GHG analysis estimates the change in foreign emissions resulting from a change in domestic supply, impacts on global prices of oil, and subsequent change in foreign consumption of oil. BOEM uses the best available information to convert MarketSim's estimate of the change in global oil market demand between the Leasing and No Leasing scenarios into an estimate of the change in foreign GHG emissions from oil consumption. To do so, BOEM makes a simplifying assumption that allows for use of a broad foreign oil consumption estimate made by MarketSim.

GLEEM takes the annual change in foreign oil consumption from MarketSim and applies an emissions factor attributable to combusted oil by using a single U.S. Environmental Protection Agency emissions factor called "Other Oil <401°F" (EPA 2021b), which is a miscellaneous emissions factor that is used when the petroleum product is unknown. Typically, rather than using a single emissions factor, it would be preferable to use a range of emissions factors that correspond to the different end uses of petroleum products after oil refining. However, for this analysis, BOEM applied the emissions factor to all overseas combusted oil due to a lack of information about the end petroleum products consumed in foreign markets. For instance, in 2019, the most recent year for which data are available, about 20% of European Union oil was consumed as motor gasoline (Eurostat 2022); in the U.S., that portion was more than double, and approximately 45% of all oil was consumed as motor gasoline (EIA 2022). This variability by regional block or country applies globally, meaning that a U.S. consumption model would not apply to the rest of the world. While these figures are available for the European Union and some other countries, they are not available globally. Therefore, BOEM has decided to apply a generic emissions factor that does not correlate with specific oil products but provides a reasonable approximation of emissions from oil consumed in other countries.

Additionally, GLEEM's ability to account for non-combustion uses of oil was applied based on the U.S. market as an approximation (Wolvovsky 2021). This method is unlikely to change the results significantly, as the amount of oil used in non-combustion products is small globally.

Foreign GHG Emissions Quantitative Results

As with domestic energy substitutions, under the Leasing scenario, oil prices would be lower, resulting in an increase in foreign oil consumption. MarketSim estimates changes in foreign oil production and consumption to determine an equilibrium in the global oil market (the price where supply equals demand). **Table C-9** shows the change in total foreign consumption of oil under the three activity levels and the associated percentage increase over the life cycle of this OCS Program.

Table C-9. Change in total foreign consumption of oil resulting from the Leasing scenario

Activity Level	High	Mid	Low*
Years of anticipated OCS production	2025–2076 (52 Years)	2025–2076 (52 Years)	2025–2062 (38 Years)
Baseline total foreign oil consumption during years of OCS production (mmBOE)	2,082,274	2,082,274	1,470,091
Simulated total increase in foreign oil consumption during years of production (mmBOE)	4,258	2,379	171
% increase from baseline	0.20%	0.11%	0.01%

Note: * = The low activity level has fewer years of activity, so the baseline and simulated consumption occur over fewer years.
Source: Wolvovsky (2021)

MarketSim estimates that at the mid activity level, foreign oil consumption would increase by roughly 2.4 billion barrels in total above that of the No Leasing scenario over the 52-year period of estimated production. This difference is small and represents 0.11% of the global consumption of 2.1 trillion barrels under the No Leasing scenario. This comparison is provided for context only regarding consumption and is not meant to characterize the relative impacts of the Leasing scenario GHG emissions to those of the No Leasing scenario. **Table C-10** presents the increase in GHG emissions attributable to the higher foreign consumption of oil under the Leasing scenario.

Table C-10. Estimated GHG emissions from an increase in foreign oil consumption under the Leasing scenario (CO_{2e}, in millions of metric tons) for high, mid, and low activity levels

Planning Area	High	Mid	Low
Atlantic Region			
North Atlantic	48	32	0
Mid-Atlantic	110	97	0
South Atlantic	52	32	0
GOM Region			
GOM Program Area 1	736	311	52
GOM Program Area 2	69	24	5
Pacific Region			
Southern California	113	95	9
Central California	27	19	0
Northern California	17	14	0
Washington/ Oregon	5	3	0
Alaska Region			
Gulf of Alaska	21	12	0
Cook Inlet	29	29	0
Chukchi Sea	268	173	0
Beaufort Sea	143	75	0

Notes: Areas are assigned a share of the increase in foreign emissions due to the total anticipated production from the schedule of lease sales under the Draft Proposal that is proportional to their anticipated oil production. Areas showing zero have zero oil production and are assigned zero share of foreign emissions. The following planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.

Foreign Emissions Qualitative Results

The foreign emissions in **Table C-10** are based on changes in foreign oil consumption only and are therefore not as comprehensive as the domestic production and consumption life cycle emissions in **Table C-8**. At this time, foreign upstream and midstream emissions cannot be quantified; however, these emissions are considered qualitatively and described in this section.

To produce such estimates, MarketSim, OECM, and GLEEM would need additional information for all global major energy forms as well as upstream, midstream, and downstream emissions. At this time, BOEM is unaware of any existing forecasts that are published by major organizations that include the required level of detail.

Given the extensive data requirements and data limitations, BOEM determined that, for this analysis, it could reasonably quantify the GHG emissions from foreign consumption of oil (**Table C-10**). However, BOEM continues to evaluate options to improve methodologies to estimate upstream and midstream emissions from foreign oil production for use in future analyses. BOEM welcomes comments on our approach to foreign emissions to account for variable energy market pathways in other countries.

Looking at the foreign energy market qualitatively, price decreases for oil under the Leasing scenario estimated by MarketSim are felt beyond U.S. borders given that oil is a globally traded commodity. The same substitutions (e.g., natural gas, coal, biofuels, and renewables) discussed earlier for the domestic energy market would likely also occur in the foreign markets in response to the decrease in the price of oil.

Foreign Oil Life Cycle Change: Upstream

MarketSim estimates that crude oil production in foreign markets would be higher under the No Leasing than the Leasing scenario. To estimate the emissions associated with this increase in production, BOEM would need information on which areas would increase their oil production and the amount of GHG emissions per unit of energy produced in different foreign oil markets. For comparison, BOEM includes the foreign upstream emissions estimate for oil imported to the U.S. in its current domestic analysis, but the calculation is more specific because the OECM includes data on U.S. trading partners and constructs a weighted average to estimate emissions based on imported oil consumed in the U.S.

These additional upstream emissions could potentially mitigate (decrease) some of the increase in incremental GHG emissions under the 2023–2028 Program. However, even when combined with other potentially offsetting sources of emissions from foreign energy substitutes currently not quantified under the No Leasing scenario, mitigating changes in foreign oil production would likely not overcome the full magnitude of increased GHG emissions from the increase in foreign oil consumption under the Leasing scenario.

Foreign Oil Life Cycle Change: Midstream

BOEM has limited capability to estimate foreign emissions. Midstream emissions resulting from the change in oil consumption would introduce several new complexities, as the GHG emissions associated with activities (such as refining) differ based on the quality of crude oil and technological capabilities of different refining sectors. Given this complexity, BOEM considers the impacts qualitatively. Unlike foreign upstream emissions, for which BOEM can provide an indication of the likely direction of the emissions for the Leasing and No Leasing scenarios, the models provide no direct estimates for foreign midstream emissions. However, it is reasonable to qualitatively conclude that midstream emissions would increase under the Leasing scenario given the increase in consumption.

Although foreign upstream emissions decrease under the Leasing scenario, foreign oil consumption increases. This increased consumption must be met with increases in midstream activities, either from the U.S. or other foreign markets. Some of the midstream refining occurs in the U.S. and is exported to foreign markets, but not all increases in midstream processes are accounted for in BOEM's estimate of new OCS oil refined in the U.S. and exported. BOEM does not account for the midstream transportation and storage activities or the refining that takes place abroad. The vast majority of the midstream emissions due to the increased consumption is unaccounted for and would represent an increase under the Leasing compared to the No Leasing scenario.

Substitutes for Oil in Foreign Markets

A main challenge in quantifying the impact of the reduced global oil price (due to new OCS production) on foreign GHG emissions is the variation and lack of data regarding substitution patterns for other energy sources that oil would replace in foreign markets. Substitutions vary among different energy sources and throughout the world. In some areas, oil may replace coal, resulting in a reduction in emissions under the Leasing scenario. However, other areas may rely more heavily on natural gas, biofuels, nuclear, or renewable energy, all of which have lower GHG emissions per unit of energy than oil. In these cases, a shift to oil under the Leasing scenario would lead to a net increase in emissions. Although there is uncertainty in the degree to which various energy substitutes might replace forgone foreign oil consumption under the No Leasing scenario, it is appropriate to acknowledge that substitution would certainly occur and mitigate a portion of the decreased emissions that would result from less foreign oil consumption shown in **Table C-10**.

Foreign Emissions Summary

In summary, the domestic life cycle analysis estimates the emissions associated with the production of energy substitutes under the No Leasing scenario, but the foreign GHG emissions quantitative analysis is limited to only the foreign downstream of oil. Missing from the foreign emissions impacts are changes in foreign oil's upstream and midstream emissions associated with downstream consumption. Because the quantifiable foreign analysis is not comprehensive, domestic production and consumption emissions and social costs are not directly comparable to the foreign estimates. For this reason, BOEM is not combining quantitative estimates of domestic and foreign emissions.

C.2.2.4 GHG Emissions Summary and Conclusion

The domestic results encompass the full life cycle of emissions—from exploration and development to production, refining, transportation, storage, and consumption. BOEM estimates the downstream foreign emissions resulting from an increase in oil consumption under the Leasing scenario, which does not capture some of the mitigating emissions reductions likely to occur in the upstream as foreign production decreases. Moreover, estimates of domestic emissions involve a dynamic incremental analysis that considers emissions from not only OCS oil and gas production but also substitute sources of energy that would replace OCS oil and gas under the No Leasing scenario. Estimated foreign emissions do not include a quantitative analysis of substitutes for oil consumption in foreign oil markets, which would mitigate some of the increase in emissions from oil consumption under the No Leasing scenario. Given these differences in the scope of the domestic and foreign analyses, it could be misleading to combine the domestic and foreign emissions estimates.

BOEM finds the incremental domestic life cycle GHG emissions to be similar with or without Leasing in most areas, but results are dependent on several factors and assumptions used in modeling. Even minor changes to certain underlying assumptions—such as elasticities, emissions factors, and level of expected exploration and development activity—could potentially change the outcome and lead to different results. However, when considering the increase in foreign emissions due to an increase in foreign oil consumption under the Leasing scenario, results become more conclusive. Given the fundamental differences between the domestic and foreign results, BOEM does not combine incremental domestic life cycle GHG emissions with foreign GHG emissions from oil consumption to estimate incremental global GHG emissions attributable to the Leasing scenario. However, based on the quantitative results and qualitative analysis, global emissions are expected to increase incrementally under the Leasing scenario.

C.2.2.5 Life Cycle Emissions Compared to Targets and Carbon Budgets

The Paris Agreement requires countries to set goals to help stabilize atmospheric GHG concentrations at a level that would limit anthropogenic interference with the climate system to keep the global average temperature increase to within 2°C, and preferably to within 1.5°C. These intermediate goals, which are on the pathway to global net-zero emissions, are referred to as Nationally Determined Contributions (NDCs) (United Nations Framework Convention on Climate Change 2015). The U.S. set its NDCs using domestic emissions from a base year of 2005. In 2005, U.S. net emissions were 6,680,300,000 metric tons of CO_2e (EPA 2021c). The U.S. achieved its 2020 goal to reduce its net GHG emissions by 17% below 2005 levels, in part due to the coronavirus pandemic. Currently, the U.S. has established NDCs for 2025 and 2030, each with a two-percentage point range (White House 2021). **Table C-11** lists the current emissions targets. The U.S. has an additional goal of net-zero emissions by 2050 (U.S. Department of State and U.S. Executive Office of the President 2021); this target is outside of the Paris Agreement framework.

Table C-11. U.S. domestic GHG reduction targets (CO_{2e}, in thousands of metric tons)

Target Year	Target Net Reduction	Target Net Emissions (Current)
2025[a]	26 to 28%	4,943,422 to 4,809,816
2030[a]	50 to 52%	3,340,150 to 3,206,544
2050[b]	100%	0

Notes:
[a] Target submitted to the United Nations as part of the U.S. NDC.
[b] Target established outside of the Paris Agreement framework.

Table C-12 compares the estimated emissions from the target year to the U.S. NDCs and shows the percentage of the target that is expected to be consumed under the Leasing and No Leasing scenarios. The percentages in **Table C-12** likely show a worst-case scenario, as there is the potential for carbon capture and storage (CCS) to allow for higher emissions than the targets, while still achieving the NDCs. By 2050, with the net-zero emissions target, all GHG emissions would have to be offset by removal of an equal CO_2e amount of GHGs from the atmosphere, including those resulting from any OCS development. As **Table C-12** shows, the Leasing scenario is expected to release higher amounts of CO_2e into the atmosphere than the No Leasing scenario, but the estimates are quite similar.

Table C-12. Comparison between Leasing and No Leasing scenarios and U.S. emissions target reductions for all planning areas (CO_{2e}, in thousands of metric tons)

Target Year	High Activity				Low Activity			
	Leasing		No Leasing		Leasing		No Leasing	
	CO_2e	%	CO_2e	%	CO_2e	%	CO_2e	%
2025	2,021	0.04 to 0.04	1,503	0.03 to 0.03	504	0.01 to 0.01	341	0.01 to 0.01
2030	60,856	1.82 to 1.90	58,332	1.75 to 1.82	6,957	0.21 to 0.22	6,457	0.19 to 0.20
2050	290,056	-	279,079	-	7,876	-	7,554	-

Notes: Percentages represent the amount of the U.S. targets that are estimated be consumed by new leasing on the OCS or substitutions. Percentage of 2050 targets consumed by OCS production, or its substitutes, is blank because (by that time period) an equal volume of emissions would have to be removed from the atmosphere to achieve the net-zero emissions target.

Carbon budgets are different from NDCs and other targets set by governments in that they project the amount of global emissions that can be emitted before a certain amount of warming occurs. These budgets can be indexed to different global average temperature increases, but most focus on the 1.5°C and 2°C targets outlined in the Paris Agreement. Estimates of the remaining CO_2 emissions left in the carbon budget do range, but they largely center around 1 trillion metric tons of CO_2 remaining (Friedlingstein et al. 2022; IPCC 2021).

Beyond seeking to reduce future emissions, another approach being aggressively pursued is CCS. This approach would effectively increase the carbon budget by capturing atmospheric or oceanic carbon and removing it from the Earth system before it would naturally be removed. The technology is relatively new, and though the OCS may play a role in CCS, efforts are currently in their infancy. With or without large-scale CCS projects, new emissions from OCS development or substitute sources of energy will count against the planet's carbon budget.

C.2.3 Social Cost of GHG Emissions

The "social cost of carbon" (SCC), "social cost of nitrous oxide" (SCN), and "social cost of methane" (SCM)—together known as the "social cost of greenhouse gases" (SC-GHG)—are estimates of the monetized damages associated with incremental increases in GHG emissions in a given year. BOEM uses estimates of SC-GHG provided in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990* by the Interagency Working Group on Social Cost of Greenhouse Gases (IWG) (IWG 2021). SC-GHG values are specific to a given year and increase through time as the harm in later years leads to greater damages given the compounding nature of GHG emissions. The IWG provides impact estimates evaluated at the 5%, 3%, and 2.5% discount rates at the average level of damage; and a fourth case that uses the 3% discount rate and 95th percentile of damages.

Differing discount rates and assumptions of a statistical level of damages represent uncertainty within SC-GHG estimates. With higher discount rates, future damages are more discounted and less significant in the total estimated costs. Because damages from GHG emissions are long term, higher discount rates lead to lower estimates of the SC-GHG. The IWG provides SC-GHG estimates through 2050 (IWG 2021). BOEM extrapolated for future years using the growth rate for the final 5 years available using the following equation:

$$\left(\frac{2050\ SC - GHG\ value}{2045\ SC - GHG\ value}\right)^{\frac{1}{5}}$$

BOEM inflated these social cost estimates to 2022 dollars based on the assumed start date of the Leasing scenario using the Gross Domestic Product Chain-type Price Index from EIA's Annual Energy Outlook 2021 (EIA 2021). See Chapter 1 of the *Draft Economic Analysis Methodology for the 2023–2028 National Outer Continental Shelf Oil and Gas Leasing Program* for more details on BOEM's methodology in estimating the social cost of GHG emissions (BOEM 2022b).

C.2.3.1 Social Cost of GHG Results: Domestic Production and Consumption Life Cycle

BOEM presents the results of its SC-GHG analysis separately—one for the SC-GHG resulting from domestic production, production of imports, and domestic consumption (**Table C-13**) and another for those resulting from foreign consumption (**Table C-14**). The results shown here use the 3% discount rate, which is routinely used in economic impact and cost-benefit analysis.

As shown in **Table C-8**, GOM Program Area 1 has more incremental emissions under the Leasing scenario than the No Leasing scenario. However, for social cost in **Table C-13**, GOM Program Area 1 has an incremental mid activity emissions cost of -$0.48 billion, indicating a reduction in emission costs under the Leasing compared to the No Leasing scenario. This apparent contradiction does not occur for most planning areas but is the result of differences in the way CO_2e and the social cost of GHGs are calculated. In both cases the values estimated are allocations of three different molecules, but they weigh the impact of those molecules slightly differently. In some cases where comparisons are of emissions which are very close, such as GOM Program Area 1, they can diverge on which scenario has the greater impact.

Table C-13. Estimated social cost of full life cycle domestic consumption and production GHG emissions with and without leasing (in $ billions) at a 3% discount rate and average level of statistical damages for high, mid, and low activity level scenarios

	Leasing			No Leasing			Incremental		
Planning Area	High	Mid	Low	High	Mid	Low	High	Mid	Low
Atlantic Region									
North Atlantic	17.20	10.47	0.01	15.30	9.47	0	1.90	1.00	0.01
Mid-Atlantic	36.70	32.22	0.02	32.98	29.15	0	3.71	3.07	0.02
South Atlantic	17.16	9.03	0	15.40	8.18	0	1.75	0.84	0
GOM Region									
GOM Program Area 1	124.45	53.48	9.81	125.12	53.95	9.77	-0.67	-0.48	0.04
GOM Program Area 2	16.31	5.71	1.59	15.58	5.45	1.53	0.73	0.26	0.06
Pacific Region									
Southern California	17.86	15.04	1.78	18.23	15.36	1.68	-0.37	-0.32	0.10
Central California	4.52	3.28	*	4.45	3.24	0	0.07	0.05	*
Northern California	3.23	2.52	*	3.06	2.41	0	0.17	0.11	*
Washington/ Oregon	1.38	0.90	0	1.18	0.79	0	0.20	0.11	0
Alaska Region									
Gulf of Alaska	3.08	2.10	*	3.12	2.05	0	-0.04	0.05	*
Cook Inlet	5.59	4.81	0.80	5.11	4.57	0.58	0.47	0.24	0.22
Chukchi Sea	36.45	24.18	*	37.85	25.12	0	-1.40	-0.94	*
Beaufort Sea	20.54	10.93	*	21.04	11.30	0	-0.50	-0.37	*

Notes: These planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.
* = Social costs of GHG emissions are estimated to be between $5 million and negative $5 million and are rounded to $0.00 billion.

Using the same process described above for domestic GHG emissions, BOEM calculates the social cost of emissions resulting from the increase in foreign oil consumption under new leasing. As discussed in **Section C.2.2.3**, BOEM's models are only able to estimate the annual shift in foreign oil consumption resulting from anticipated production under the Leasing scenario. **Table C-14** shows the higher social cost of GHG emissions under the Leasing scenario due to higher foreign oil consumption emissions.

Table C-14. Estimated social cost of GHG emissions resulting from an increase in foreign oil consumption with leasing ($ billions) at a 3% discount rate and average level of statistical damages

Planning Area	High Activity Level	Mid Activity Level	Low Activity Level
Atlantic Region			
North Atlantic	1.73	1.15	0
Mid-Atlantic	3.94	3.47	0
South Atlantic	1.87	1.13	0
GOM Region			
GOM Program Area 1	29.54	12.73	2.12
GOM Program Area 2	2.77	0.97	0.23
Pacific Region			
Southern California	4.80	4.03	0.37
Central California	1.09	0.79	0
Northern California	0.69	0.55	0
Washington/ Oregon	0.19	0.13	0
Alaska Region			
Gulf of Alaska	0.87	0.49	0
Cook Inlet	1.21	1.21	0
Chukchi Sea	10.53	6.97	0
Beaufort Sea	5.85	3.14	0

Note: These planning areas with no anticipated production in any of the three activity cases are not displayed in this table: Hope Basin, Norton Basin, Navarin Basin, St. George Basin, Shumagin, Kodiak, Aleutian Basin, Bowers Basin, Aleutian Arc, St. Matthew-Hall, and Straits of Florida.

C.2.3.2 Social Cost of GHGs Summary

BOEM acknowledges that there is significant uncertainty in determining the incremental social cost of GHG emissions attributable to the Leasing scenario. The variables include factors such as the anticipated activity and production of OCS oil and natural gas within exploration and development scenarios, various modeling assumptions and inputs, and per-unit social costs estimated by the IWG. These uncertainties are captured to a large extent by including the low, mid, and high activity levels.

When considering the social costs of both domestic and foreign GHG emissions, global social costs of the Leasing scenario relative to GHG emissions are higher than the No Leasing scenario. As discussed in **Section C.2.2.3**, the scope of the domestic and foreign analyses is inherently different. Adding them together would not provide a complete and accurate estimate of incremental global GHG emissions attributable to the Leasing scenario. This conclusion also applies to the estimates of the social costs of domestic and foreign GHG emissions.

C.2.4 Areas of Uncertainty in Modeling Inputs

BOEM's analysis demonstrates differences in emissions between the regions and the importance of several key variables. As shown in the preceding tables, domestic consumption and production emissions associated with the Leasing scenario and those associated with the energy substitutes under the No Leasing scenario are very similar. Some OCS areas may have slightly more emissions than substitutes and others slightly less, but general results are similar and recognize the importance of understanding and considering the trade-offs of different policy decisions. Several factors and inherent differences in model assumptions lead to differences in results. Among the primary factors are those related to elasticities, adjustment rates, and ratio of anticipated OCS oil versus OCS natural gas. The interplay of the different elasticities for oil versus natural gas and their substitutes with the ratio of oil versus natural gas production is the main driver of the differences in emissions between OCS oil and natural gas and their substitutes.

This section focuses on the two key variables in the analysis and the importance of those assumptions in the final results: 1) elasticities and adjustment rates and 2) anticipated activity and production, specifically the ratio of anticipated OCS oil versus natural gas in a given area.

C.2.4.1 Elasticities and Adjustment Rates

Elasticities and adjustment rates within MarketSim are integral to the GHG emissions results, and there is inherent uncertainty within the values used by the model.

Elasticities are used to determine the amount of fuel switching or increase and decrease of demand and supply between alternate energy sources in response to the price change driven by the anticipated production of OCS oil and natural gas. Elasticity measures the percentage change of one economic variable in response to a change in another variable. It is often used to estimate a change in supply or demand given a change in price (**Figure C-3**). Additionally, there are cross-price elasticities that describe the response consumers have to a particular energy source "A" given a change in price of a substitute energy source "B."

$$\text{Supply Elasticity} = \frac{\text{\% Change, Quantity Supplied}}{\text{\% Change, Price of Supply}} \Rightarrow \text{\% Change, Price of Supply} = \frac{\text{\% Change, Quantity Supplied}}{\text{Supply Elasticity}}$$

Figure C-3. Illustration of supply elasticity

Along with elasticities, MarketSim also includes an adjustment rate variable, which limits the amount an energy source can adjust in any year given that the elasticities are long-term elasticities. Elasticities and adjustment rates together determine the change in supply and demand of substitute energy sources, given a change in the anticipated production from the Leasing scenario. The changes in substitute energy sources, primarily determined by the elasticities and adjustment rates, determine the substitution rates estimated by MarketSim. In turn, these substitution rates impact GHG emissions rates for each portion of the GHG emissions life cycle, from upstream to downstream.

BOEM continually evaluates its models to update them with the most recent available data. BOEM completed a review and update of its MarketSim model and documentation in November 2021. The updated model includes new elasticity values from the peer-reviewed literature and expert sources, as well as two new baseline oil supply categories of conventional onshore (lower 48) and unconventional onshore (lower 48) oil production. Industrial Economics Inc. (2021) provides a description of the most recent set of updates made to MarketSim and its elasticities.

C.2.4.2 Anticipated Activity & Production: Oil and Gas Ratios

Another model input that drives results and has an element of uncertainty is anticipated activity and production. The amount of production and associated activities (exploration, development, and decommissioning) drive the upstream emissions from Leasing. However, the ratio of anticipated OCS oil to OCS natural gas production is the major driver for the substitutions analysis and, subsequently, the No Leasing scenario and incremental life cycle emissions. Chapter 5 of the *Draft Economic Analysis Methodology for the 2023–2028 National Outer Continental Shelf Oil and Gas Leasing Program* discusses BOEM's process for estimating anticipated production (BOEM 2022b).

Changes in the ratios of production of oil versus natural gas lead to different substitution rates and, consequently, different GHG emissions results. Oil and natural gas have different own-price supply and demand elasticities as well as cross-price elasticities with substitute energy sources. **Table C-5** shows the substitution rates specifically for oil and natural gas. Furthermore, each planning area has different volumes of anticipated oil versus natural gas production. Therefore, GHG emissions estimates vary among areas depending in part on their proportion of oil to natural gas production.

C.2.4.3 Changes in Current Laws and Policies

As noted above, substitution analysis is impacted by significant uncertainty given that it is an indicator of changes in energy markets. MarketSim uses as its baseline the Annual Energy Outlook, which is based only on current policies and laws and does not assume regulations will be implemented that would achieve the policy of net-zero GHG reductions by 2050. If additional climate policies were put into place, there could be major changes in future energy markets and corresponding changes in how a reduced supply of oil may impact the markets. Alternatively, if major international supplies of oil are no longer available, the importance of OCS oil may increase, and substitutions could then have even broader implications for society. BOEM is considering ways to incorporate climate commitments of the U.S. and future climate scenarios into its modeling analysis and welcomes feedback and alternate approaches. The changes in producer and consumer behavior patterns and policy changes that could help in achieving net-zero energy emissions are largely beyond the scope of BOEM's authority, but the Bureau recognizes the need to continually seek the best available information for our analyses and to address the policy mandates adopted under the Paris Agreement and established by the President for the Nation.

Appendix D: Species Names

The draft programmatic environmental impact statement (Draft Programmatic EIS) considers the effects of the 2023–2028 National Outer Continental Shelf (OCS) Oil and Gas Leasing Proposed Program on the marine and coastal environments in and around the Bureau of Ocean Energy Management (BOEM) planning areas, which include a high diversity of species. The Draft Programmatic EIS does not list them all; rather, the description and analysis call out species groups, representative species, and particularly sensitive species. Several of these species are protected as threatened (T) or endangered (E) under the Endangered Species Act (ESA) and have critical habitat designated, which provides further protection of areas that contain features essential to the conservation of these species (**Figure D-1**). A full list of species referenced in the Draft Programmatic EIS and the OCS region in which they are found is compiled in **Table D-1**, which also notes ESA status and any overlap of critical habitat with BOEM planning areas.

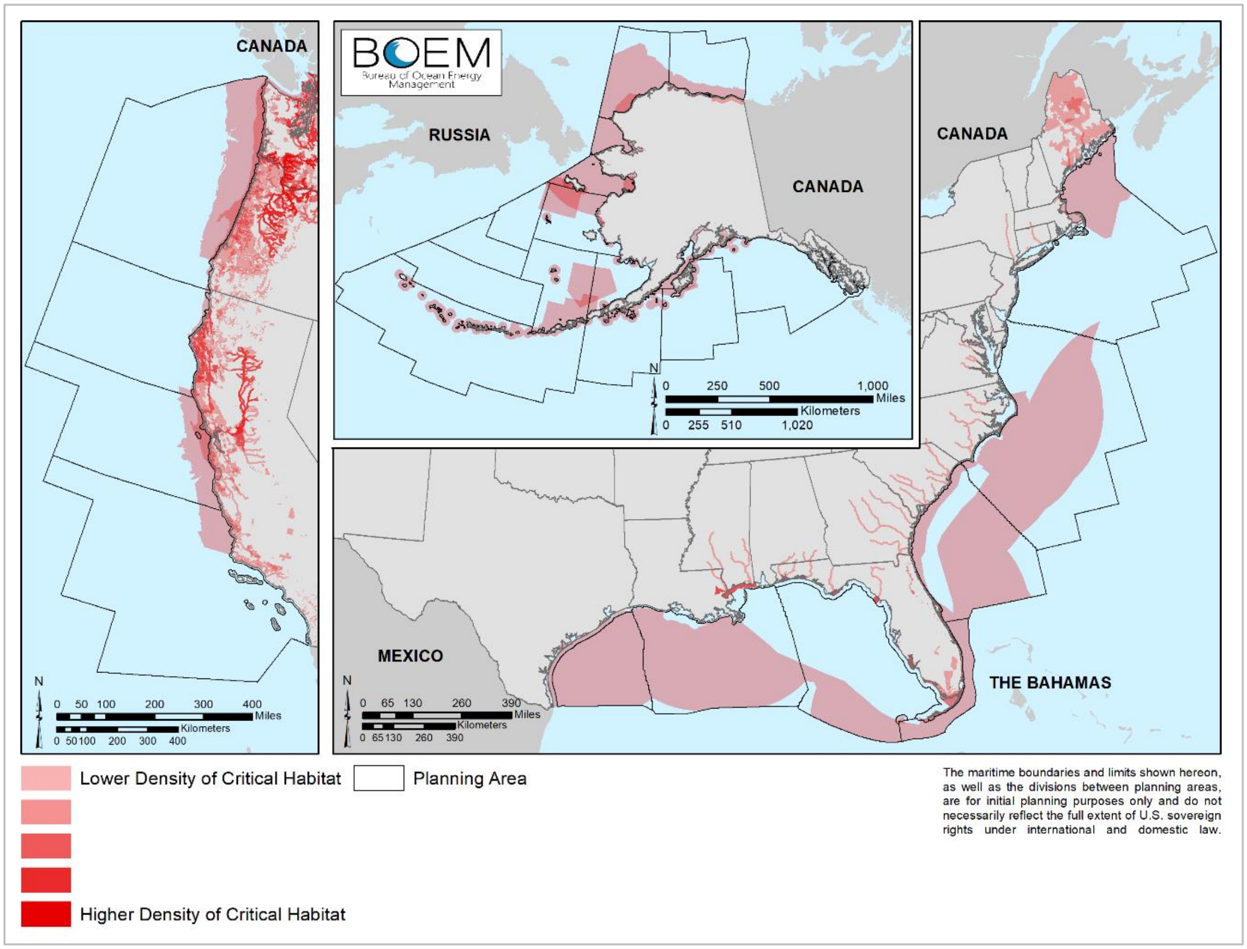

Figure D-1. Density of critical habitat within and adjacent to BOEM planning areas

Table D-1. Marine and coastal species of the Draft Programmatic EIS
Notes: T= Threatened; E = Endangered; FR = *Federal Register*

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
FISH									
Atlantic salmon	*Salmo salar*	✓	-	-	-	+	E: 65 FR 69459	74 FR 29300	None
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	✓	-	-	-	+	E: 77 FR 5914; T/E: 77 FR 5880	82 FR 39160	None
Eulachon	*Thaleichthys pacificus*	✓	+	+	-	-	T: 75 FR 13012	76 FR 65324	None
Giant manta ray	*Manta birostris*	✓	-	+	+	+	T: 83 FR 2916	None	-
Green sturgeon	*Acipenser medirostris*	✓	+	+	-	-	T: 72 FR 16284; 71 FR 17757	74 FR 52300	Central California, Northern California, Washington/Oregon
Gulf grouper	*Mycteroperca jordani*	✓	-	+	-	-	E: 81 FR 72545	None	-
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	✓	-	-	+	-	T: 56 FR 49653	68 FR 13370	Central GOM, Eastern GOM
Largetooth sawfish[1]	*Pristis pristis*	✓	-	-	+	+	E: 79 FR 73978	None	-
Nassau grouper	*Epinephelus striatus*	✓	-	-	+	+	T: 81 FR 42268	None	-
Oceanic whitetip shark	*Carcharhinus longimanus*	✓	-	-	+	+	T: 83 FR 4153	None	-
Salmon (coho, Chinook, sockeye, and chum)	*Oncorhynchus kisutch, O. tshawytscha, O. nerka, O. keta*	✓	+	+	-	-	T/E: 77 FR 19552; 73 FR 7816; 70 FR 37160; 64 FR 50394; 64 FR 14508; 64 FR 14528; 64 FR 14308; 62 FR 24588; 61 FR 56138; 59 FR 222; 57 FR 14653; 56 FR 58619; 55 FR 46515	81 FR 9252; 73 FR 7816; 70 FR 52630; 70 FR 52488; 65 FR 7764; 64 FR 57399; 64 FR 24049; 58 FR 68543; 58 FR 33212	None
Scalloped hammerhead shark	*Sphyrna lewini*	✓	-	+	+	+	T (Central & Southwest Atlantic), E (Eastern Atlantic, Eastern Pacific): 79 FR 38213	None	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Shortnose sturgeon	*Acipenser brevirostrum*	✓	-	-	-	+	E: 32 FR 4001	None	-
Smalltooth sawfish	*Pristis pectinata*	✓	-	-	+	+	E: 79 FR 73978	74 FR 45353	Eastern Gulf of Mexico (GOM), Straits of FL
Steelhead trout	*Oncorhynchus mykiss*	✓	+	+	-	+	T/E: 72 FR 26722; 71 FR 5248; 67 FR 21586; 65 FR 36074; 64 FR 14517; 63 FR 13347; 62 FR 43937	81 FR 9252; 70 FR 52630; 70 FR 52488	None
Tidewater goby	*Eucyclogobius newberryi*	✓	-	+	-	-	E: 59 FR 5494	78 FR 8745	None
Anchovies	Family Engraulidae	-	-	+	+	+	Not listed	-	-
Anglerfishes	Superfamily Ceratioidea	-	+	+	+	+	Not listed	-	-
Arctic cod	*Arctogadus glacialis*	-	+	-	-	-	Not listed	-	-
Atka mackerel	*Pleurogrammus monopterygius*	-	+	-	-	-	Not listed	-	-
Atlantic bluefin tuna	*Thunnus thynnus*	-	-	-	+	+	Not listed	-	-
Atlantic cod	*Gadus morhua*	-	-	-	-	+	Not listed	-	-
Atlantic croaker	*Micropogonias undulatus*	-	-	-	-	+	Not listed	-	-
Atlantic halibut	*Hippoglossus hippoglossus*	-	-	-	-	+	Not listed	-	-
Atlantic herring	*Clupea harengus*	-	-	-	-	+	Not listed	-	-
Atlantic mackerel	*Scomber scombrus*	-	-	-	-	+	Not listed	-	-
Atlantic menhaden	*Brevoortia tyrannus*	-	-	-	-	+	Not listed	-	-
Atlantic sailfish	*Istiophorus albicans*	-	-	-	+	+	Not listed	-	-
Bigeye tuna	*Thunnus obesus*	-	-	+	+	+	Not listed	-	-
Billfishes	Order Istiophoriformes	-	+	+	+	+	Not listed	-	-
Black drum	*Pogonias cromis*	-	-	-	+	+	Not listed	-	-
Black sea bass	*Centropristis striata*	-	-	-	-	+	Not listed	-	-
Blacknose shark	*Carcharhinus acronotus*	-	-	-	+	+	Not listed	-	-
Blacktip shark	*Carcharhinus limbatus*	-	-	-	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Blue marlin	*Makaira nigricans*	-	-	-	+	+	Not listed	-	-
Blue shark	*Prionace glauca*	-	+	+	+	+	Not listed	-	-
Bluefish	*Pomatomus saltatrix*	-	-	-	+	+	Not listed	-	-
Bonnethead shark	*Sphyrna tiburo*	-	-	+	+	+	Not listed	-	-
Bristlemouths	Family Gonostomatidae	-	+	+	+	+	Not listed	-	-
Bull shark	*Carcharhinus leucas*	-	-	-	+	+	Not listed	-	-
Butterfish	*Peprilus triacanthus*	-	-	-	+	+	Not listed	-	-
Capelin	*Mallotus villosus*	-	+	+	-	+	Not listed	-	-
Cobia	*Rachycentron canadum*	-	-	-	+	+	Not listed	-	-
Cods	Family Gadidae	-	+	+	+	+	Not listed	-	-
Drums	Family Sciaenidae	-	-	+	+	+	Not listed	-	-
Flatfishes	Order Pleuronectiformes	-	+	+	+	+	Not listed	-	-
Giant kelpfish	*Heterostichus rostratus*	-	-	+	-	-	Not listed	-	-
Giant sea bass	*Stereolepis gigas*	-	-	+	-	-	Not listed	-	-
Goliath grouper	*Epinephelus itajara*	-	-	-	+	+	Not listed	-	-
Greenland turbot	*Reinhardtius hippoglossoides*	-	+	+	-	-	Not listed	-	-
Grenadiers	Subfamily Macrourinae	-	+	+	-	+	Not listed	-	-
Groupers	Family Serranidae	-	-	+	+	+	Not listed	-	-
Gulf corvina	*Cynoscion othonopterus*	-	-	-	-	-	Not listed	-	-
Gulf menhaden	*Brevoortia patronus*	-	-	-	+	-	Not listed	-	-
Gulf toadfish	*Opsanus beta*	-	-	-	+	-	Not listed	-	-
Gulper eel	*Eurypharynx pelecanoides*	-	+	+	+	+	Not listed	-	-
Haddock	*Melanogrammus aeglefinus*	-	-	-	-	+	Not listed	-	-
Hammerhead sharks	Family Sphyrnidae	-	-	-	+	+	Not listed	-	-
Hogfish	*Lachnolaimus maximus*	-	-	-	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Jack mackerel	*Trachurus symmetricus*	-	+	+	-	-	Not listed	-	-
Jacks	Family Carangidae	-	-	+	+	+	Not listed	-	-
Kelp bass	*Paralabrax clathratus*	-	-	+	-	-	Not listed	-	-
King mackerel	*Scomberomorus cavalla*	-	-	-	+	+	Not listed	-	-
Lanternfishes	Family Myctophidae	-	+	+	+	+	Not listed	-	-
Lingcod	*Ophiodon elongatus*	-	+	+	-	-	Not listed	-	-
Lionfish[2]	*Pterois volitans, Pterois miles*	-	-	-	+	+	Not listed	-	-
Mackerels	Family Scombridae	-	-	+	+	+	Not listed	-	-
Mahi-mahi	*Coryphaena hippurus*	-	-	+	+	+	Not listed	-	-
Marlins	Family Instiophoridae	-	-	+	+	+	Not listed	-	-
Menhaden	Genus *Brevoortia*	-	-	-	+	+	Not listed	-	-
Nurse shark	*Ginglymostoma cirratum*	-	-	-	+	+	Not listed	-	-
Pacific barracuda	*Sphryaena argentea*	-	-	+	-	-	Not listed	-	-
Pacific bluefin tuna	*Thunnus orientalis*	-	-	+	-	-	Not listed	-	-
Pacific cod	*Gadus macrocephalus*	-	+	+	-	-	Not listed	-	-
Pacific hake	*Merluccius productus*	-	+	+	-	-	Not listed	-	-
Pacific halibut	*Hippoglossus stenolepis*	-	+	+	-	-	Not listed	-	-
Pacific herring	*Clupea pallasii*	-	+	+	-	-	Not listed	-	-
Pacific lamprey	*Entosphenus tridentatus*	-	+	+	-	-	Not listed	-	-
Pink salmon	*Oncorhynchus gorbuscha*	-	+	+	-	-	Not listed	-	-
Rattails	Family Macrouridae	-	+	+	+	+	Not listed	-	-
Rays	Superorder Batoidea	-	+	+	+	+	Not listed	-	-
Red drum	*Sciaenops ocellatus*	-	-	-	+	+	Not listed	-	-
Red snapper	*Lutjanus campechanus*	-	-	-	+	+	Not listed	-	-
Rockfishes	Genus *Sebastes*	-	+	+	-	-	Not listed	-	-
Sablefish	*Anoplopoma fimbria*	-	+	+	-	-	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Saffron cod	*Eleginus gracilis*	-	+	-	-	-	Not listed	-	-
Salmon	Family Salmonidae	-	+	+	-	+	Listed as individual species	-	-
Sand lances	Genus *Ammodytes*	-	+	+	-	+	Not listed	-	-
Sand tiger shark	*Carcharias taurus*	-	-	-	+	+	Not listed	-	-
Sandbar shark	*Carcharhinus plumbeus*	-	-	-	+	+	Not listed	-	-
Sardine	*Sardinops sagax*	-	+	+	+	+	Not listed	-	-
Scup	*Stenotomus chrysops*	-	-	-	-	+	Not listed	-	-
Seatrouts	Genus *Cynoscion*	-	-	+	+	+	Not listed	-	-
Sharks	Class Chondrichthyes	-	+	+	+	+	Not listed	-	-
Shortspine thornyhead	*Sebastolobus alascanus*	-	+	+	-	-	Not listed	-	-
Silver hake	*Merluccius bilinearis*	-	-	-	-	+	Not listed	-	-
Skates	Order Rajiformes	-	+	+	+	+	Not listed	-	-
Smelts	Family Osmeridae	-	+	+	-	+	Not listed	-	-
Snapper/grouper complex	Family Lutjanidae, Family Serranidae	-	-	-	+	+	Not listed	-	-
Snowy grouper	*Hyporthodus niveatus*	-	-	-	+	+	Not listed	-	-
Spot	*Leiostomus xanthurus*	-	-	-	+	+	Not listed	-	-
Spotted seatrout	*Cynoscion nebulosus*	-	-	-	+	+	Not listed	-	-
Striped bass	*Morone saxatilis*	-	-	-	+	+	Not listed	-	-
Summer flounder	*Paralichthys dentatus*	-	-	-	-	+	Not listed	-	-
Surfperches	Family Embiotocidae	-	-	+	-	-	Not listed	-	-
Swordfish	*Xiphias gladius*	-	+	+	+	+	Not listed	-	-
Tarpon	*Megalops atlanticus*	-	-	-	+	+	Not listed	-	-
Tilefishes	Family Malacanthidae	-	-	+	+	+	Not listed	-	-
Tripod fish	*Bathypterois grallator*	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Trouts	Genera *Oncorhynchus*, *Salmo* and *Salvelinus*	-	+	+	-	+	Not listed	-	-
Tunas	Family Scombridae	-	+	+	+	+	Not listed	-	-
Vermilion snapper	*Rhomboplites aurorubens*	-	-	-	+	+	Not listed	-	-
Viperfishes	Genus *Chauliodus*	-	+	+	+	+	Not listed	-	-
Wahoo	*Acanthocybium solandri*	-	-	+	+	+	Not listed	-	-
Walleye pollock	*Gadus chalcogrammus*	-	+	+	-	-	Not listed	-	-
Whale shark	*Rhincodon typus*	-	-	+	+	+	Not listed	-	-
White marlin	*Kajikia albida*	-	-	-	+	+	Not listed	-	-
White seabass	*Atractoscion nobilis*	-	+	+	-	-	Not listed	-	-
White sturgeon	*Acipenser transmontanus*	-	+	+	-	-	Not listed	-	-
Winter flounder	*Pseudopleuronectes americanus*	-	-	-	-	+	Not listed	-	-
Wrasses	Family Labridae	-	+	+	+	+	Not listed	-	-
Yellowtail flounder	*Limanda ferruginea*	-	-	-	-	+	Not listed	-	-
BIRDS									
Bermuda petrel	*Pterodroma cahow*	✓	-	-	-	+	E: 35 FR 8491	35 FR 8491	None
California least tern	*Sterna antillarum browni*	✓	-	+	-	-	E: 35 FR 8491	None	-
California Ridgway's rail	*Rallus longirostris obsoletus*	✓	-	+	-	-	E: 35 FR 16047	None	-
Hawaiian petrel	*Pterodroma sandwichensis*	✓	+	+	-	-	E: 32 FR 4001	None	-
Least tern	*Sternula antillarum*	✓	-	+	+	+	E: 50 FR 21784	None	-
Light-footed Ridgway's rail	*Rallus longirostris levipes*	✓	-	-	+	+	E: 35 FR 16047	None	-
Marbled murrelet	*Brachyramphus marmoratus*	✓	+	+	-	-	T: 57 FR 45328	81 FR 51348	Washington/Oregon, Northern California

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Piping plover	*Charadrius melodus*	✓	-	-	+	+	E (Great Lakes), T (Northeast): 50 FR 50726	74 FR 23476; 67 FR 57638	None
Roseate tern	*Sterna dougallii*	✓	-	-	+	+	E (Northeast), T (Southeast): 52 FR 42064	None	-
Rufa red knot	*Calidris canutus rufa*	✓	-	-	+	+	T: 79 FR 73705	None	-
Short-tailed albatross	*Phoebastria albatru*	✓	+	+	-	-	E: 35 FR 8491	None	-
Spectacled eider	*Somateria fischeri*	✓	+	-	-	-	T: 58 FR 27474	66 FR 9146	Chukchi Sea, Navarin Basin, Norton Basin, St. Matthew-Hall
Steller's eider	*Polysticta stelleri*	✓	+	-	-	-	T (Alaska breeding population): 62 FR 31748	66 FR 8850	St. Matthew-Hall
Western snowy plover	*Charadrius nivosus nivosus*	✓	-	+	+	+	T: 58 FR 12864	77 FR 36727	Washington/Oregon, Northern California, Central California, Southern California
Wood stork	*Mycteria americana*	✓	-	+	+	+	T: 49 FR 7332	None	-
Albatrosses	Family Diomedeidae	-	+	+	+	+	Not listed	-	-
Alcids	Family Alcidae	-	+	+	-	+	Not listed	-	-
Arctic tern	*Sterna paradisaea*	-	+	+	+	+	Not listed	-	-
Ashy storm-petrel	*Hydrobates homochroa*	-	-	+	-	-	Not listed	-	-
Atlantic puffin	*Fratercula arctica*	-	-	-	-	+	Not listed	-	-
Auklets	Genera *Aethia* and *Ptychoramphus*	-	+	+	-	-	Not listed	-	-
Black brant	*Branta bernicla nigricans*	-	+	+	-	-	Not listed	-	-
Black-bellied plover	*Pluvialis squatarola*	-	+	+	+	+	Not listed	-	-
Black-capped petrel	*Pterodroma hasitata*	-	-	-	+	+	Not listed	-	-
Black-legged kittiwake	*Rissa tridactyla*	-	+	-	-	-	Not listed	-	-
Boobies	Genus *Sula*	-	-	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Brant	*Branta bernicla*	-	+	+	-	-	Not listed	-	-
Brown pelican	*Pelecanus occidentalis*	-	-	+	+	+	Not listed	-	-
Clapper rail	*Rallus crepitans*	-	-	-	+	-	Not listed	-	-
Common eider	*Somateria mollissima*	-	+	-	-	+	Not listed	-	-
Common loon	*Gavia immer*	-	+	+	+	+	Not listed	-	-
Common murre	*Uria aalge*	-	+	+	-	+	Not listed	-	-
Cormorants	Family Phalacrocoracidae	-	+	+	+	+	Not listed	-	-
Cory's shearwater	*Calonectris borealis*	-	-	-	+	+	Not listed	-	-
Cranes	Genus *Grus*	-	+	+	+	+	Not listed	-	-
Dovekie	*Alle alle*	-	+	-	-	+	Not listed	-	-
Eagles	Genus *Haliaeetus*	-	+	+	+	+	Not listed	-	-
Egrets	Family Ardeidae	-	+	+	+	+	Not listed	-	-
Eiders	Genus *Somateria*	-	+	-	-	+	Listed as individual species	-	-
Grebes	Family Podicipedidae	-	+	+	+	+	Not listed	-	-
Frigatebirds	Genus *Fregata*	-	-	+	+	+	Not listed	-	-
Fulmars	Genus *Fulmarus*	-	+	+	-	+	Not listed	-	-
Glaucous gull	*Larus hyperboreus*	-	+	+	+	+	Not listed	-	-
Glaucous-winged gull	*Larus glaucescens*	-	+	+	-	-	Not listed	-	-
Greater shearwater	*Puffinus gravis*	-	-	-	+	+	Not listed	-	-
Guillemots	Genus *Cepphus*	-	+	+	-	+	Not listed	-	-
Gulls	Suborder Lari	-	+	+	+	+	Not listed	-	-
Herons	Family Ardeidae	-	+	+	+	+	Not listed	-	-
Ibises	Genera *Eudocimus* and *Plegadis*	-	-	+	+	+	Not listed	-	-
Jaegers	Genus *Stercorarius*	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
King eider	*Somateria spectabilis*	-	+	-	-	+	Not listed	-	-
Kittiwakes	Genus *Rissa*	-	+	+	-	+	Not listed	-	-
Kittlitz's murrelet	*Brachyramphus brevirostris*	-	+	-	-	-	Not listed	-	-
Laughing gull	*Larus atricilla*	-	-	-	+	+	Not listed	-	-
Long-billed dowitcher	*Limnodromus scolopaceus*	-	+	+	+	+	Not listed	-	-
Long-tailed duck	*Clangula hyemalis*	-	+	+	-	+	Not listed	-	-
Loons	Genus *Gavia*	-	+	+	+	+	Not listed	-	-
Murres	Family Alcidae	-	+	+	-	+	Not listed	-	-
Northern fulmar	*Fulmarus glacialis*	-	+	+	-	+	Not listed	-	-
Northern gannet	*Morus bassanus*	-	-	-	+	+	Not listed	-	-
Oystercatchers	Genus *Haematopus*	-	+	+	+	+	Not listed	-	-
Petrels	Genus *Pterodroma*	-	+	+	+	+	Not listed	-	-
Phalaropes	Genus *Phalaropus*	-	+	+	-	+	Not listed	-	-
Plovers	Family Charadriidae	-	+	+	+	+	Not listed	-	-
Puffins	Genus *Fratercula*	-	+	+	-	+	Not listed	-	-
Rails	Family Rallidae	-	-	+	+	+	Not listed	-	-
Red knot	*Calidris canutus*	-	+	+	+	+	Not listed	-	-
Red phalarope	*Phalaropus fulicarius*	-	+	+	-	+	Not listed	-	-
Red-necked phalarope	*Phalaropus lobatus*	-	+	+	-	+	Not listed	-	-
Red-throated loon	*Gavia stellata*	-	+	+	-	+	Not listed	-	-
Roseate spoonbill	*Platalea ajaja*	-	-	-	+	+	Not listed	-	-
Royal tern	*Sterna maxima*	-	-	+	+	+	Not listed	-	-
Sabine's gull	*Xema sabini*	-	+	+	-	+	Not listed	-	-
Sandpipers	Family Scolopacidae	-	+	+	+	+	Not listed	-	-
Scoters	Genus *Melanitta*	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Scripps's murrelet	*Synthliboramphus scrippsi*	-	-	+	-	-	Not listed	-	-
Sea ducks	Subfamily Merginae	-	+	+	+	+	Listed as individual species	-	-
Seaside sparrow	*Ammodramus maritimus*	-	-	-	+	+	Not listed	-	-
Shearwaters	Family Procellariidae	-	+	+	+	+	Not listed	-	-
South polar skua	*Stercorarius maccormicki*	-	+	+	-	+	Not listed	-	-
Stilts	Genus *Himantopus*	-	-	+	+	+	Not listed	-	-
Storm-petrels	Family Hydrobatidae	-	+	+	+	+	Not listed	-	-
Terns	Subfamily Sterninae	-	+	+	+	+	Not listed	-	-
Tropicbirds	Genus *Phaeton*	-	-	+	+	+	Not listed	-	-
Yellow-billed loon	*Gavia adamsii*	-	+	+	-	-	Not listed	-	-
White pelican	*Pelecanus erythrorhynchos*	-	-	+	+	+	Not listed	-	-
SEA TURTLES									
Green turtle	*Chelonia mydas*	✓	-	+	+	+	T: 81 FR 20057	None	-
Hawksbill turtle	*Eretmochelys imbricata*	✓	-	-	+	+	E: 35 FR 8492	64 FR 46693	None
Kemp's ridley turtle	*Lepidochelys kempii*	✓	-	-	+	+	E: 35 FR 18319	None	-
Leatherback turtle	*Dermochelys coriacea*	✓	-	+	+	+	E: 35 FR 8491	44 FR 17710	Central California, Northern California, Southern California, Washington/Oregon
Loggerhead turtle	*Caretta caretta*	✓	-	+	+	+	E (North Pacific DPS), T (Northwest Atlantic DPS): 76 FR 58868	79 FR 39755	Central GOM, Eastern GOM, Western GOM, North/Mid/South Atlantic, Straits of FL

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Olive ridley turtle	*Lepidochelys olivacea*	✓	-	+	-	+	E (Mexico's Pacific Coast breeding colonies), T (all other areas): 43 FR 32800	None	-
MARINE MAMMALS									
Bearded seal	*Erignathus barbatus*	✓	+	-	-	-	T (Beringia DPS): 77 FR 76739	None	-
Beluga whale	*Delphinapterus leucas*	✓	+	-	-	-	E (Cook Inlet DPS): 73 FR 62919	76 FR 20180	Cook Inlet
Blue whale	*Balaenoptera musculus*	✓	+	+	+	+	E: 35 FR 18319	35 FR 18319	None
Bowhead whale	*Balaena mysticetus*	✓	+	-	-	-	E: 35 FR 18319	None	-
Bryde's whale	*Balaenoptera edeni brydei*	✓	-	+	-	-	E: 84 FR 15446	None	-
Fin whale	*Balaenoptera physalus*	✓	+	+	+	+	E: 35 FR 12222	None	-
Gray whale	*Eschrichtius robustus*	✓	+	+	-	-	E (Western North Pacific DPS): 35 FR 18319	None	-
Guadalupe fur seal	*Arctocephalus townsendi*	✓	-	+	-	-	T: 32 FR 4001	None	-
Humpback whale	*Megaptera novaeangliae*	✓	+	+	+	+	E (Central America and Western North Pacific DPSs), T (Mexico DPS): 81 FR 62259	None	-
Killer whale	*Orcinus orca*	✓	+	+	+	+	E (Southern resident DPS): 70 FR 69903	71 FR 69054	None
North Atlantic right whale	*Eubalaena glacialis*	✓	-	-	-	+	E: 73 FR 12024	81 FR 4837	North/Mid/South Atlantic
North Pacific right whale	*Eubalaena japonica*	✓	+	+	-	-	E: 73 FR 12024	73 FR 19000	Kodiak, North Aleutian, St. George Basin
Northern sea otter	*Enhydra lutris kenyoni*	✓	+	+	-	-	T (Southwest Alaska DPS): 70 FR 46366	74 FR 51988	Aleutian Arc, Cook Inlet, Kodiak, North Aleutian, Shumagin

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Polar bear	*Ursus maritimus*	✓	+	-	-	-	T: 73 FR 28212	75 FR 76086	Beaufort Sea, Chukchi Sea, Hope Basin, Norton Basin, St. Matthew-Hall
Rice's whale (previously Bryde's whale, Gulf of Mexico subspecies)	*Balaenoptera ricei*	✓	-	-	+	-	E: 84 FR 15446 (ESA status did not change with taxonomic change)	None	-
Ringed seal	*Pusa hispida*	✓	+	-	-	-	T: 79 FR 42687	None	-
Sei whale	*Balaenoptera borealis*	✓	+	+	+	+	E: 35 FR 12222	None	-
Southern sea otter	*Enhydra lutris nereis*	✓	+	+	-	-	T: 42 FR 2965	None	-
Sperm whale	*Physeter macrocephalus*	✓	+	+	+	+	E: 35 FR 18319	None	-
Spotted seal	*Phoca largha*	✓	+	-	-	-	T (foreign): 75 FR 65239	None	-
Steller sea lion	*Eumetopias jubatus*	✓	+	+	-	-	E (Western DPS): 55 FR 49203	64 FR 14052	Aleutian Arc
West Indian manatee	*Trichechus manatus*	✓	-	-	+	+	T: 32 FR 4001	42 FR 47840	None
Atlantic spotted dolphin	*Stenella frontalis*	-	-	-	-	+	Not listed	-	-
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	-	-	-	-	+	Not listed	-	-
Beaked whales	Family Ziphiidae	-	+	+	+	+	Not listed	-	-
Bottlenose dolphin	*Tursiops truncatus*	-	-	+	+	+	Not listed	-	-
California sea lion	*Zalophus californianus*	-	-	+	-	-	Not listed	-	-
Dolphins	Family Delphinidae	-	+	+	+	+	Not listed	-	-
Gray seal	*Halichoerus grypus*	-	-	-	-	+	Not listed	-	-
Harbor porpoise	*Phocoena phocoena*	-	-	+	+	+	Not listed	-	-
Harbor seal	*Phoca vitulina*	-	+	+	-	+	Not listed	-	-
Harp seal	*Pagophilus groenlandicus*	-	-	-	-	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Hooded seal	*Cystophora cristata*	-	-	-	-	+	Not listed	-	-
Ice seals	Family Phocidae	-	+	-	-	-	Not listed	-	-
Minke whale	*Balaenoptera acutorostrata*	-	+	+	+	+	Not listed	-	-
Northern elephant seal	*Mirounga angustirostris*	-	+	+	-	-	Not listed	-	-
Northern fur seal	*Callorhinus ursinus*	-	+	+	-	-	Not listed	-	-
Pacific walrus	*Odobenus rosmarus divergens*	-	+	-	-	-	Not listed	-	-
Ribbon seal	*Histriophoca fasciata*	-	+	-	-	-	Not listed	-	-
Risso's dolphin	*Grampus griseus*	-	+	+	+	+	Not listed	-	-
Seals	Suborder Pinnipedia	-	+	+	-	+	Not listed	-	-
Short-finned pilot whale	*Globicephala macrorhynchus*	-	+	+	+	+	Not listed	-	-
Striped dolphin	*Stenella coeruleoalba*	-	-	+	+	+	Not listed	-	-
Walrus	*Odobenus rosmarus*	-	+	-	-	-	Not listed	-	-
Whales	Infraorder Cetacea	-	+	+	+	+	Not listed	-	-
INVERTEBRATES									
Black abalone	*Haliotis cracherodii*	✓	-	+	-	-	E: 74 FR 1937	76 FR 66806	None
Boulder star coral	*Orbicella franksi*	✓	-	-	+	-	T: 79 FR 53852	None	-
Elkhorn coral	*Acropora palmata*	✓	-	-	+	+	T: 79 FR 53852	70 FR 14052	Eastern GOM, Straits of FL
Lobed star coral	*Orbicella annularis*	✓	-	-	-	+	T: 79 FR 53852	None	-
Mountainous star coral	*Orbicella faveolata*	✓	-	-	+	+	T: 79 FR 53852	None	-
Orbicella star corals	Genus *Orbicella*	✓	-	-	+	+	T: 79 FR 53852	None	-
Pillar coral	*Dendrogyra cylindrus*	✓	-	-	+	+	T: 79 FR 53852	None	-
Rough cactus coral	*Mycetophyllia ferox*	✓	-	-	+	+	T: 79 FR 53852	None	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Staghorn coral	*Acropora cervicornis*	✓	-	-	+	+	T: 79 FR 53852	70 FR 14052	Eastern GOM
White abalone	*Haliotis sorenseni*	✓	-	+	-	-	E: 66 FR 29046	None	-
Abalones	Family Haliotidae	-	+	+	-	-	Not listed	-	-
American horseshoe crab	*Limulus polyphemus*	-	-	-	-	+	Not listed	-	-
American lobster	*Homarus americanus*	-	-	-	-	+	Not listed	-	-
Amphipods	Order Amphipoda	-	+	+	+	+	Not listed	-	-
Anemones	Order Actiniaria	-	+	+	+	+	Not listed	-	-
Arrow squid	*Doryteuthis plei*	-	-	-	+	+	Not listed	-	-
Ascidians	Class Ascidiacea	-	+	+	+	+	Not listed	-	-
Atlantic surfclam	*Spisula solidissima*	-	-	-	-	+	Not listed	-	-
Basket stars	Order Euryalida	-	+	+	+	+	Not listed	-	-
Bivalves	Class Bivalvia	-	+	+	+	+	Not listed	-	-
Black corals	Order Antipatharia, Genera *Antipathes, Leiopathes*	-	+	+	+	+	Not listed	-	-
Blue crab	*Callinectes sapidus*	-	-	-	+	+	Not listed	-	-
Blue king crab	*Paralithodes platypus*	-	+	-	-	-	Not listed	-	-
Bristle worm	*Phragmatopoma lapidosa*	-	+	+	+	+	Not listed	-	-
Brittle stars	Class Ophiuroidea	-	+	+	+	+	Not listed	-	-
Calanoid copepods	Order Calanoida	-	+	+	+	+	Not listed	-	-
California spiny lobster	*Panulirus interruptus*	-	-	+	-	-	Not listed	-	-
Clams	Class Bivalvia	-	+	+	+	+	Not listed	-	-
Copepods	Subclass Copepoda	-	+	+	+	+	Not listed	-	-
Corals	Class Anthozoa	-	+	+	+	+	Not listed	-	-
Crabs	Infraorder Brachyura	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Crinoids	Class Crinoidea	-	+	+	+	+	Not listed	-	-
Crustaceans	Subphylum Crustacea	-	+	+	+	+	Not listed	-	-
Cuttlefishes	Order Sepiida	-	-	-	-	+	Not listed	-	-
Deepsea red crab	*Chaceon quinquedens*	-	-	-	+	+	Not listed	-	-
Dumbo octopuses	Genus *Grimpoteuthis*	-	+	+	+	+	Not listed	-	-
Dungeness crab	*Metacarcinus magister, Cancer magister*	-	+	+	-	-	Not listed	-	-
Eastern oyster	*Crassostrea virginica*	-	-	+	+	+	Not listed	-	-
Echinoderms	Phylum Echinodermata	-	+	+	+	+	Not listed	-	-
Fiddler crabs	Genus *Uca*	-	-	+	+	+	Not listed	-	-
Fuzzy hermit crab	*Dardanus megistos*	-	+	-	-	-	Not listed	-	-
Gastropods	Class Gastropoda	-	+	+	+	+	Not listed	-	-
Ghost shrimp	*Callichirus islagrande*	-	-	-	+	-	Not listed	-	-
Giant squid	*Architeuthis dux*	-	+	+	+	+	Not listed	-	-
Golden crab	*Chaceon fenneri*	-	+	-	-	-	Not listed	-	-
Gorgonian corals	Class Anthozoa	-	+	+	+	+	Not listed	-	-
Green sea urchin	*Strongylocentrotus droebachiensis*	-	+	-	-	-	Not listed	-	-
Humboldt squid	*Dosidicus gigas*	-	-	+	-	-	Not listed	-	-
Hydroids	Class Hydrozoa	-	-	+	-	-	Not listed	-	-
Hydrozoans	Class Hydrozoa	-	+	+	+	+	Not listed	-	-
Jellyfishes	Phyla Cnidaria and Ctenophora	-	+	+	+	+	Not listed	-	-
Jonah crab	*Cancer borealis*	-	-	-	+	+	Not listed	-	-
Krill	Order Euphausiacea	-	+	+	+	+	Not listed	-	-
Lace corals	Genus *Distichopora*	-	-	+	+	+	Not listed	-	-
Limpets	Order Patellogastropoda	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Longfin inshore squid	*Doryteuthis pealeii*	-	-	-	+	+	Not listed	-	-
Lophelia corals	Genus *Lophelia*	-	-	+	+	+	Not listed	-	-
Mole (sand) crabs	Genus *Emerita*	-	+	+	+	+	Not listed	-	-
Mollusks	Phylum Mollusca	-	+	+	+	+	Not listed	-	-
Mussels	Subclass Heterodonta	-	+	+	+	+	Not listed	-	-
Northern shortfin squid	*Illex illecebrosus*	-	-	-	-	+	Not listed	-	-
Octocorals	Subclass Octocorallia	-	+	+	+	+	Not listed	-	-
Octopuses	Order Octopoda	-	+	+	+	+	Not listed	-	-
Oculina corals	Family Oculinidae	-	-	-	+	+	Not listed	-	-
Oyster parasite	*Perkinsus marinus*	-	-	+	+	+	Not listed	-	-
Oysters	Family Ostreidae	-	+	+	+	+	Not listed	-	-
Pacific octopus	*Enteroctopus dofleini*	-	+	+	-	-	Not listed	-	-
Pacific razor clam	*Siliqua patula*	-	+	+	-	-	Not listed	-	-
Peanut worms	Phylum Sipuncula	-	+	+	+	+	Not listed	-	-
Pismo clam	*Tivela stultorum*	-	-	+	-	-	Not listed	-	-
Polychaetes	Class Polychaeta	-	+	+	+	+	Not listed	-	-
Purple-orange sea star	*Pisaster ochraceus*	-	+	+	-	-	Not listed	-	-
Quahog	*Mercenaria mercenaria*	-	-	-	+	+	Not listed	-	-
Red king crab	*Paralithodes camtschaticus*	-	+	-	-	-	Not listed	-	-
Red rock crab	*Cancer productus*	-	+	+	-	-	Not listed	-	-
Rock scallop	*Crassodoma gigantea*	-	+	+	-	-	Not listed	-	-
Scallops	Family Pectinidae	-	+	+	+	+	Not listed	-	-
Scleractinian corals	Order Scleractinia	-	+	+	+	+	Not listed	-	-
Sea cucumbers	Class Holothuroidea	-	+	+	+	+	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Sea fans	Genus *Gorgonia*	-	+	+	+	+	Not listed	-	-
Sea pens	Order Pennatulacea	-	+	+	+	+	Not listed	-	-
Sea scallop	*Placopecten magellanicus*	-	-	-	-	+	Not listed	-	-
Sea stars	Class Asteroidea	-	+	+	+	+	Not listed	-	-
Sea urchins	Class Echinoidea	-	+	+	+	+	Not listed	-	-
Sea whips	Order Gorgonacea	-	+	+	+	+	Not listed	-	-
Shore crabs	Family Varunidae	-	+	+	-	+	Not listed	-	-
Shrimps	Infraorder Caridea	-	+	+	+	+	Not listed	-	-
Snapping shrimps	Family Alpheidae	-	-	+	+	+	Not listed	-	-
Snow crabs	Genus *Chionoecetes*	-	+	+	-	+	Not listed	-	-
Soft corals	Order Alcyonacea	-	+	+	+	+	Not listed	-	-
Southern shortfin squid	*Illex coindetii*	-	-	-	+	-	Not listed	-	-
Spiny lobsters	Family Palinuridae	-	-	+	+	+	Not listed	-	-
Sponges	Phylum Porifera	-	+	+	+	+	Not listed	-	-
Squids	Order Teuthida	-	+	+	+	+	Not listed	-	-
Stone crab	*Menippe mercenaria*	-	-	-	+	-	Not listed	-	-
Stony coral	*Lophelia pertusa*	-	-	-	+	+	Not listed	-	-
Tanner crab	*Chionoecetes bairdi*	-	+	+	-	-	Not listed	-	-
Tubeworms	Family Siboglinidae	-	+	+	+	+	Not listed	-	-
Tunicates	Subphylum Tunicata	-	+	+	+	+	Not listed	-	-
Worms	Phylum Annelida	-	+	+	+	+	Not listed	-	-
OTHER									
Beach mice	*Peromyscus polionotus spp.*	✓	-	-	+	-	E: 49 FR 23794, 50 FR 23872, 63 FR 70053	71 FR 60238, 72 FR 4330	None
Algae	Kingdom Protista	-	+	+	+	+	Not listed	-	-
Arctic fox	*Vulpes lagopus*	-	+	-	-	-	Not listed	-	-

Common Name	Latin Name	Protected Species	Alaska Region	Pacific Region	GOM Region	Atlantic Region	ESA Status	Critical Habitat and FR Number	Planning Areas with Critical Habitat
Arctic hare	*Lepus arcticus*	-	+	-	-	-	Not listed	-	-
Bears	Genus *Ursus*	-	+	+	+	+	Not listed	-	-
Brown algae	Genus *Desmarestia*	-	+	+	+	+	Not listed	-	-
Brown bear	*Ursus arctos gyas*	-	+	-	-	-	Not listed	-	-
Bryozoans	Phylum Bryozoa	-	+	+	+	+	Not listed	-	-
Caribou	*Rangifer tarandus*	-	+	-	-	-	Not listed	-	-
Coralline algae	*Lithothamnium*	-	+	+	+	+	Not listed	-	-
Eelgrass	*Zostera marina*	-	+	+	+	+	Not listed	-	-
Giant kelp	*Macrocystis pyrifera*	-	+	+	-	-	Not listed	-	-
Harmful algal bloom	*Pseudo-nitzschia spp., Karenia brevis*	-	+	+	+	+	Not listed	-	-
Kelps	Order Laminariales	-	+	+	-	+	Not listed	-	-
Mangroves	Genera *Avicennia, Laguncularia*, and *Rhizophora*	-	-	-	+	+	Not listed	-	-
Rabbits	Order Lagomorpha	-	+	+	+	+	Not listed	-	-
Sargassum	*Sargassum*	-	-	-	+	+	Not listed	-	-
Seagrasses	Order Astimatales	-	+	+	+	+	Not listed	-	-
Shoalweed	*Halodule wrightii*	-	-	-	+	-	Not listed	-	-
Widgeongrass	*Ruppia maritima*	-	+	+	+	+	Not listed	-	-

[1]Likely extinct in U.S. range; [2]Not native to the U.S.

Appendix E: Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) (16 U.S.C. § 1801 *et seq*–1882, including reauthorizations) established eight regional fishery management councils. The MSFCMA mandates development of fishery management plans (FMPs) for responsible fish and invertebrate harvests in U.S. waters and designation of essential fish habitat (EFH) for managed species. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. § 1802). Factors that may determine EFH include substrate type, temperature, currents, bottom features, and geography. When sufficient data are available, EFH is designated for each lifestage of a species or group (e.g., reef fish or corals) to indicate habitat areas important for survival and reproduction (**Figure E-1**). For example, EFH areas offshore of the Gulf of Mexico (GOM) and South Atlantic have been designated for highly migratory species, while many coastal species have EFH concentrated around southern Alaska. There is no commercial fishing in the Arctic, and only Arctic cod, which are harvested elsewhere, have EFH designated there. **Figure E-1** shows the density of designated EFH, but this figure does not necessarily correlate to number of species because some EFH are designated for a group of multiple species.

Areas designated as EFH must be described and identified in FMPs, have potential adverse effects identified, and have required actions identified that will conserve and enhance the EFH. Coordination and consultation must occur on any Federal and state actions that may adversely affect EFH. Designation as EFH does not confer specific protections or restrictions, but limitations on activities may be proposed as conservation recommendations as part of the consultation process. The National Marine Fisheries Service (NMFS) and the regional fishery management councils designate Habitat Areas of Particular Concern (HAPCs) to increase focus on specific areas for research purposes and conservation efforts, but this designation does not confer additional specific protections or restrictions (**Figure E-2**).

The Bureau of Ocean Energy Management (BOEM) consults with NMFS when planning or authorizing activities that could adversely affect EFH or HAPCs and implements measures to avoid, minimize, or mitigate impacts when appropriate. For oil and gas development, these consultations would occur during subsequent review and approval at the lease sale and plan stages. **Table E-1** lists the numbers of managed fish species or groups with designated EFH and HAPCs in each BOEM planning area.

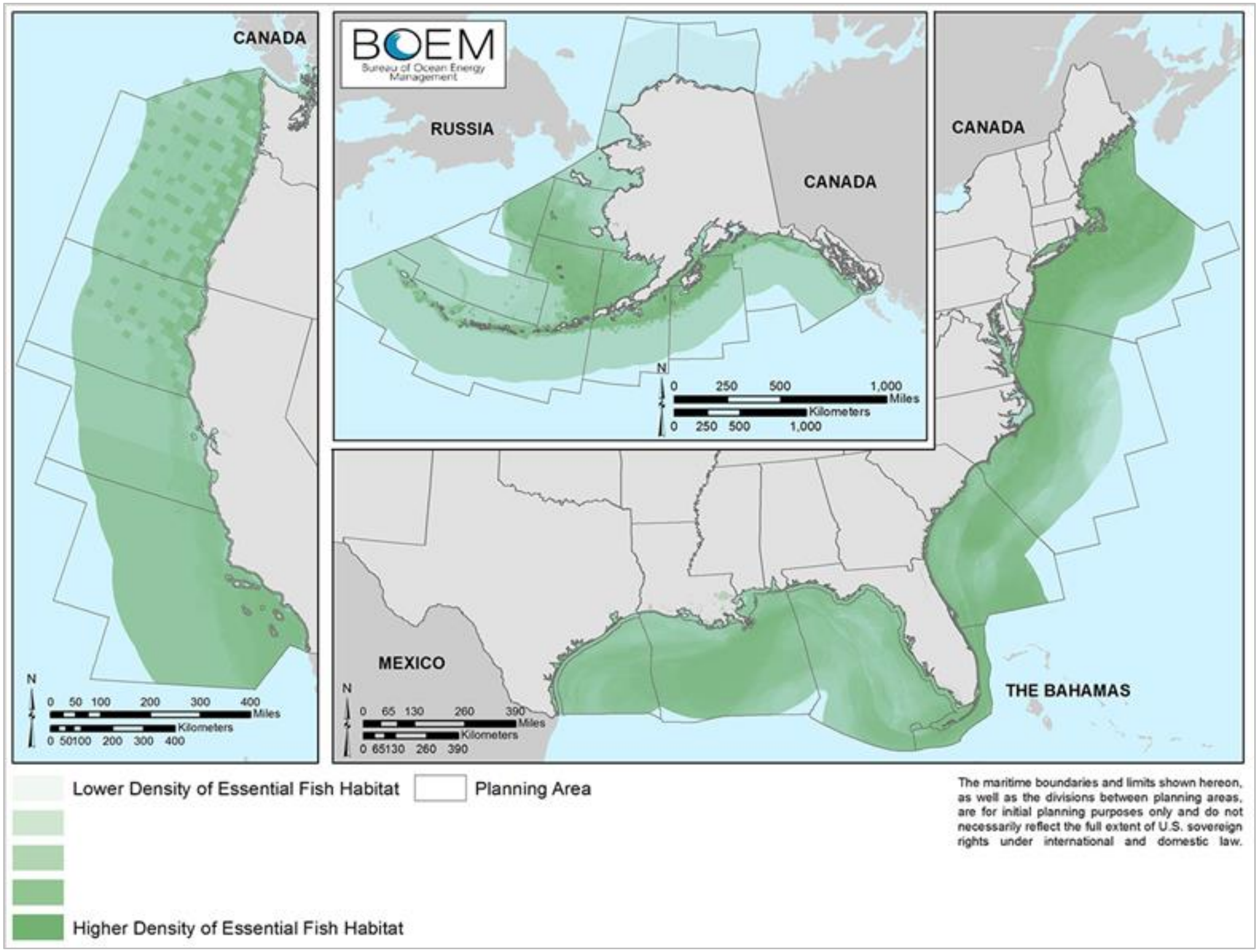

Figure E-1. Density of EFH in and adjacent to BOEM planning areas

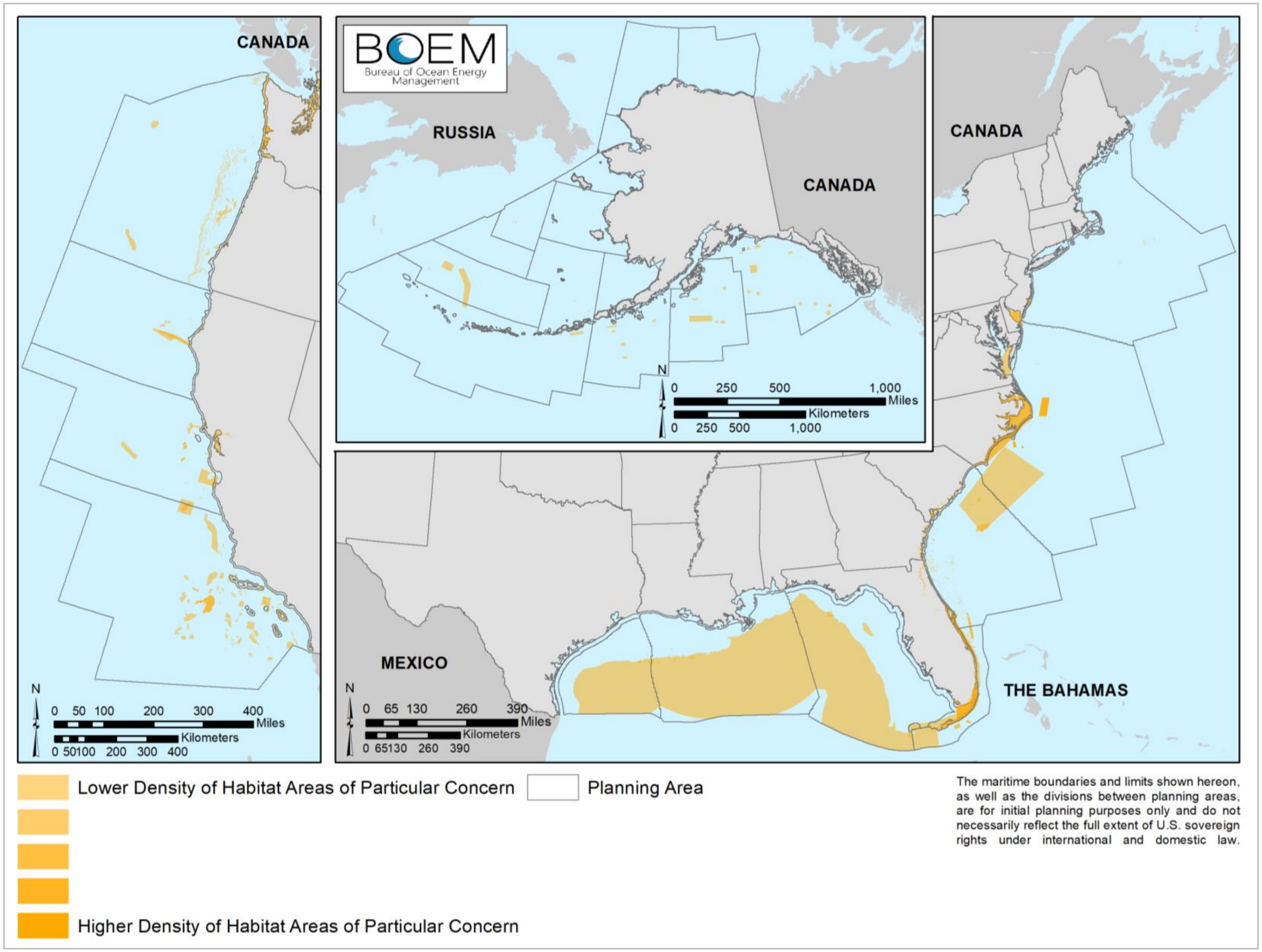

Figure E-2. Density of HAPCs in and adjacent to BOEM planning areas

Table E-1. Number of EFH and HAPCs in each BOEM planning area

Region	Planning Area	Number of Managed Fish Species or Groups with EFH	Number of HAPCs
Alaska	Aleutian Arc	28	1
Alaska	Aleutian Basin	24	0
Alaska	Beaufort Sea	1	0
Alaska	Bowers Basin	22	3
Alaska	Chukchi Sea	3	0
Alaska	Cook Inlet	27	0
Alaska	Gulf of Alaska	25	0
Alaska	Hope Basin	3	0
Alaska	Kodiak	27	0
Alaska	Navarin Basin	28	0
Alaska	North Aleutian Basin	29	0
Alaska	Norton Basin	14	0
Alaska	Shumagin	28	0
Alaska	St. George Basin	34	0
Alaska	St. Matthew-Hall	25	0
Pacific	Washington/Oregon	25	4
Pacific	Northern California	23	1
Pacific	Central California	21	7
Pacific	Southern California	17	16
GOM	Western GOM	34	6
GOM	Central GOM	35	8
GOM	Eastern GOM	40	4
Atlantic	Straits of Florida	42	17
Atlantic	South Atlantic	45	11
Atlantic	Mid-Atlantic	67	6
Atlantic	North Atlantic	66	3

Appendix F: Mitigations

This draft programmatic environmental impact statement (Draft Programmatic EIS) analyzes potential impacts that could result from activities associated with new leasing under the 2023–2028 National Outer Continental Shelf (OCS) Oil and Gas Leasing Program (2023–2028 Program). This appendix presents a sample of regulatory controls that the Bureau of Ocean Energy Management (BOEM) uses to minimize or avoid these potential impacts. These mitigations are not being adopted as part of the decision and are examples of mitigations that have been used previously and may again be used in lease sales and conditions of approval on post-lease activities.

BOEM's lease stipulations, regulations, compliance with environmental laws, and other measures adopted pursuant to consultations or derived through BOEM's internal analysis of new research collectively provide a robust regulatory mechanism for ensuring that oil and gas development activities proceed in an environmentally responsible way. BOEM's Environmental Studies Program, as well as multiple Federal agencies and Tribal partners, support the analyses and monitoring programs that inform these regulatory controls.

All BOEM leases are subject to regulations prescribing environmental controls on prospective lessees, their operators, and subcontractors and in addition to stipulations placed on a lease. BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) maintain a series of Notices to Lessees (NTLs) that communicate additional recommendations for adhering to environmental protection standards and clarify certain regulatory requirements. Lease stipulations may be applied to BOEM leases sold in a particular lease sale.

BOEM works closely with the BSEE to achieve environmental protection goals. BSEE has broad regulatory, permitting, inspection, monitoring, and enforcement authority to ensure safe operations and environmental protection, including the authority to issue civil penalties. BSEE ensures use of the best available and safest technologies during exploration, development, production, and decommissioning; incorporates environmental protection conditions in permits; and enforces lease stipulation requirements and mitigation measures. BSEE monitors operations after drilling has begun and carries out periodic inspections of facilities (in certain instances, in conjunction with other Federal agencies, such as the U.S. Environmental Protection Agency [USEPA]) to ensure safe and clean operations throughout the life of a lease.

By implementing lease stipulations and other mitigating measures, potential impacts could be minimized or avoided. A representative sample of lease stipulations and other protective environmental measures typically applied at subsequent National OCS Program stages is presented below. The region or planning area in which leases may be subject to a given lease stipulation or NTL is noted in parentheses.

F.1 PROTECTIONS FOR ARCHAEOLOGICAL AND CULTURAL RESOURCES

F.1.1 Archaeological Resource Reports and Survey and Report Requirements (All Planning Areas)

BOEM issued the NTLs to clarify when BOEM may require an archaeological resource report and to provide recommendations on how to prepare such a report and conduct archaeological surveys. This notice includes a series of measures describing procedures for conducting archaeological surveys before bottom-disturbing activities can occur. The measures, when applied, avoid impacting potential historic properties, including pre-contact and historic period archaeological resources. These NTLs also remind lessees and operators that if they discover any archaeological resource while conducting operations, they must immediately halt operations in the area of the discovery and notify BOEM of any discoveries so that the discovery can be protected. Refer to the following:

- BOEM NTL No. 05-A03—Archaeological Survey and Evaluation for Exploration and Development Activities: www.boem.gov/sites/default/files/documents/oil-gas-energy/BOEM%20NTL%20No.%202005-A03.pdf
- NTL No. 06-P03—Archaeological Survey and Report Requirements: www.boem.gov/Regulations/Notices-To-Lessees/2006/06-P03.aspx
- BOEM NTL No. 2005-G07—Archaeological Resource Reports and Surveys: www.boem.gov/Regulations/Notices-To-Lessees/2005/05-G07.aspx

F.1.2 Orientation to Alaska Native Community Cultures (Alaska Region)

This lease stipulation was designed to provide an increased understanding of, and appreciation for, local community values, customs, and lifestyles of Alaska Native communities. It requires that an orientation program must be designed in sufficient detail to inform individuals working on OCS projects of specific types of environmental, social, and cultural concerns in the area.

The orientation program must provide information to industry employees on protected species, biological resources used for commercial and subsistence purposes, and archaeological resources of the area. Information includes appropriate ways to protect them and reduce industrial noise and disturbance effects on marine mammals and marine and coastal birds. The program also must include information about avoiding conflicts with subsistence activities. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 3—Orientation Program: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/
- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/

- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.4. Stipulation No. 2. Orientation Program: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf
- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Info.pdf

F.2 PROTECTIONS FOR BENTHIC RESOURCES

F.2.1 Protection of Benthic Communities (Gulf of Mexico [GOM] Region)

The topographic features lease stipulation designates a "No Activity Zone" around numerous underwater topographic features commonly called "banks," the crests and flanks of which host ecologically important benthic communities, such as corals. The No Activity Zone is designed to protect the biota of these features from adverse effects of routine offshore oil and gas activities by preventing the emplacement of platforms or the anchoring of service vessels or mobile drilling units directly on the banks and requiring that drilling discharges be shunted in such a manner that they do not settle on the biota. NTL No. 2009-G39, *Biologically-Sensitive Underwater Features and Areas*, provides additional guidance for operators to plan proposed activities in the vicinity of such biologically sensitive features in a manner consistent with applicable regulations and to avoid or lessen potential impacts on benthic communities. Review of proposed activities may also result in the application of further conditions of approval to a plan or permit to ensure operator and contractor compliance with specific mitigation measures. The topographic features stipulation is under consideration for application at the programmatic stage and is discussed in **Section 4.5.3.** If this stipulation is selected for application at the programmatic stage, any lease issued in the GOM Region under the 2023–2028 Program would include these required mitigation measures. In practice, the stipulation has consistently been applied to leases in the affected OCS blocks, and it is expected that application of the stipulation would continue even if it is not adopted at the programmatic stage. Refer to the following:

- NTL No. 2009-G39—Biologically-Sensitive Underwater Features and Areas: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G39.aspx

F.2.2 Protection of Live Bottom (Pinnacle Trend and Low Relief; GOM Region)

These live bottom stipulations are intended to protect the Pinnacle Trend area and the associated live bottom areas in the GOM, as well as other live bottom areas not associated with bathymetric features on the seafloor, from damage from oil and gas activities. For the purpose of this stipulation, "live bottom areas" are defined as seagrass communities; areas that contain biological assemblages consisting of sessile invertebrates, such as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon and attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna. If the required live bottom survey report determines that the live bottom may be adversely impacted by the proposed activity, certain measures, such as relocation or monitoring, may be required. The live bottom (Pinnacle Trend) stipulation is under consideration for application at the programmatic stage and is discussed in **Section 4.5.3**; if this stipulation is selected, any lease issued in the GOM Region under the 2023–2028 Program would include these required mitigation measures. In practice, the stipulation has consistently been applied to leases in the affected OCS blocks, and it is expected that application of the stipulation would continue even if it is not adopted at the programmatic stage. Refer to the following:

- NTL No. 2009-G39—Biologically-Sensitive Underwater Features and Areas: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G39.aspx

F.2.3 Protection of Deepwater Benthic Communities (GOM Region)

This category includes mitigation measures to avoid impacts on deepwater benthic communities (which include chemosynthetic communities) in deepwater areas of the GOM. NTL No. 2009-G40, *Deepwater Benthic Communities*, provides additional guidance for operators to plan proposed activities in the vicinity of such biologically sensitive habitats and communities in a manner consistent with applicable regulations and to avoid or lessen potential impacts on deepwater benthic communities. Refer to the following:

- NTL No. 2009-G40—Deepwater Benthic Communities: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G40.aspx

F.3 PROTECTIONS FOR BIOLOGICAL RESOURCES

F.3.1 Biological Survey and Report Requirements (Pacific Region)

This stipulation requires that a lessee conduct and submit results of biological surveys in the area of proposed operations. The purpose of a biological survey is to describe the habitat and key species within the survey area that may be affected by the proposed operations. Refer to the following:

- NTL No. 2006-P02—Biological Survey and Report Requirements: www.boem.gov/sites/default/files/uploadedFiles/BOEM/Regulations/Notices_To_Lessees/2006/06-P02.pdf

F.3.2 Additional Mitigation Measures for the Protection of Biological Resources (GOM Region)

A number of additional mitigation measures apply to oil spill preparedness, seismic surveys, protected species, essential fish habitat (EFH), and other issues. Refer to the following:

- BOEM NTL No. 2009-G34—Ancillary Activities: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G34.aspx
- Protected Species Lease Stipulation:

  This lease stipulation requires lessees and their operators to:

1. Comply with the reasonable and prudent measures and implementing terms and conditions of the Biological Opinion issued by the National Marine Fisheries Service (NMFS) on March 13, 2020 (NMFS 2020).
2. Immediately report all sightings and locations of injured or dead protected species (e.g., marine mammals and sea turtles) to the appropriate hotlines.
3. Unless previously approved by BOEM or BSEE through a plan or permit issued under this lease, notify BOEM at least 15 days prior to any proposed vessel transit of the Rice's whale area and receive prior approval for that transit from BOEM.

Certain post-lease approvals (e.g., for activities proposing new and unusual technologies, seismic surveys, use of equipment presenting entanglement risks) require step-down review by NMFS, as provided by NMFS (2020), and additional mitigations to protect ESA-listed species may be applied at that time. At the lessee's option, the lessee and its operators, personnel, and contractors may comply with the most current measures to protect species in place at the time an activity is undertaken under this lease, including but not limited to, new or updated versions of NMFS (2020), its appendices, or through new or activity-specific consultations. The most current applicable terms and conditions and reasonable and prudent measures from NMFS (2020) or other relevant consultations will be applied to post-lease approvals. The lessee and its operators, personnel, and subcontractors will be required to comply with the mitigation measures identified NMFS (2020) (including appendices) and additional measures in the conditions of approvals for their plans or permits.

F.3.3 Modifying Operations to Protect Unique Biological Populations (Cook Inlet Planning Area)

This lease stipulation provides for identifying and protecting previously unknown important or unique biological populations or habitats that may occur in a lease area. If previously unknown sensitive biological resources are identified during activity approved under a Plan of Exploration or Development and Production Plan, the lessee will be required to modify operations, if necessary, to minimize adverse impacts on those biological populations or habitats. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 2—Protection of Biological Resources: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/
- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/
- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.4. Stipulation No. 1. Protection of Biological Resources: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf

- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Info.pdf

F.3.4 Protection of Beluga Whales (Cook Inlet Planning Area)

Three lease stipulations are designed to protect beluga whales when they are most likely to be present in the Cook Inlet Planning Area. To protect critical habitat and the animals themselves, the lessee, its operators, and subcontractors are prohibited from conducting any on-lease marine seismic surveys or exploratory drilling between November 1 of any given year of the lease and April 1 of the following year. To protect nearshore feeding, the lessee, its operators, and subcontractors are prohibited from conducting any on-lease marine seismic surveys between July 1 and September 30 of each year. Except for when a waiver or variance is granted by BOEM, these prohibitions remain in force regardless of whether the lessee, its operators, or subcontractors have received a permit or authorization under the Endangered Species Act (16 U.S.C. 1531–1544), Marine Mammal Protection Act (16 U.S.C. 1361–1423h), or other state or Federal statute for such activities. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 1—Protection of Fisheries: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/
- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/

F.3.5 Protection of Northern Sea Otter Critical Habitat (Cook Inlet Planning Area)

This lease stipulation is designed to protect northern sea otters when they are most likely to be present and distributed across the Cook Inlet Planning Area. The lessee, its operators, and subcontractors are prohibited from discharging drilling fluids and cuttings and from conducting seafloor-disturbing activities, including anchoring and placement of bottom-founded structures, within 1,000 m of areas designated as northern sea otter critical habitat. Except for when a waiver or variance is granted by BOEM, this prohibition remains in force regardless of whether the lessee(s), its operators or subcontractors have received a permit or authorization under the Endangered Species Act (16 U.S.C. 1531–1544), Marine Mammal Protection Act (16 U.S.C. 1361–1423h), or other state or Federal statute for such activities. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 1—Protection of Fisheries: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/

- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/

F.3.6 Protection of Spectacled and Steller's Eiders (Chukchi Sea and Beaufort Sea Planning Areas)

This lease stipulation is designed to minimize the likelihood that spectacled or Steller's eiders will strike drilling structures or vessels. The stipulation requires specific lighting protocols for structures and vessels, a plan for recording and reporting bird strikes, and avoidance of specified blocks by OCS-related vessels engaged in exploration activities. Refer to the following:

- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.7. Stipulation No. 7. Measures to Minimize Effects to Spectacled and Steller's Eiders During Exploration Activities: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf
- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Stips.pdf

F.4 PROTECTIONS FOR SUBSISTENCE PRACTICES

F.4.1 Monitoring Program for Marine Mammal Subsistence Resources (Chukchi Sea and Beaufort Sea Planning Areas)

This lease stipulation requires industry to perform site-specific monitoring to determine when marine mammals are present in the vicinity of exploration operations, including ancillary seismic surveys, during periods of subsistence use. The monitoring program and review process required for Marine Mammal Protection Act authorization will satisfy the requirements of this stipulation. The monitoring plan must provide for reports on marine mammal sightings and the extent of observed behavioral effects because of lease activities. It also provides a formal mechanism for the oil and gas industry to coordinate logistics activities with the BOEM Bowhead Whale Aerial Survey Program. The stipulation provides for an opportunity for recognized co-management organizations to review and comment on the proposed monitoring plan before BOEM approval. The stipulation also requires the lessee to fund an independent peer review of the proposed monitoring plan and draft reports on results of the monitoring program. No monitoring program will be required if the BOEM Alaska Regional Supervisor for Office of Leasing and Plans, in consultation with the appropriate agencies and co-management organizations, determines that a monitoring program is not necessary based on the size, timing, duration, and scope of the proposed operations. Refer to the following:

- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.4. Stipulation No. 4. Industry Site-Specific Monitoring Program for Marine Mammal Subsistence Resources:

www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf

- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Stips.pdf

F.4.2 Protection of Whaling and Other Marine Mammal Subsistence Activities (Chukchi Sea and Beaufort Sea Planning Areas)

This lease stipulation is designed to reduce disturbance effects on Alaska Native subsistence practices from OCS oil and gas industry activities by requiring the industry to make reasonable efforts to conduct all aspects of their operations in a manner that recognizes Alaska Native subsistence requirements and avoids conflict with local subsistence-harvest activities. The stipulation applies to both on-lease operations and support activities, such as vessel and aircraft traffic. The stipulation requires industry to consult with directly affected subsistence communities, the North Slope Borough, and the recognized co-management organizations to discuss possible siting and timing conflicts and to assure that exploration, development, and production activities do not result in unreasonable conflicts with subsistence whaling and other subsistence harvests. The stipulation also provides a mechanism to address unresolved conflicts between the oil and gas industry and subsistence activities. Refer to the following:

- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.5. Stipulation No. 5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Marine Mammal Subsistence-Harvesting Activities: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf
- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Stips.pdf

F.5 OTHER ENVIRONMENTAL PROTECTIONS

This category includes mitigation measures and background information that apply to offshore exploration, development, and pipeline activities.

F.5.1 Air Quality (GOM and Alaska Region)

NTL No. 2009-N11, *Air Quality Jurisdiction on the Outer Continental Shelf*, originally effective December 4, 2009, and reissued on June 19, 2020, is applicable in all OCS regions where BOEM has air quality jurisdiction. Refer to the following:

- BOEM NTL No. 2009-N11—Air Quality Jurisdiction on the Outer Continental Shelf: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-N11.aspx

- BOEM NTL No. 2020-N03—2021 OCS Emissions Inventory, Western Gulf of Mexico and Adjacent to the North Slope Borough of the State of Alaska: www.boem.gov/sites/default/files/documents/about-boem/NTL-2020-N03.pdf

F.5.2 Transportation and Transfer of Fuels and Hydrocarbons

F.5.2.1 Transportation of Hydrocarbons (Alaska Region)

This lease stipulation informs lessees that BOEM reserves the right to require the placement of pipelines only in certain designated management areas, that those pipelines must be designed and constructed to withstand the hazardous conditions that may be encountered in the lease sale area, and that pipeline construction and associated activities must comply with regulations.

This stipulation requires the use of pipelines for transportation of oil and gas, if pipeline rights-of-way can be determined and obtained, laying such pipelines is technologically feasible and environmentally preferable, and, in the opinion of the lessor, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 4—Transportation of Hydrocarbons: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/
- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/
- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.4. Stipulation No. 3. Transportation of Hydrocarbons: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf
- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Stips.pdf

F.5.2.2 Requirements for Fuel Transfers (Chukchi Sea and Beaufort Sea Planning Areas)

This lease stipulation requires the placement of a protective boom during fuel transfers in order to reduce the potential impacts of a fuel spill, should one to occur during fuel transfer. Refer to the following:

- Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 in the Chukchi Sea, Alaska, Appendix D, Guide to Lease Stipulations, D-2.1.7. Stipulation No. 6. Pre-booming Requirements for Fuel Transfers:

www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/LeaseSale_193_DraftSSEIS_Vol2.pdf

- Final Notice of Sale Package for Chukchi Sea Oil and Gas Lease Sale 193: www.boem.gov/sites/default/files/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Leasing_and_Plans/Leasing/Lease_Sales/Sale_193/Stips.pdf

F.5.3 Coastal Zone Management (GOM Region)

NTL No. 2009-G27, *Submitting Exploration Plans and Development Coordination Documents*, explains the four types of changes that can be made to an approved or pending exploration plan (EP) or Development Operations Coordination Document (DOCD) and when a lessee must revise or supplement its EP or DOCD. The NTL clarifies the policy regarding revising OCS plans when a lessee proposes to change approved anchor patterns or anchor areas, provides guidance for wells the lessee plans to sidetrack, makes minor administrative changes, and/or includes a guidance document statement (providing some guidance on Coastal Zone Management review). It also clarifies BOEM's policy regarding revising OCS plans when a lessee proposes to change approved anchor patterns or anchor areas and provides guidance for wells the lessee plans to sidetrack. This NTL also specifies the number of copies of EPs and DOCDs needed for state Coastal Zone Management review, as well as the cost recovery fees charged by BOEM and the various states for review of the EPs and DOCDs. Refer to the following:

- NTL No. 2009-G27—Submitting Exploration Plans and Development Operations Coordination Documents: www.boem.gov/sites/default/files/regulations/Notices-To-Lessees/2009/09-G27.pdf

F.6 MITIGATIONS TO ADDRESS SPACE-USE CONFLICTS

F.6.1 Protection of Fisheries (Cook Inlet Planning Area)

This lease stipulation is designed to minimize spatial conflicts between OCS activities and commercial, sport, and subsistence fishing activities. If determined necessary by the BOEM Alaska Regional Supervisor for Office of Leasing and Plans, lease-related uses will be restricted to prevent unreasonable conflicts with fishing operations. The stipulation requires the lessee to review planned exploration and development activities (including plans for seismic surveys, drilling rig transportation, or other vessel traffic) with potentially affected fishing organizations, subsistence communities, and port authorities to prevent unreasonable fishing gear conflicts. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 1—Protection of Fisheries: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/

- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/

F.6.2 Protection of Gillnet Fishery (Cook Inlet Planning Area)

This lease stipulation is designed to avoid conflicts with the drift gillnet fishery. The lessee, its operators, and subcontractors are prohibited by the Alaska Department of Fish and Game from conducting on-lease marine seismic surveys during the drift gillnet fishing season as designated each year from approximately mid-June to mid-August. The lessee is required to notify the United Cook Inlet Drift Association of any temporary or permanent structures in place or planned to be emplaced during the drift gillnet fishing season. The lessee must coordinate with the association to attempt to resolve and avoid any conflicts to the maximum extent practicable. Refer to the following:

- Cook Inlet Planning Area—Final Environmental Impact Statement for Lease Sale 244, Volume 1, Chapter 2, Section 2.6.1. Lease Stipulations, Stipulation No. 1—Protection of Fisheries: www.boem.gov/Cook-Inlet-Lease-Sale-244-Final-EIS-Volume-1/
- Final Notice of Sale for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Final/
- Lease Stipulations for Cook Inlet Oil and Gas Lease Sale 244: www.boem.gov/Sale-244-FNOS-Stipulations/

F.6.3 Military Areas (GOM Region)

This lease stipulation has three sections: hold harmless, electromagnetic emissions, and operational. The hold harmless section serves to protect the U.S. Government from liability in the event of an accident involving a lessee and military activities. The electromagnetic emissions section requires the lessee and its agents to reduce and curtail the use of equipment emitting electromagnetic energy in certain areas. This reduces the impact of offshore oil and gas activities on military communications and missile testing. The operational section requires prior notification of the military when offshore oil and gas activities are scheduled within a military use area to assist in scheduling activities and to prevent potential conflicts. The operational section also requires the evacuation, upon the receipt of a directive from the BSEE Regional Director, of all personnel from all structures on the lease and the shutting in and securing of all wells and other equipment, including pipelines, on the lease. Refer to the following:

- NTL No. 2014-G04—Military and Water Test Areas: /www.boem.gov/BOEM-NTL-No-2014-G04/
- JOINT NTL No. 2009-G26—U.S. Air Force Communication Towers: www.boem.gov/Regulations/Notices-To-Lessees/2009/09-G26.aspx

Additional stipulations are applied to leases in the Eastern GOM Planning Area only. In cooperation with the U.S. Air Force, defined periods for conducting exploratory drilling operations (“drilling windows”) in the active leases east of the Military Mission Line are established. These drilling windows allow military operations to proceed without being disrupted by oil and gas activities and provides defined periods to safeguard drilling and lease operations.

F.7 SHALLOW HAZARDS REQUIREMENTS (ALL PLANNING AREAS)

These stipulations require a lessee to conduct an analysis of seafloor and subsurface geologic and man-made hazards of all areas considered for production platforms and pipelines. Hazards analysis is the process of identifying and evaluating conditions that may affect the safety of proposed operations or conditions that may be affected by the proposed operations. Potentially hazardous shallow conditions, features, or processes include seismicity, subsurface faults, fault scarps, shallow gas, steep-walled canyons and slopes, buried channels, current scour, migrating sedimentary bedforms, ice gouging, permafrost, gas hydrates, unstable soil conditions, pipelines, anchors, ordnance, shipwrecks, and other geological or man-made features.

The stipulations and various NTLs provide guidance for how to perform shallow hazards geophysical surveys, evaluations, and reporting procedures for the appropriate OCS region. Refer to the following:

- NTL No. 05-A01—Shallow Hazards Survey and Evaluation for OCS Exploration and Development Drilling: www.boem.gov/Regulations/Notices-To-Lessees/2005/05-a01.aspx
- NTL No. 05-A02—Shallow Hazards Survey and Evaluation for Alaska OCS Pipeline Routes and Rights-of-Way: www.boem.gov/Regulations/Notices-To-Lessees/2005/05-a02.aspx
- NTL No. 2008-G05—Shallow Hazards Program: www.boem.gov/NTL-No-2008-G05/

F.8 INFORMATION TO LESSEES (ITL)

ITLs are formal documents used to communicate additional information or clarification of OCS standards and regional requirements to bidders during a lease sale. BOEM and BSEE may use ITLs to communicate with lessees and operators about new environmental, social, or cultural concerns and related mitigation.

F.9 OTHER PROTECTIVE MEASURES APPLIED THROUGH LAWS AND REGULATIONS (ALL PLANNING AREAS)

Other protective measures applied through laws and regulations could reduce potential impacts on resources as analyzed in the Draft Programmatic EIS. BOEM assumes OCS activities will occur in compliance with all laws, regulations, and associated protective measures. The following is a list of measures commonly applicable to the resource areas analyzed in this Draft Programmatic EIS. For more information on the related laws and regulations, see **Appendix H**.

- National Ambient Air Quality Standards as required by the Clean Air Act where USEPA has air quality jurisdiction, and BOEM does not
- Prevention of Significant Deterioration Program for air pollutant concentrations where USEPA has air quality jurisdiction, and BOEM does not
- National Pollutant Discharge Elimination System permitting as administered by the USEPA
- Liability and compensation for oil spill-related damages as required by the Oil Pollution Act and administered by the U.S. Coast Guard

- Mitigation measures, as applied through ESA consultations with U.S. Fish and Wildlife Service and the NMFS, are designed to ensure the protection of endangered or threatened species and their designated critical habitat. Examples of protective measures for OCS oil and gas activities include (but are not limited to) the following:
  - Pre-activity survey requirements
  - Activity ramp-up procedures
  - Vessel speed restrictions
  - Activity exclusion zones
  - Seasonal and time-area closures
  - Protected species observers
  - Vessel distance restrictions
  - Flight restrictions
- Archaeological survey and mitigation as required by the National Historic Preservation Act and BOEM and BSEE regulations
- EFH conservation recommendations developed with NMFS and implemented by BOEM through Magnuson-Stevens Fishery Conservation and Management Act consultation

Appendix G: Oil Spill Estimates

The Bureau of Ocean Energy Management (BOEM) estimates the occurrence of offshore oil spills (small and large) using estimated oil production for each planning area, the source or assumed mode of transportation, and a spill rate constant.

A catastrophic discharge event (CDE) references a very large—but very unlikely—spill that could result from Outer Continental Shelf (OCS) exploration, development, and production activities involving rigs, facilities, pipelines, tankers, or support vessels. A CDE is not considered part of the 2023–2028 Program or development scenarios because of its low probability of occurrence and the many factors that determine the severity of potential impacts. For further analysis of the impacts of a low-probability CDE, see *Catastrophic Spill Event Analysis* (BOEM 2017b), *Beaufort Sea: Hypothetical Very Large Oil Spill And Gas Release* (BOEM 2020), and the *2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* (BOEM 2018a).

Historical OCS spill data provide the most relevant basis for use in estimating the number of future oil spills. Spill rates are calculated using spill data and the volume of annual oil production from 1974 to 2015 (ABS Consulting Inc 2016) (**Tables G-1 and G-2**). Spills from platforms are assumed to occur within or adjacent to planning areas. Spills from pipelines are assumed to occur along their respective routes from production platform to destination. For additional information on accidental oil spills, including CDEs, see *2019–2024 National Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program* (BOEM 2018a), *Catastrophic Spill Event Analysis* (BOEM 2017b), and *Liberty Development and Production Plan Final Environmental Impact Statement* (BOEM 2018b).

Table G-1. Estimated number of accidental spills that could occur from the 2023–2028 Program

Region or Volume	Planning Area	Large[a] ≥ 1,000 bbl Platform	Large[a] ≥ 1,000 bbl Pipeline	Small < 1,000 bbl	Small < 1,000 bbl
Assumed spill volume (bbl)	Any	3,283	3,750	≥ 1 to < 50	≥ 50 to < 1,000
Alaska	Beaufort Sea	0–1	0–3	0–283	0–53
	Chukchi Sea	0–1	0–5	0–424	0–79
	Cook Inlet	0–1	0–1	16–52	3–10
	Gulf of Alaska	0–1	0–1	4–31	1–6
Pacific	Washington/Oregon	0–1	0–1	0–4	0–1
	Northern California	0–1	0–1	0–14	0–3
	Central California	0–1	0–1	9–21	2–4
	Southern California	0–1	0–1	7–89	0–11
Gulf of Mexico (GOM)	Western, Central, and Eastern GOM	0–2	1–7	45–574	8–107
	Central/Eastern GOM[b]	0–1	0–1	4–54	0–10
Atlantic	South Atlantic	0–1	0–1	0–41	0–8
	Mid-Atlantic	0–1	0–1	0–86	0–16
	North Atlantic	0–1	0–1	0–38	0–7

[a] A large spill is defined as ≥ 1,000 bbl. Large spills are reported separately for platforms and pipelines. Four platform spills ≥ 1,000 bbl occurred from 1974–2015, including the *Deepwater Horizon* oil spill and 16 pipeline spills. The ongoing Taylor Energy oil spill was not included in the ABS Consulting Inc (2016) report but will be included in future spill rate updates.
[b] This area includes only portions of the Central and Eastern GOM Planning Areas within the Gulf of Mexico Energy Security Act moratorium.
Notes: bbl = barrel(s)
Planning areas not listed in the table have spill estimates < 1.
Spills from tankers carrying oil from OCS production were not included in this table because spill estimates are < 1.
Source: ABS Consulting Inc (2016)

Table G-2. Spill rates and sizes for different spill classes

Description of Spill Class	Spill Rate (spills/Bbbl)	Median Spill Size (bbl)[a]	Source of Spill Rate	Source of Spill Size
Platform spills ≥ 1,000 bbl	0.22	3,283	ABS Consulting Inc (2016)	ABS Consulting Inc (2016)
Pipeline spills ≥ 1,000 bbl	0.89	3,750	ABS Consulting Inc (2016)	ABS Consulting Inc (2016)
Platform spills 1–50 bbl	75.64	25	ABS Consulting Inc (2016)	Calculated[b]
Platform spills 50–1,000 bbl	14.13	525	ABS Consulting Inc (2016)	Calculated[b]

[a] Rounded to the nearest hundred barrel; [b] Calculated from ABS Consulting Inc (2016)
Notes: Bbbl = billion barrels, bbl = barrel(s)

SPILL RESPONSE

The Bureau of Safety and Environmental Enforcement (BSEE) is tasked with a number of oil spill planning and response duties and planning as required by the Oil Pollution Act of 1990. Within BSEE, the Oil Spill Preparedness Division addresses all aspects of offshore oil spill prevention, planning, preparedness, and response. More information about the Oil Spill Preparedness Division can be found on BSEE's website at www.bsee.gov/what-we-do/oil-spill-preparedness.

For more than 25 years, BSEE and its predecessors have maintained a comprehensive long-term research program to improve oil spill response knowledge and technologies. The focus of the program is to improve the methods and technologies used for oil spill detection, containment, treatment, recovery, and cleanup. The BSEE Oil Spill Response Research Program is a cooperative effort bringing together funding and expertise from research partners in state and Federal Government agencies, industry, academia, and the international community. The funded projects cover numerous spill-response-related issues, such as chemical treating agents; in situ burning of oil; research conducted at BSEE's Oil Spill Response Research and Renewable Energy Test Facility (Ohmsett); behavior of oil; decisionmaking support tools; mechanical containment; and remote sensing.

Recently awarded oil spill response research contracts can be found on BSEE's website at www.bsee.gov/what-we-do/research/oil-spill-preparedness/oil-spill-response-research.

Appendix H: Federal Laws, Executive Orders, and Secretary's Orders

The Bureau of Ocean Energy Management (BOEM) is required to comply with Federal laws, Executive Orders (EOs), and Secretary's Orders (SOs) when developing a National Outer Continental Shelf (OCS) Oil and Gas Leasing Program and Programmatic Environmental Impact Statement. Additionally, BOEM must consult with other Federal agencies that have the authority to govern and manage ocean resources pursuant to other Federal laws.

The Gulf of Mexico (GOM) Regional Office developed the *OCS Regulatory Framework* (Cameron Jr and Matthews 2016) to serve as an appendix in BOEM National Environmental Policy Act (NEPA) documents. *OCS Regulatory Framework* describes Federal laws and EOs in place as of March 2016; it is hereby incorporated by reference and available at www.boem.gov/OCS-Regulatory-Framework/.

EOs and SOs that have been issued after the 2016 *OCS Regulatory Framework* and that are relevant to the National OCS Program are presented below.

EO 13751: Safeguarding the Nation from the Impacts of Invasive Species

On December 5, 2016, President Obama signed EO 13751 to serve as an amendment to EO 13112, *Invasive Species*, signed February 3, 1999, and direct actions to continue coordinated Federal prevention and control efforts related to invasive species. This order maintains the National Invasive Species Council (Council) and the Invasive Species Advisory Committee; expands the membership of the Council; clarifies the operations of the Council; incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species; and strengthens coordinated, cost-efficient Federal action.

EO 13990: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis

On January 20, 2021, President Biden signed E. 13990, directing a review of certain national monument boundaries; restoring Arctic withdrawals established in EO 13754 and the Presidential Memorandum of December 20, 2016; directing Federal agencies to realign their policies, research, and analyses towards addressing climate change; and (among other actions) revoking EO 13766, EO 13778, EO 13783, EO 13792, and EO 13795.

EO 14008: Tackling the Climate Crisis at Home and Abroad

On January 27, 2021, President Biden signed EO 14008, reengaging the U.S. with international efforts to address climate change, including rejoining the Paris Agreement. In combination with EO 13990, this order directs a government-wide approach to addressing the climate crisis, calls for a greater emphasis on environmental justice when addressing climate change, and directs the Secretary of the Interior to conduct a comprehensive review of Federal oil and gas leasing and permitting practices.

SO 3398: Revocation of Secretary's Orders Inconsistent with Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis

SO 3398, signed April 16, 2021, was issued to implement the review of U.S. Department of the Interior actions as directed by EO 13990 and revokes the following secretarial orders: 3348; 3349; 3350; 3351; 3352; 3354; 3355; 3358; 3360; 3380; 3385; and 3389. This order is intended to improve the internal management of the Department.

SO 3399: Department-Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process

SO 3399, signed on April 16, 2021, was issued to (1) establish a Climate Task Force with the goal of reducing climate pollution, improve adaptation and resilience to climate change, address environmental justice, protect public health, and conserve department lands, (2) restore transparency and integrity to the department's decisionmaking process, including changes to the department's approach to greenhouse gas emissions, climate impacts, Tribal consultations, and environmental justice in NEPA documents.

Appendix I: Potential Exclusions in Withdrawn Areas

This draft programmatic environmental impact statement (Draft Programmatic EIS) analyzes all planning areas and potential exclusions included in the Draft Proposed Program (DPP) (BOEM 2018a). Many of the potential exclusions included in the DPP (**Table I-1**) are within areas later withdrawn under Section 12(a) of the Outer Continental Shelf (OCS Lands Act, 43 U.S.C. § 1341(a). This appendix provides the analysis of potential exclusions that fall within withdrawn areas. Analysis of potential exclusions from areas available for leasing under the 2023–2028 Program can be found in **Section 4.5**.

Table I-1. Areas analyzed as potential exclusions in this Draft Programmatic EIS

Region	Area	Included in a Withdrawal*	DPP Subarea Option	Analysis Location
Alaska	Chukchi Sea Subsistence Use Area	✔	✔	Appendix I
Alaska	15-mi Chukchi Sea coastal buffer	✔	-	Appendix I
Alaska	25-mi Chukchi Sea coastal buffer	✔	✔	Appendix I
Alaska	50-mi Chukchi Sea coastal buffer	✔	-	Appendix I
Alaska	Hanna Shoal	✔	✔	Appendix I
Alaska	Expanded Hanna Shoal	✔	-	Appendix I
Alaska	Barrow Whaling Area	✔	✔	Appendix I
Alaska	Expanded Barrow Whaling Area	✔	-	Appendix I
Alaska	Barrow Canyon Biologically Focused Area (BFA)	Partial	-	Section 4.5
Alaska	Harrison Bay BFA	Partial	-	Section 4.5
Alaska	Cross Island BFA	-	-	Section 4.5
Alaska	Camden Bay BFA	✔	-	Appendix I
Alaska	Kaktovik Whaling Area	✔	✔	Appendix I
Alaska	Kaktovik Bowhead Whaling Area	✔	-	Appendix I
Alaska	Kaktovik BFA	✔	-	Appendix I
GOM	Topographic Features and Pinnacle Trend Stipulations	-	-	Section 4.5
GOM	Baldwin County buffer	-	✔	Section 4.5
GOM	50-, 75-, 100-, 125-mi Eastern GOM coastal buffers	✔	✔	Appendix I
Atlantic	25-nmi Coastal Buffer	Partial	✔	Section 4.5
Atlantic	Biodiversity Strip	Partial	-	Section 4.5
Atlantic	Gulf of Maine	-	-	Section 4.5
Atlantic	Georges Bank	-	-	Section 4.5
Atlantic	Atlantic canyons	-	✔	Section 4.5

* Areas included in a withdrawn area are not available for leasing.
Note: Areas that fall completely within a withdrawn portion of the OCS are analyzed in this appendix.

POTENTIAL EXCLUSIONS IN THE ALASKA REGION

In Alaska, a number of potential exclusions overlay geologic plays in the Chukchi Sea and Beaufort Sea Planning Areas but fall entirely within withdrawn areas (**Table I-2**).

Table I-2. Potential exclusions that fall entirely within withdrawn portions of the OCS that overlay geologic plays in the Alaska Region

Exclusions	Exclusion Size (Million Acres)	Planning Area Acreage (Million Acres)	Percent Planning Area Acreage (Size/Planning Area Acreage)	Number of Geologic Plays Overlapping Exclusion
Chukchi Sea Planning Area	-	-	-	-
Subsistence Use Area*	2.4	62.6	3.9%	7
15-mi coastal buffer	3.5	62.6	5.5%	12
25-mi coastal buffer*	6.6	62.6	10.6%	12
50-mi coastal buffer	13.0	62.6	20.8%	18
Hanna Shoal*	1.6	62.6	2.6%	11
Expanded Hanna Shoal	6.5	62.6	10.4%	15
Beaufort Sea Planning Area	-	-	-	-
Barrow Whaling Area*	0.23	65.1	0.4%	5
Expanded Barrow Whaling Area	0.5	65.1	0.7%	5
Camden Bay BFA	0.13	65.1	0.2%	5
Kaktovik Whaling Area*	0.12	65.1	0.2%	2
Kaktovik Bowhead Whaling Area	0.7	65.1	1.0%	4
Kaktovik BFA	0.5	65.1	0.7%	2

* DPP Subarea Option

Chukchi Sea Planning Area

The potential exclusions considered in the Chukchi Sea Planning Area include the Chukchi Sea Subsistence Use Area, a coastal buffer (**Figure I-1**), and Hanna Shoal. The 2017–2022 Final Programmatic EIS (BOEM 2016d) provides additional analysis on the coastal buffer and Hanna Shoal. This analysis considers a range of coastal buffers: 15, 25, and 50 mi (24, 40, and 80 km). Although these areas are analyzed in this Draft Programmatic EIS, they are currently withdrawn under Section 12(a) of the OCS Lands Act.

Chukchi Sea Subsistence Use Area & Chukchi Sea Coastal Buffer (DPP Subarea Options)

Figure I-1 shows the location of a 25-mi coastal buffer and the Chukchi Sea Subsistence Use Area north of Utqiaġvik. The Chukchi Sea Subsistence Use Area was included as a subarea option for analysis in the DPP and encompasses high and medium subsistence use offshore areas where Alaska Native peoples from Utqiaġvik target whales, walrus, seals, and migratory waterfowl (Stephen R. Braund & Associates 2010).

The coastal buffer, also a DPP subarea option, overlaps with this area (**Figure I-1**), and the overlap increases with increasing buffer width. A 50-mi buffer almost subsumes the entire Chukchi Sea Subsistence Use Area; a buffer of this width would largely obviate the need to consider separately excluding the Subsistence Use Area. A 15-mi coastal buffer would also overlap this area, although to a considerably lesser extent. The nearshore areas of the Chukchi Sea Planning Area that are included in these potential exclusions contain important seasonal habitat for many species, including marine mammals and birds, as well as important subsistence use areas and spring ice lead systems (narrow, linear cracks in the ice that form when ice floes diverge). The Chukchi Sea coast includes haulouts for walrus, nearshore feeding areas for bearded and ringed seals, and designated critical habitat for polar bears (FWS 2010; Jay et al. 2012; Marine Mammal Commission 2018). Ledyard Bay southwest of Point Lay is designated critical habitat for the ESA-listed spectacled eider. A coastal buffer of 15 mi (24 km) or more would afford protection to these species and their habitats.

Many studies highlight the ecological importance of Chukchi Sea coastal waters. Kuletz et al. (2015) identified "hotspots" for marine mammals and seabirds all along the Chukchi Sea coast. Hauser et al. (2014) identified core areas for the Eastern Chukchi Sea stock of beluga whales offshore of Utqiaġvik and off Kasegaluk Lagoon during July and August. A coastal buffer out to 50 mi (80 km) overlaps important feeding habitat for gray whales and the spring migration route for beluga and bowhead whales (Clarke et al. 2017). Wilson et al. (2014) identified areas of expected preferential use for non-denning polar bears within the southwestern portion of the coastal buffer and expanding slightly beyond it, noting that use is most likely to occur during periods of sea ice retreat and expansion. Areas of high benthic biomass are located offshore Point Lay from Ledyard Bay to Kasegaluk Lagoon, offshore Utqiaġvik and northwest of Wainwright. **Figure I-1** shows hotspot locations of walrus, beluga, and bowhead whales based on distribution and abundance data collected by aerial surveys These three species are not only ecologically important in this area but also important species for subsistence activities. The persistent hotspot maps represent detected hotspots through time (2000–2019). Each cell on the map provides a probability of detecting a species-specific hotspot through time at a specific location bounded by each individual cell. The Chukchi Sea coast and, to a lesser extent, the Chukchi Sea Subsistence Use Area continually attract elevated densities of multiple species.

Exclusion of a 25-mi coastal buffer would provide protection for the nearshore lead system, which many species transit during spring migration. Beluga and bowhead whales, walrus, and various seabird and sea duck species all use this area. Gray whales migrate up the coast later in the open-water season, and fin and humpback whales occur nearshore in the Chukchi Sea. Seals and polar bears use the lead system extensively while foraging in late winter and spring. A 50-mi coastal buffer would protect this same area and may reduce spatial conflict between industrial activities and subsistence activities, which tend to occur primarily within 35 to 50 mi (56 to 80 km) of shore. A 15-mi coastal buffer would reduce the area potentially impacted by oil and gas activity but may be less effective in protecting species and reducing space-use conflicts than a larger buffer.

Table I-2 provides more detail on the Chukchi Sea Subsistence Use Area and 25-mi coastal buffer, including the percent area and overlapping geologic plays, which encompass areas of high and medium petroleum potential. The portions of the Chukchi Sea Subsistence Use Area seaward of the 25-mi coastal buffer overlap almost entirely with medium resource potential areas. There are no historical or active leases in the Chukchi Sea Subsistence Use Area, and there are eight historical leases to the NNW of Point Lay within a 25-mi coastal buffer. A 50-mi coastal buffer would exclude more areas of high resource potential, as well as additional areas where leasing has occurred in the past; a 15-mi coastal buffer would exclude less of the potential hydrocarbon resource. A coastal buffer of 15 to 50 mi (24 to 80 km) from shore would cover places used by a distinct concentration of species and subsistence hunters within a relatively small footprint along the coast compared with the rest of the planning area (Stephen R. Braund & Associates 2010) (**Figure I-1**). Furthermore, medium to high resource potential would still be available in other parts of the planning area.

Hanna Shoal (DPP Subarea Option) and Expanded Hanna Shoal

The Hanna Shoal and Expanded Hanna Shoal exclusion areas host high benthic biomass and provide primary foraging habitat for walrus, gray whales, and various seabird species during the open-water season (Brueggeman 2009; Kuletz et al. 2015) (**Figure I-1**). Sea ice remnants grounded on the shoal remain after sea ice retreats from most of the shelf area into the summer, providing resting habitat for walrus and seals between foraging attempts. Walrus begin hauling out on land once the remnant ice melts. In recent low-ice years, as many as 35,000 walrus have been hauling out near Point Lay (also a persistent hotspot identified in **Figure I-1**) and traveling to Hanna Shoal to feed (Fischbach et al. 2016; Jay et al. 2012). In addition, bowhead whales migrate over Hanna Shoal from August to December (Quakenbush et al. 2013).

The Hanna Shoal and Expanded Hanna Shoal exclusion areas were identified largely to avoid or minimize impacts on the Pacific walrus, an important subsistence resource for Alaska Native communities along the Chukchi Coast. Walrus are benthic feeders. Activities that disturb the seafloor and impact the benthos, such as exploration drilling, may impact walrus by reducing available prey species, even if the activities are conducted when walrus are not present (**Section 4.1.6**).

Hanna Shoal and Expanded Hanna Shoal encompass high-use areas for walrus, as defined by foraging and occupancy use distributions from June through December (Jay et al. 2012). **Figure I-1** also shows numerous areas of persistent high density of walrus within the Hanna Shoal area and throughout portions of the Expanded Hanna Shoal, indicating that walrus are using this area consistently over time. The 40-m isobath roughly delineates the plateau of Hanna Shoal; however, positive effects of Hanna Shoal on the ecosystem extend beyond this feature. Persistent walrus foraging hotspots occur in portions of the Expanded Hanna Shoal exclusion area (**Figure I-1**), indicating that walrus respond to abundant benthic prey and feed in this area consistently over time. Results from walrus tagging studies conducted by USGS identified foraging and resting areas that corroborate with hotspots in **Figure I-1** (Clarke et al. 2017; Jay et al. 2012).

Exclusion of this area may avoid or minimize impacts on walrus and other species that use Hanna Shoal and Expanded Hanna Shoal, as well as those human communities that rely on subsistence use of these animals. Potential exclusion of this area may not align exactly with the areas shown in **Figure I-1**.

Additional analysis and public input prior to approval of a Final Program could help determine whether exclusion is appropriate and the extent of an exclusion area.

Table I-2 provides more detail on Hanna Shoal and Expanded Hanna Shoal, including the percent area and associated geologic plays implicated, which encompass substantial areas of high petroleum potential, especially with an expanded footprint. There are numerous historical leases in the Hanna Shoal and Expanded Hanna Shoal area.

Beaufort Sea Planning Area

Three potential exclusions in the Beaufort Sea Planning Area (**Figure I-2**) fall within areas currently available for leasing and are analyzed in **Section 4.5**. Six areas fall within withdrawn portions of the OCS and are analyzed in this appendix (**Figure I-3**) (**Table I-2**). These analyses are based on identification in the DPP, ecological importance, human use, and precedent for exclusion or deferral from leasing in previous oil and gas leasing programs. Excluding any of these areas from leasing would prevent access to hydrocarbon resources. These areas are all along the coast of the Beaufort Sea (**Figure I-3**):

- Barrow Whaling Area (DPP Subarea Option)
- Expanded Barrow Whaling Area
- Camden Bay BFA
- Kaktovik Area: Kaktovik Whaling Area (DPP Subarea Option), Kaktovik Bowhead Whaling Area, and Kaktovik BFA

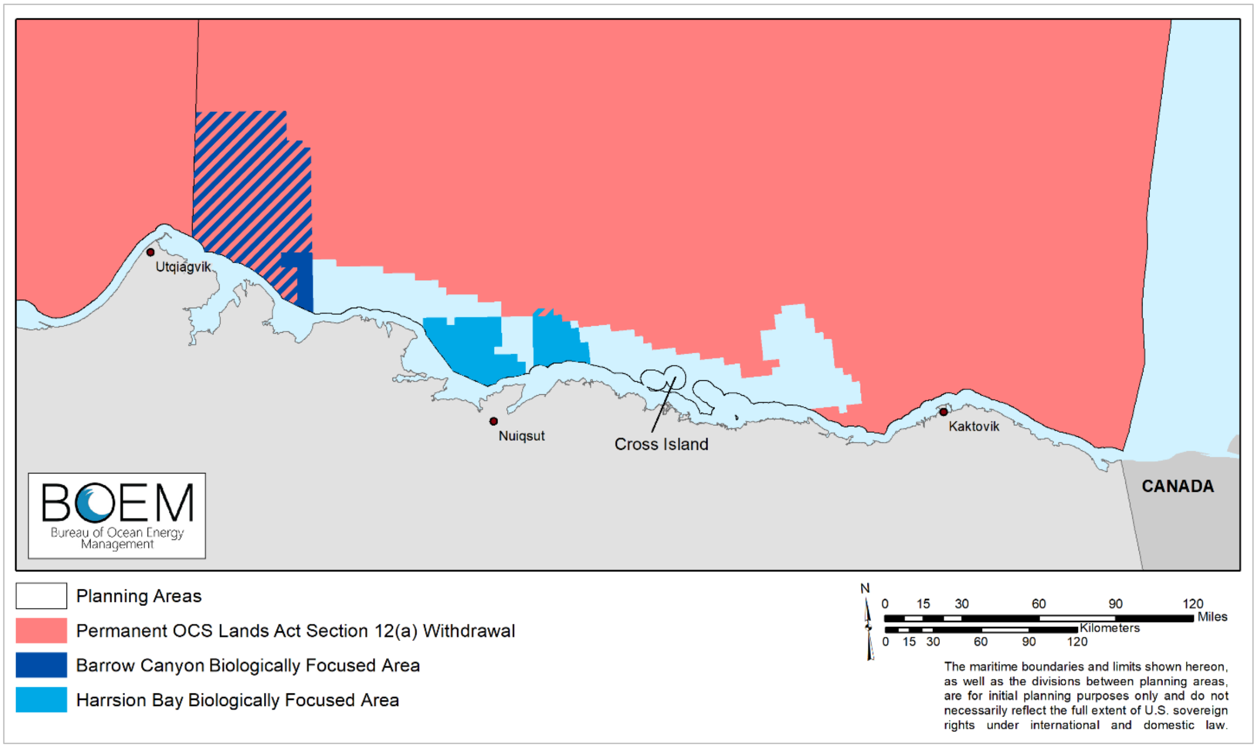

Figure I-2. In the Beaufort Sea Planning Area, locations of areas withdrawn from leasing under Section 12(a) of the OCS Lands Act, the Barrow Canyon BFA, and the Harrison Bay BFA

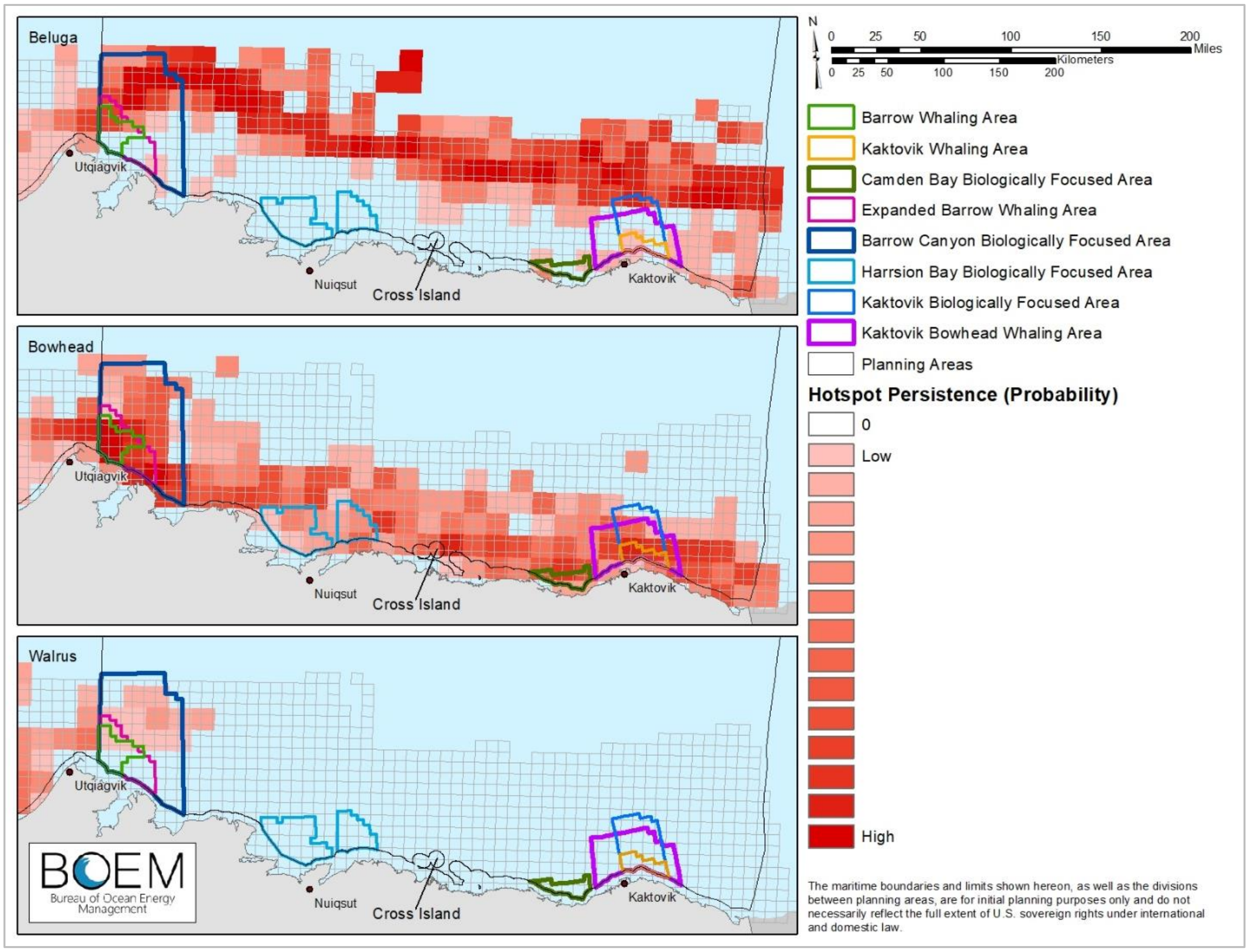

Figure I-3. Locations of potential exclusions in the Beaufort Sea Planning Area in relation to hotspots for bowhead whales, belugas, and walrus

Utqiaġvik (Barrow) Area (DPP Subarea Option)

Three potential exclusion areas overlap in the Beaufort Sea Planning Area north of Utqiaġvik (Barrow). Two of these, the Barrow Whaling Area and the Expanded Barrow Whaling Area, fall within withdrawn portions of the OCS. The third, the Barrow Canyon BFA is analyzed in **Section 4.5**. Excluding either or both of the Barrow Whaling Area and the Expanded Barrow Whaling Area may avoid or minimize impacts on subsistence hunting (particularly whaling) in the area—the smaller Barrow Whaling Area that was included in the DPP and a larger area called the Expanded Barrow Whaling Area. The residents of Utqiaġvik harvest, consume, and share substantial amounts of bowhead whale from these areas, which is critically important for villages along Alaska's northern coast. Whaling captains harvest 40–50 bowhead whales per year, providing 500–1,000 tons (454–907 metric tons) of meat to thousands of native people in the region and throughout the state (Alaska Eskimo Whaling Commission 2018). Bowhead whales use Beaufort Sea shelf waters consistently from year to year, especially within the Expanded Barrow Whaling Area (**Figure I-3**). Residents also harvest ringed and bearded seals in that area.

Exclusion of these two areas may avoid or minimize impacts on bowhead whale and other species that rely on the ecologically rich habitats around Utqiaġvik, as well as on those communities with cultural and subsistence practices that depend upon these animals. The Barrow Whaling Area represents a minimum area of subsistence use; the surrounding Expanded Barrow Whaling Area also captures important subsistence use. The Barrow Canyon BFA (analyzed in **Section 4.5**) is larger than these areas because it would include additional ecologically important areas where upwelling and high primary productivity from Barrow Canyon serve to congregate numerous species (**Figure I-3**).

The final exclusion areas, if any, may not align exactly with the areas described and shown in **Figure I-3**. Additional analysis and public input prior to approval of a Final Program could help define an appropriate exclusion area. Seasonal restrictions or other mitigation measures for activities near Utqiaġvik may reduce potential impacts in lieu of exclusion, although seasonal restrictions would not address impacts once production begins. **Table I-2** provides more detail on the Utqiaġvik (Barrow) Area, including the percent area and overlapping geologic plays, which encompass areas of high and medium petroleum potential. Areas of high petroleum potential are closer to shore, and there is historical leasing activity in both areas.

Kaktovik Area: Kaktovik Whaling Area (DPP Subarea Option), Kaktovik Bowhead Whaling Area, and Kaktovik BFA

Three potential exclusion areas overlap in the Beaufort Sea Planning Area north of Kaktovik (**Figure I-3**). These include two areas designed to avoid or minimize impacts on subsistence hunting, particularly whaling: the smaller Kaktovik Whaling Area (DPP Subarea Option), and a larger area called the Kaktovik Bowhead Whaling Area, which encompasses the smaller Kaktovik Whaling Area and includes much of the remaining core subsistence whaling area.

Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions. The region east of Kaktovik is an important feeding area for bowhead whales during the westward fall migration (Clarke et al. 2017). Whaling crews generally hunt bowhead within 10 mi (16 km) of shore but occasionally range to 20 mi (32 km) from the coast. Residents of Kaktovik also hunt seals and beluga whales in this area (Kofinas et al. 2015). Impacts from oil and gas development and related activities, such as seismic surveys or vessel noise, may impact the timing of migration, alter the migration routes, and/or disturb the feeding patterns of marine mammals.

The third potential exclusion near Kaktovik is the Kaktovik BFA (**Figure I-3**). This area extends north from the Kaktovik Whaling Area and captures important habitat for bowhead whales during their fall migration nearshore (Clarke et al. 2017). The eastern portion of the BFA overlaps with marine mammal “hotspots” identified by Kuletz et al. (2015) and in this analysis (**Figure I-1**). The BFA also includes waters used for subsistence hunting of bowhead whales (Wolfe 2013). The areas around Kaktovik are important habitats for birds, including brants, eiders, gulls, and loons (Drew and Piatt 2020; Smith et al. 2014). Polar bears have denned in the area for over a century and are expected to continue to use it despite expected changes in sea ice extent (Durner et al. 2009; Durner et al. 2010).

An exclusion in this area may protect marine mammals, polar bears, seals, seabirds, and benthic habitats from nearly all IPFs. Additional analysis and public input before approval of the 2023–2028 Program could help define the area's boundaries. **Table I-2** provides more detail on the Kaktovik Area, including the percent area and overlapping geologic plays, which encompass areas of primarily high petroleum potential. Leasing has previously occurred in all three Kaktovik potential exclusion areas.

POTENTIAL EXCLUSIONS IN THE PACIFIC REGION

There are no areas analyzed for potential exclusion in the Pacific Region. See **Section 4.5.2** for more information.

POTENTIAL EXCLUSIONS IN THE GOM REGION

Areas for potential exclusion in the GOM Region (**Table I-3, Figure I-4**) include areas subject to Topographic Features and Live Bottom lease stipulations, a Baldwin County buffer, and an Eastern GOM coastal buffer. The first two potential exclusions—Topographic Features and Live Bottom areas and a Baldwin County buffer—are analyzed in **Section 4.5**.

Table I-3. Potential exclusions that fall entirely within withdrawn portions of the OCS that overlay geologic plays in the GOM Region

Exclusion	Exclusion Size (Million Acres)	Planning Area Acreage (Million Acres)	Percent Planning Area Acreage (Size/Planning Area Acreage)	Number of Geologic Plays Overlapping Exclusion
50-mi Eastern GOM coastal buffer*	20.7	159.3	13.0%	7
75-mi Eastern GOM coastal buffer*	31.0	159.3	19.5%	12
100-mi Eastern GOM coastal buffer*	39.5	159.3	24.8%	13
125-mi Eastern GOM coastal buffer*	46.5	159.3	29.2%	13

* DPP Subarea Option

Exclusion areas associated with topographic and pinnacle trend features are shown in **Figure I-4**. Because these areas are relatively small and distributed throughout the Western and Central GOM Planning Areas, they are not included in this table.

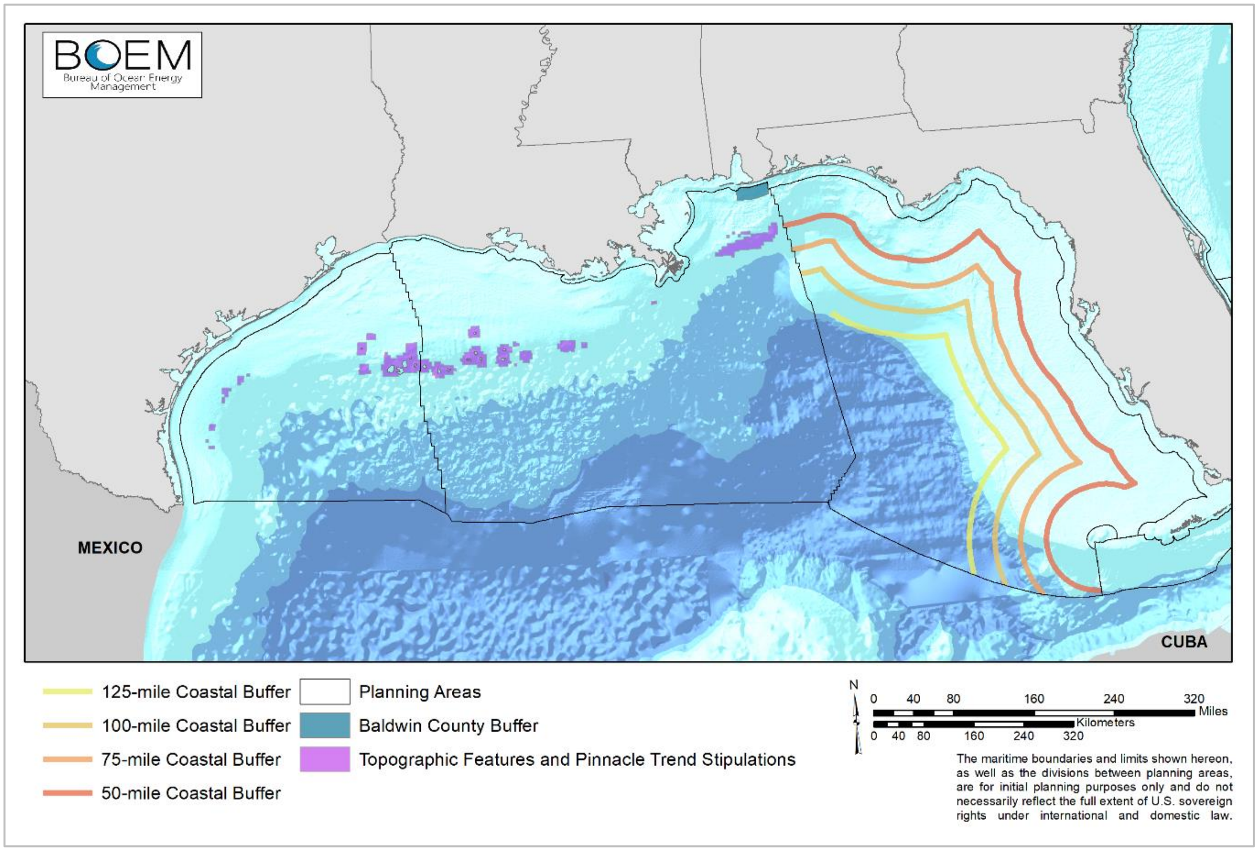

Figure I-4. Locations of potential exclusions in the GOM Region

Eastern GOM Coastal Buffer (DPP Subarea Option)[1]

Coastal buffers of 50, 75, 100, or 125 mi (80, 120, 160, 200 km) off Florida's Gulf Coast may directly protect coastal, offshore, and human resources that may be impacted by OCS oil and gas activities (**Section 2.8**).

The Eastern GOM provides important coastal and estuarine habitat for a wide variety of species, including numerous species that are ESA-listed and would receive greater protection from a buffer exclusion. The beaches in this area make up 90% of the nesting habitat for the ESA-listed Northwest Atlantic population of the loggerhead sea turtle (Ceriani and Meylan 2017). The ESA-listed Kemp's ridley sea turtle also uses this coastal habitat for nesting (Valverde and Holzward 2017). Staghorn and elkhorn coral, both ESA-listed species, have critical habitat that runs along the Straits of Florida and into the Eastern GOM. Shallow-water, coastal seagrass habitats along the coast are important habitat for ESA-listed sea turtles and the Florida subspecies of the West Indian manatee (Ward 2017). Furthermore, riverine and coastal habitats of Florida's Gulf Coast have critical habitat for anadromous species, including ESA-listed Atlantic shortnose and Gulf sturgeon and the smalltooth sawfish (**Appendix D**). Development on the coast may reduce essential dune habitat for ESA-listed beach mice. Barrier islands lining the west coast of Florida are key resting areas for migratory birds traveling the Atlantic Flyway.

Mangrove and wetland habitats are found along the west Florida Coast. These habitats serve important ecological functions, such as providing key habitat and protected nursery grounds for many commercially important fish species, and habitat for terrestrial fauna and birds. These habitats also play an important role in improving water quality in coastal areas and providing protection from storms (NOAA 2020d). Additionally, estuarine habitats along the Florida Coast serve as habitat for oysters, which are commercially and recreationally harvested.

The continental shelf of the Eastern GOM, particularly off west Florida, is wide and extends farther out than in other areas of the GOM. Most of the nearshore waters and waters extending out into the continental shelf are EFH for dozens of species of reef fish, multiple species of shrimp, spiny lobster, corals, coastal migratory pelagic species (e.g., fish such as mackerels), and several species of sharks (e.g., bonnethead, blacktip, nurse, blacknose, and bull) (NOAA 2020b). Shallower areas of the Eastern GOM—which include 2 NMSs, 1 National Research Reserve, and 10 NWRs—host high abundances of sessile invertebrates (e.g., corals, sponges, crinoids), demersal fishes (fish that live or feed near the bottom), and numerous protected species. The shelf has abundant calcareous sediment and ideal surface temperatures and salinity, which create optimal conditions for coral reef production (Hine et al. 2008). These shallow, hard bottom reefs occur as benthic features in depths less than 984 ft (300 m). Areas of the central West Florida Shelf, known as the "Sticky Grounds," include extensive hard bottom habitat that is important for benthic species and serves as EFH for reef fish and fisheries species (Locker et al. 2016). There are also areas of reef and banks HAPCs along other areas of the shelf, particularly toward the edge of the shelf off the southwestern Florida Coast.

[1] The vast majority of the Eastern GOM has since been withdrawn from consideration for leasing until June 2032.

A 50-mi coastal buffer may reduce or eliminate potential impacts on nearshore coastal and marine resources because it may avoid impacts related to oil and gas activities and limit other impacting factors, such as vessel traffic. A 75-mi coastal buffer option would include additional protection further out onto the shelf and would expand protection for resources in those areas. The West Florida Shelf and Florida Middle Grounds, which are distinct submerged features made of carbonate accretions serving as habitat for coral, would be included in the extended buffer (Hine et al. 2008). The DeSoto Canyon is critical habitat for loggerhead sea turtles, especially near the shelf edge (Mullin and Hoggard 2000), and is habitat for the ESA-listed Rice's whale. Rice's whale is unique to the Eastern GOM Planning Area and has a small, year-round population there (Hayes et al. 2018; NMFS 2016; Roberts et al. 2016). DeSoto Canyon and its resources would have more protection under an extended buffer. The 75-mi buffer also includes areas such as Steamboat Lumps and the Edges Marine Reserves west of the Florida Middle Grounds, which are essential areas for fish spawning.

In addition to the benefits listed in the 50-mi and 75-mi coastal buffers, a 100-mi coastal buffer would provide additional protection to marine habitat and associated resources. This buffer would extend protections into Atlantic bluefin tuna spawning areas, EFH for adults, and HAPCs for the species, which is important for this species because it already faces increasing challenges from climate change and other stressors. A 125-mi coastal buffer would extend further protection for Rice's whale habitat off the continental shelf break and expand coverage of key habitat and spawning areas for Atlantic bluefin tuna. Pulley Ridge Reef, a coral habitat to the west of the Florida Keys would also receive protection under this extended buffer.

Deeper waters of the Eastern GOM Planning Area contain many areas that provide ideal conditions for deepsea coral habitat, including those made up of stony corals, black corals, and soft corals like gorgonians. Black and soft corals are found at a range of depths that may receive some limited protection from a 50- or 75-mi buffer; however, additional protection would be more likely from a buffer that extends out further onto the shelf. Stony corals such as *Lophelia pertusa* are typically found in deeper waters and would receive the greatest protection from an Eastern GOM buffer that extends further than 100 mi (160 km). Recent models of 28 genera of habitat structure-forming sensitive deepwater corals have shown widespread predicted distribution throughout the continental shelf waters of the GOM, with the Eastern GOM containing particularly important coral habitat (**Figure I-5**). Different genera are found at varying depths, locations, and abundances throughout the Eastern GOM (**Figure I-5**). The 50- and 75-mi buffer options would offer protection for shallower water coral and hard bottom habitat, as well as some areas of deepwater habitats. The 100- and 125-mi buffer options would expand protection of those habitats that extend out further into the deeper water of the continental shelf, with the 125-mi buffer offering the greatest protection.

An Eastern GOM buffer option may reduce or eliminate potential impacts on recreation and tourism, which are dependent on beach nourishment from the OCS. A buffer would also protect vulnerable coastal communities from potential impacts from noise, traffic, emissions, lighting, visible infrastructure and space-use conflicts. Some of these communities rely on subsistence harvesting, including fishing and hunting.

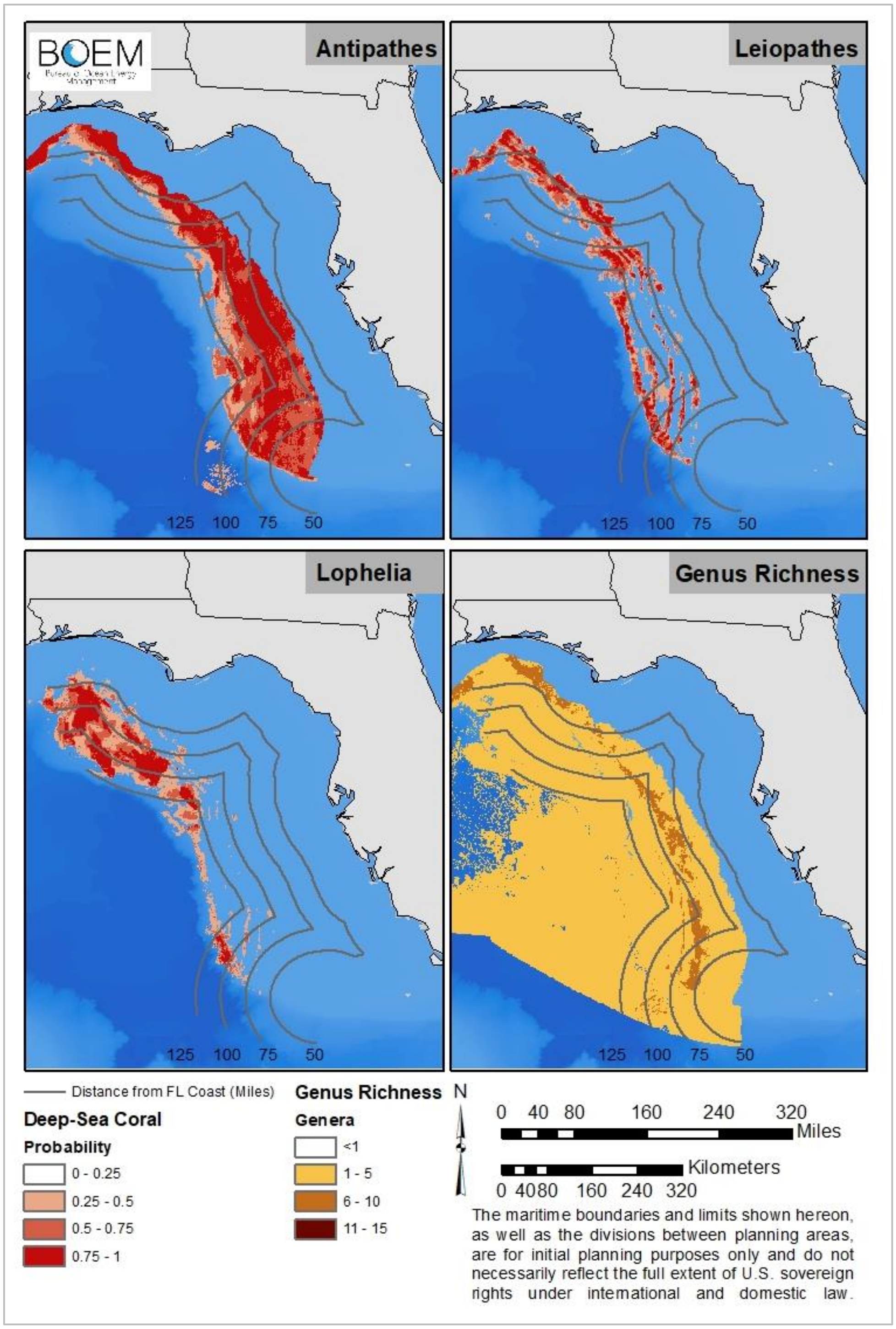

Figure I-5. Distributions of deepsea coral habitat-forming genera (*Antipathes*, *Leiopathes*, and *Lophelia*) and overall genus richness along potential Eastern GOM buffer exclusion areas

A coastal buffer may also reduce space-use conflicts between the oil and gas industry and commercial and recreational fisheries, military, shipping, and other uses. It is expected that many oil-and-gas-related activities that would be needed to support new OCS activities in the Eastern GOM Planning Area would take place in the Western and Central GOM Planning Areas, where such activities are already occurring.

Table I-3 shows the area of each buffer as a percentage of the total planning area, as well as the number of geologic plays that overlap each buffer option.

POTENTIAL EXCLUSIONS IN THE ATLANTIC REGION

None of the areas analyzed for exclusion in the Atlantic Region fall entirely within a withdrawn portion of the OCS. See **Section 4.5.4** for more information.

Appendix J: Relevant Environmental Studies Program Research

J.1 INTRODUCTION

Section 20 of the Outer Continental Shelf (OCS) Lands Act mandates scientific research to inform decisions on the development of energy and mineral resources on the OCS. Research topics of BOEM's Environmental Studies Program (ESP) include physical oceanography, atmospheric sciences, biology, protected species, social sciences and economics, submerged cultural resources, and environmental fates and effects. The ESP-funded studies included in this appendix informed the National OCS Oil and Gas Leasing Program Draft Programmatic Environmental Impact Statement analysis. All studies are available online at www.boem.gov/studies.

J.2 RESOURCES

Air Quality

Brashers et al. 2015-049: Arctic air quality modeling study meteorological model performance evaluation: 2009-2013 BOEM Arctic WRF dataset

Davis-Noland et al. 2009-055: Synthesis, analysis, and integration of meteorological and air quality data for the Gulf of Mexico Region Volume I: user's manual for the Gulf of Mexico air quality database (Version 1.0)

Davis-Noland et al. 2009-056: Synthesis, analysis, and integration of meteorological and air quality data for the Gulf of Mexico Region Volume II: technical reference manual for the Gulf of Mexico air quality database

Do et al. 2017-029: Arctic air quality modeling study; final near-field dispersion modeling report

Do et al. 2017-040: Arctic air quality modeling study; evaluation of the emissions exemption thresholds

Douglas et al. 2014-008: Synthesis, analysis, and integration of meteorological and air quality data for the Atlantic coast region

Douglas et al. 2009-057: Synthesis, analysis, and integration of meteorological and air quality data for the Gulf of Mexico Region Volume III: data analysis

Douglas and Hudischewskyj 2008-029: Five-year meteorological datasets for CALMET/CALPUFF and OCD5 modeling of the Gulf of Mexico (GOM) region

Douglas et al. 2009-058: Synthesis, analysis, and integration of meteorological and air quality data for the Gulf of Mexico Region Volume IV: CART analysis of modeling episode days

Duncan 2020-046: NASA resources to monitor offshore and coastal air quality

Fields et al. 2014-1001: Arctic air quality modeling study: emissions inventory - final task report

Li et al. 2020-015: A real-time ocean observing station off Timbalier Bay, Louisiana

MRS Environmental, Inc. 2019-016: Air emissions associated with decommissioning operations for Pacific Outer Continental Shelf oil and gas platforms; volume I: final report

MRS Environmental, Inc. 2019-016: Air emissions associated with decommissioning operations for Pacific Outer Continental Shelf oil and gas platforms; volume II: users guide for decommissioning emissions estimation for platforms (DEEP) tool and database

Simms et al. 2018-020: Arctic air quality impact assessment modeling study final project report

Snyder et al. 2019-071: Enhancing the capability of a new meteorological model for air quality and other BOEM applications in the Gulf of Mexico

Stoeckenius et al. 2016-076: Arctic air quality modeling study; final photochemical modeling report

Systems Applications International 95-0038: Gulf of Mexico air quality study, final report - Volume I: summary of data analysis and modeling

Systems Applications International 95-0039: Gulf of Mexico air quality study, final report - Volume II: data analysis, Appendices A-M

Systems Applications International 95-0040: Gulf of Mexico air quality study, final report - Volume III: inventory preparation, Appendices N-P

Thompson 2020-047: Evaluation of NASA's remote-sensing capabilities in coastal environments

Wilson et al. 2014-666: Year 2011 Gulfwide emissions inventory study

Wilson et al. 2017-044: Year 2014 Gulfwide emissions inventory study

Wilson et al. 2019-057: Air quality modeling in the Gulf of Mexico Region

Wilson et al. 2019-072: Year 2017 emissions inventory study

Water Quality

Bemis et al. 2013-208: Determining the potential release of contaminants into the marine environment from Pacific OCS shell mounds

Boehm et al. 2001-011: Deepwater program: literature review, environmental risks of chemical products used in Gulf of Mexico deepwater oil and gas operations, Volume I: technical report

Bothner et al. 86-0102: Analysis of trace metals in bottom sediments in support of deepwater biological processes studies on the U.S. Mid-Atlantic continental slope and rise. Final report

Brocklehurst et al. 1989: Effects of petroleum contaminated waterways on migratory behavior of adult pink salmon

Brodersen et al. 1983: Effects of oiled sediment on juvenile king crab

Brown 2010-004: cANIMIDA Task 2, hydrocarbon and metal characterization of sediments in the cANIMIDA study area

Bushdosh et al. 1980: California commercial and sports fish oil toxicity study impact assessment report

Cameron and Smith 1977: Acute effects, Pacific herring roe in the Gulf of Alaska

Capuzzo 1982-30: Crude oil effects to developmental stages of the American lobster, final report

Carroll et al. 2016-020: An analysis of the impacts of the *Deepwater Horizon* on the seafood industry

Crecelius et al. 2007-061: Study of barite solubility and the release of trace components to the marine environment

Dasher et al. 2017-072: Alaska monitoring and assessment program 2015 National Petroleum Reserve - Alaska estuary survey

Foley et al. 1983: California commercial/sport fish and shellfish oil toxicity study, Volume II: synthesis of findings

Johnsen et al. 1987: Effects of petroleum contaminated waterways on spawning migration of Pacific salmon: Phase 1, laboratory studies

Karinen et al. 1985: Reproductive success in dungeness crab (*Cancer magister*) during long-term exposures to oil-contaminated sediments

Kasper et al. 2017-032: Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA): contaminants, sources, and bioaccumulation; Executive Summary

Lakhini et al. 2018-048: Oil-spill occurrence estimators: fault tree analysis for one or more potential future Beaufort Sea OCS lease sales

Leigh et al. 2018-036: Fate and persistence of oil spill response chemicals in Arctic seawater

Leigh et al. 2020-033: Microbial biodegradation of Alaska North Slope crude oil and Corexit 9500 in the Arctic marine environment

Luyendyk et al. 2003-054: A methodology for investigation of natural hydrocarbon gas seepage in the northern Santa Barbara Channel

MacDonald et al. 2017-030: Remote sensing assessment of surface oil transport and fate during spills in the Gulf of Mexico

McCarthy et al. 2016-078: Evaluating Chukchi Sea trace metals and hydrocarbons in the Yukon River delta, Alaska

Michel 2021-048: Oil spill effects literature study of spills of 500 to 20,000 barrels of crude oil, condensate, or diesel

Michel 2020-058: Oil spill effects literature study of spills of greater than 20,000 barrels of crude oil, condensate, or diesel

Myers et al. 2018-032: US Outer Continental Shelf oil spill causal factors report

Naidu et al. 2001-061: Historical changes in trace metals and hydrocarbons in the inner shelf sediments, Beaufort Sea: prior and subsequent to petroleum-related industrial developments

Naidu et al. 2011-031: Synthesis of time-interval changes in trace metals and hydrocarbons in nearshore sediments of the Alaskan Beaufort Sea: a statistical analysis

National Academy of Sciences 1983-15: Drilling discharges in the marine environment. Panel on assessment of fates and effects of drilling fluids and cuttings in the marine environment

Neff et al. 2009-037: cANIMIDA - Task 005: integrated biomonitoring and bioaccumulation of contaminants in the cANIMIDA study area

Payne et al. 1985-18: Georges Bank monitoring program: analysis of hydrocarbons in bottom sediments and analysis of hydrocarbons and trace metals in benthic fauna during the third year of monitoring

Rabalais 2005-044: Relative contribution of produced water discharge in the development of hypoxia

Rember et al. 2016-079: Distribution and behavior of select trace metals in Beaufort Sea ice

Roberts et al. 2018-006: US Outer Continental Shelf oil spill statistics

Robertson et al. 2020-050: Oil spill occurrence rates from Alaska North Slope oil and gas exploration, development and production

Robertson et al. 2020-051: Oil spill occurrence rates for Cook Inlet, Alaska oil and gas exploration, development, and production

Schiewer 2015-041: Biodegradation and transport of crude oil in sand and gravel beaches of Arctic Alaska

Stalfort et al. 2021-065: Alternative oil spill occurrence estimators for determining rates for the Atlantic Outer Continental Shelf

Trefry et al. 2009-014: cANIMIDA Tasks 3 and 4: sources, concentrations, composition, partitioning and dispersion pathways for suspended sediments and potential metal contaminants in the coastal Beaufort Sea

Zhao 2017-042: Oil and dispersed oil-sediment interactions in the marine environment and impacts of dispersants on the environmental fate of persistent oil components

Pelagic Communities

Balcom et al. 2011-019: A comparison of marine productivity among Outer Continental Shelf planning areas

Berchok et al. 2015-034: Final report of the Chukchi Sea acoustics, oceanography, and zooplankton study

Iken et al. 2021-017: Initiating an Arctic Marine Biodiversity Observing Network (AMBON)

Johnson et al. 2021-049: Hydrodynamic modeling, particle tracking and agent-based modeling of larvae in the U.S. mid-Atlantic bight

Kelley 2021-018: High-frequency characterization of the physicochemical parameters of Cook Inlet, Alaska

Mocklin and Friday 2018-008: Chukchi Sea Acoustics, Oceanography, and Zooplankton Study: Hanna Shoal Extension (CHAOZ-X)

Okkonen 2008-010: Exchange between Elson Lagoon and the nearshore Beaufort Sea and its role in the aggregation of zooplankton

Scott et al. 2001-063: Spatial and temporal variability of plankton stocks on the basis of acoustic backscatter intensity and direct measurements in the northeastern Gulf of Mexico

Wiese et al. 2019-009: Marine ARctic Ecosystem Study (MARES): moorings on the Beaufort Sea shelf, 2016-2017

Wiese et al. 2020-029: Marine ARctic Ecosystem Study (MARES): moorings on the Beaufort Sea Shelf (2016-2018) and program synthesis

Marine Benthic Communities

Battelle and Woods Hole 1985-9: Georges Bank benthic infauna monitoring program. Executive summary report for three years of sampling. (July, 1981 - June, 1984)

Bartley et al. 2018-047: Benthic monitoring during wind turbine installation and operation at the Block Island Wind Farm, Rhode Island

Bartley et al. 2019-019: Benthic monitoring during wind turbine installation and operation at the Block Island Wind Farm, Rhode Island Year 2

Battista et al. 2019-069: Comprehensive seafloor substrate mapping and model validation in the New York Bight

Benfield and Kupchik 2020-022: Continuing and expanding a deepwater biological observation system in the northern Gulf of Mexico

Blank et al. 2017-032: Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA): contaminants, sources, and bioaccumulation

Brooks et al. 2009-046: Investigations of chemosynthetic communities on the lower continental slope of the Gulf of Mexico, interim report 2

Bryden and Butman 1983: Seasonal biological observations near the ocean bottom on the southern side of Georges Bank: December 1976 - September 1977

Bourque and Demopoulos 2019-033: Quantifying changes to infaunal communities associated with several deepsea coral habitats in the Gulf of Mexico and their potential recovery for the *Deepwater Horizon* oil spill

Carney 2016-058: Optimization of non-voucher Gulf of Mexico benthic fauna specimen archives with the U.S. Museum of Natural History

Coletti et al. 2017-045: Evaluation of nearshore communities and habitats in Lower Cook Inlet, Alaska

Collie et al. 2021-010: Spatial and temporal distributions of lobsters and crabs in the Rhode Island Massachusetts Wind Energy Area, 2018 update

Collins 2017-087: Crude oil infiltration and movement in first-year sea ice: Impacts on ice-associated biota and physical constraints

CSA Ocean Sciences, Inc. et al. 2019-066: Large submarine canyons of the United States Outer Continental Shelf atlas

Dunton et al. 2016-047: Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Hanna Shoal Ecosystem Study

Dunton et al. 2019-053: ANIMIDA III Boulder Patch and other kelp communities in development area

Foster et al. 2010-005: Evaluating a potential relict Arctic invertebrate and algal community on the west side of Cook Inlet

Gillett et al. 2019-050: Benthic infauna of the Southern California Bight continental slope: characterizing community structure for the development of an index of disturbance

Goddard and Love 2007-007: Megabenthic invertebrates on shell mounds under oil and gas platforms off California

Goyert et al. 2021-027: Characterizing spatial distributions of deep-sea corals and chemosynthetic communities in the US Gulf of Mexico through data synthesis and predictive modeling

Hawai'i International Environmental Services, Inc. 2016-059: Review of the long-term monitoring program and the associated data of the long-term monitoring program at the Flower Garden Banks National Marine Sanctuary

HDR 2020-019: Seafloor disturbance and recovery monitoring at the Block Island Wind Farm, Rhode Island; Summary report

Henkel et al. 2014-662: Benthic habitat characterization offshore the Pacific Northwest

Henkel et al. 2020-008: Cross-shelf habitat suitability modeling for benthic macrofauna

Hughes and Locker 2021-069: Identifying sensitive, hardbottom habitat in shallow Federal waters of the Gulf of Mexico: final report

Hutchison et al. 2020-044: Benthic and epifaunal monitoring during wind turbine installation and operation at the Block Island Wind Farm (BIWF), Rhode Island Project report

Iken and Dunton 2009-040: Long-term monitoring of the kelp community in the Stefansson Sound Boulder Patch: detection of change related to oil and gas development

Iken and Konar 2019-078: Nearshore food web structure on the OCS in Cook Inlet

Johnston et al. 2015-027: Long-term monitoring at the East and West Flower Garden Banks National Marine Sanctuary, 2011-2012, Volume 1: technical report

Johnston et al. 2017-058: Long-term monitoring at East and West Flower Garden Banks, 2013-2015, Volume 1: Technical Report

Jones et al. 2019-075: Assessment of nearshore communities and habitats: Lower Cook Inlet Nearshore Ecosystem 2015-2018

Konar 2012-011: Recovery in a high Arctic kelp community

Konar and Iken 2016-051: Testing the use of unmanned aircraft systems for intertidal surveys-proof of concept

Konar and Ravelo 2013-01148: Epibenthic community variability on the Alaskan Beaufort Sea continental shelf

Kruse and Glass 2014-659: Analysis of benthic communities on weathervane scallop beds in Shelikof Strait

Kuhnz et al. 2021-037: California deepwater investigations and groundtruthing (Cal DIG) I, volume 1: biological site characterization offshore Morro Bay

Lafferty et al. 2019-064: The response of kelp forest organisms to spatial and temporal variation in wave energy in the California Channel Islands

Maciolek-Blake et al. 1985-1: Georges Bank benthic infauna monitoring program. Final report for third year of sampling. Volume 1, final executive summary

Miner and Swearingen 2020-053: Multi-agency rocky intertidal highlights

Neff et al. 1989: Impacts of exploratory drilling for oil and gas on the benthic environment of Georges Bank

Poti et al. 2020-021: Cross-shelf habitat suitability modeling: characterizing potential distributions of deep-sea corals, sponges, and macrofauna offshore of the U.S. west coast

Precht et al. 2008-019: Post-hurricane assessment at the East Flower Garden Bank long-term monitoring site: November 2005

Prouty et al. 2019-034: Multidisciplinary assessment of deepwater coral ecosystems: tools to detect impacts of sub-lethal stress

Raimondi and Gaddam 2010-05: Multi-agency rocky intertidal network (MARINe) study of rocky intertidal communities adjacent to OCS activities - final report (2007-2010)

Rassweiler and Reed 2019-063: DOI partnership: distinguishing between human and natural causes of changes in nearshore ecosystems using long-term data from DOI monitoring programs

Roberts 2001-050: Improved geohazards and benthic habitat evaluations: digital acoustic data with ground truth calibrations

Ross et al. 2017-060: Exploration and research of mid-Atlantic deepwater hard bottom habitats and shipwrecks with emphasis on canyons and coral communities: Atlantic deepwater canyons study, volume I: final technical report

Rowe and Kennicutt 2009-039: Northern Gulf of Mexico continental slope habitats and benthic ecology study, final report

Sammarco 2013-216: Corals on oil and gas platforms near the Flower Garden Banks: population characteristics, recruitment, and genetic affinity

Sammarco 2013-217: Deepwater coral distribution and abundance on active offshore oil and gas platforms and decommissioned Rigs-to-Reefs platforms

Sammarco 2017-083: Genetic affinities in populations of the invasive Indo-Pacific coral *Tubastraea micranthus* on northern Gulf of Mexico platforms: multiple invasions?

Schroeder 2007-035: Seafloor characteristics and distribution patterns of *Lophelia pertusa* and other sessile megafauna at two upper-slope sites in the northeastern Gulf of Mexico

Strong et al. 2019-003: Sample strategy plan; Outer Continental Shelf (OCS) genomic sample strategy for the Bureau of Ocean Energy Management (BOEM) to archive OCS invertebrates

Tricas and Gill 2011-09: Effects of EMFs from undersea power cables on elasmobranchs and other marine species-final report

Walton et al. 2021-044: California deepwater investigations and groundtruthing (Cal DIG) I,volume 2: fault and shallow geohazard analysis offshore Morro Bay

Wiese et al. 2018-024: Marine Arctic Ecosystem Study; biophysical and chemical observations from glider and benthic surveys in 2016

Wooller et al. 2019-030: Identifying sources of organic matter to benthic organisms in the Beaufort and Chukchi Outer Continental Shelves

Vollenweider et al. 2016-066: Arctic coastal ecosystems: evaluating the functional role and connectivity of lagoon and nearshore habitats

Zarillo 2008-005: Biological characterization/numerical wave model analysis within borrow sites offshore of the west Florida Coast, Vol I

Coastal & Estuarine Habitats

LUMCON 1991: University research on the effects of offshore petroleum development in the Gulf of Mexico - nekton use of the marsh surface: a comparison between channelized and natural marshes

Johnson and Mahoney 2021-019: Measuring wave forces along Alaska's coastal sea ice

Park et al. 2018-037: Shorezone imaging and mapping along the Alaska Peninsula

Powell et al. 2015-045: Sediment characteristics and infauna of deltaic mudflats along the Alaskan Beaufort Sea

Proffitt 98-0018: Effects and management of oil spills in marsh ecosystems: a review produced from a workshop convened July 1996 at McNeese State University

Rozas 92-0066: A comparison of shallow-water and marsh-surface habitats associated with pipeline canals and natural channels in Louisiana salt marshes

Fish & Essential Fish Habitat

Chesney et al. 2019-077: Use of small shallow water oil and gas as reef habitat for fishes and fouling biota

Courtney et al. 2021-067: Ocean migration and behavior of steelhead kelts in Alaskan OCS oil and gas lease areas, examined with satellite telemetry

Frisk et al. 2019-074: Monitoring endangered Atlantic sturgeon and commercial finfish habitat use in the New York lease area

Grothues et al. 2021-036: Literature synthesis of NY Bight fish, fisheries, and sand features; volume 1: literature synthesis and gap analysis

Herman et al. 2021-026: Habitat use of oceanic manta rays (*Mobula birostris*) in the vicinity of marine mineral extraction activities

Holladay 2017-034: US-Canada transboundary fish and lower trophic communities; abundance, distribution, habitat and community analysis; database description

Hutchison et al. 2021-083: Electromagnetic field impacts on American eel movement and migration from direct current cables

Kazyak et al. 2020-062: Using advanced population genomics to better understand the relationship between offshore and spawning habitat use for Atlantic sturgeon

McKay et al. 2002-004: Proceedings: Gulf of Mexico fish and fisheries: bringing together new and recent research

Mueter et al. 2017-077: Arctic Ecosystem Integrated Survey final report on distribution of fish, crab, and lower trophic communities in the Northeastern Bering Sea and Chukchi Sea

Marsh et al. 2021-056: Model-based fish distributions and habitat descriptions for Arctic cod (*Boreogadus saida*), saffron cod (*Eleginus gracilis*) and snow crab (*Chionoecetes opilio*) in the Alaskan Arctic

Murphy 2007-042: Variation in the abundance of Arctic cisco in the Colville River: analysis of existing data and local knowledge: Vol II appendices

Norcross 2013-00118: Trophic links: Forage fish, their prey, and ice seals in the Northeast Chukchi Sea

Norcross et al. 2017-034: US-Canada transboundary fish and lower trophic communities; abundance, distribution, habitat and community analysis

Nowling et al. 2010-002: Proof of concept for platform recruited reef fish, phase 1: do platforms provide habitat for subadult red snapper?

Pembroke et al. 2013-300: Effects of noise on fish, fisheries, and invertebrates in the U.S. Atlantic and Arctic from energy industry sound-generating activities, workshop report

Pickens and Taylor 2020-002: Regional essential fish habitat geospatial assessment and framework for offshore sand features

Rutecki et al. 2015-012: Understanding the habitat value and function of shoal/ridge/trough complexes to fish and fisheries on the Atlantic and Gulf of Mexico Outer Continental Shelf. Final literature synthesis and gap analysis

Birds

Adams et al. 2020-006: Habitat affinities and at-sea ranging behaviors among Main Hawaiian Island seabirds: breeding telemetry, 2013-2016

Allison et al. 2009-020: Determining night-time distribution of long-tailed ducks using satellite telemetry

Arimitsu et al. 2021-031: Monitoring the recovery of seabirds and forage fish following a major ecosystem disruption in Lower Cook Inlet

Dugan 99-0069: Utilization of sandy beaches by shorebirds: relationships to population characteristics of macrofauna prey species and beach morphodynamics

Gordon 2011-048: New insights and new tools regarding risk to roseate terns, piping plovers, and red knots from wind facility operations on the Atlantic Outer Continental Shelf - final report

Hamer et al. 2014-013: Nocturnal surveys for ashy storm-petrels (*Oceanodroma homochroa*) and Scripps's murrelets (*Synthliboramphus scrippsi*) at offshore oil production platforms, southern California

Hollmén and Riddle 2016-064: Sensitivity to hydrocarbons and baselines of exposure in marine birds on the Chukchi and Beaufort Seas

Johnson et al. 1990-0028: Use of Kasegaluk Lagoon, Chukchi Sea, Alaska by marine birds and mammals, draft report of 1989-1990 studies

Johnson et al. 2011-047: Determining the potential effects of artificial lighting from Pacific Outer Continental Shelf (POCS) region oil and gas facilities on migrating birds

Kinlan et al. 2016-039: Modeling at-sea occurrence and abundance of marine birds to support Atlantic marine renewable energy planning Phase I report

Kuletz et al. 2017-004: Seabird distribution and abundance in the offshore environment

Labunski et al. 2017-011: Seasonality of seabird distribution in Lower Cook Inlet

Lamb et al. 2020-036: Ecological drivers of brown pelican movement patterns and reproductive success in the Gulf of Mexico

Leirness et al. 2021-014: Modeling at-sea density of marine birds to support renewable energy planning on the Pacific Outer Continental Shelf of the contiguous United States

Loring et al. 2018-046: Tracking movements of threatened migratory rufa red knots in U.S. Atlantic Outer Continental Shelf waters

Loring et al. 2019-017: Tracking offshore occurrence of common terns, endangered roseate terns, and threatened piping plovers with VHF arrays

Loring et al. 2019-017: Tracking offshore occurrence of common terns, endangered roseate terns, and threatened piping plovers with VHF arrays; appendices A-K

McCraken et al. 2006-040: Population genetic structure of common eiders nesting on coastal barrier islands adjacent to oil facilities in the Beaufort Sea, Alaska

O'Connell 2012-076A: Compendium of avian occurrence information for the continental shelf waters along the Atlantic coast of the United States, shorebird data section

O'Connell 2012-076B: Compendium of avian occurrence information for the continental shelf waters along the Atlantic coast of the United States: final report (database section seabirds)

Orr et al. 2013-0116: Evaluation of lighting schemes for offshore wind facilities and impacts to local environments

Paton et al. 2021-009: Assessing movements of birds using digital VHF transmitters: a validation study

Pelletier et al. 2013-01163: Information synthesis on the potential for bat interactions with offshore wind facilities

Powell 2005-057: Importance of the Alaskan Beaufort Sea to king eiders (*Somateria spectabilis*)

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J.3 EXCLUSIONS

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Appendix K: Glossary

This glossary provides the following definitions to explain how these terms are used in this specific document. Some terms may differ slightly from their commonly used definitions.

acoustic masking – occurs when the perception of one sound is obscured by the presence of another sound.

affected environment – areas and resources potentially impacted by the National Outer Continental Shelf Oil and Gas Leasing Program.

air pollutants – contaminants in the ambient air; may affect human health, crops and other vegetation, animals, man-made materials (such as buildings), and visibility.

air quality – condition of the ambient air.

anadromous fish – fish born in freshwater who spend most of their lives in saltwater and return to freshwater to spawn.

anthropogenic – coming from human sources; relating to the effect of man on nature.

archaeological interest – resource with the potential to provide understanding of past human behavior, cultural adaptation, or related topics.

archaeological resource – as defined in 30 CFR § 550.105 is material remains of human life or activities that are at least 50 years of age and of archaeological interest. In the marine environment, this term often refers to shipwrecks or submerged pre-contact period sites, as well as onshore historic resources. Archaeological resources are deemed significant when they meet the criteria of significance for eligibility for listing on the *National Register of Historic Places* as defined in 36 CFR 60.4.

attainment area – area classified by the U.S. Environmental Protection Agency as meeting the primary and secondary ambient air quality standards.

baleen whales – group of filter-feeding whales that use baleen plates in their mouth to prey on their small planktonic food (e.g., krill, forage fish, copepods).

barrel – standard unit of measure in the oil industry, equal to 42 U.S. gallons (159 liters).

benthic – bottom dwelling; associated with (in or on) the seafloor.

benthic environment – interface between water column and seafloor; does not include seafloor areas within the coastal environment.

benthos – organisms that dwell near, on, or in the seafloor.

birds – refers to the birds that spend at least part of their lives near the ocean, including species that live entirely at sea, migrate over parts of the sea, or live in coastal areas.

bivalves – general term for two-shelled mollusks (e.g., clams, oysters, scallops, mussels).

canyon – steep-sided valley cut into the seabed. Most marine canyons are on the edge of the continental slope and extend into the continental shelf.

cetacean – animals of the order Cetacea; includes whales, dolphins, and porpoises.

chemosynthetic communities – deepwater benthic communities that rely upon oxidation of various inorganic compounds rather than photosynthesis for primary production. These communities establish around natural oil and gas seeps and hydrothermal vents.

coastal and estuarine ecosystems – flora and fauna of areas at the land and ocean interface adjacent to the Outer Continental Shelf; does not include fish, sea turtles, birds, or marine mammals.

coastal environment – interface between land and sea, loosely bounded by the portions of the land and sea that are influenced by their proximity to each other.

coastal wetlands – area exposed to coastal waters, including forested and nonforested habitats, mangroves, and marsh islands. Forested wetlands include hardwood hammocks, cypress, tupelo, gum swamps, and fluvial vegetation or bottomland hardwoods. Nonforested wetlands include fresh, brackish, and salt marshes.

coastal zone – state land and water area officially designated in a state coastal zone program and approved by the U.S. Department of Commerce under the Coastal Zone Management Act; includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. Excludes areas managed by the Federal Government.

commercial and recreational fisheries – people and industries that rely on harvesting fish for their livelihood (commercial) or enjoyment (recreational).

continental margin – shallow-water area adjacent to a land mass. The continental margin contains the continental rise, continental slope, and continental shelf.

continental shelf (or shelf) – broad, gently sloping, shallow feature extending from the shore to the continental slope, generally considered to exist to the depth of 656 ft (200 m); the part of the continental margin between the continental shelf and the continental rise (or oceanic trench). See *Outer Continental Shelf* for the jurisdictional definition.

continental slope (or slope) – relatively steep, narrow feature paralleling the continental shelf; region in which the steepest descent to the ocean bottom occurs.

contingency plan – plan for possible offshore emergencies prepared and submitted by an oil or gas operator as part of the plan of development and production; also may be required for part of the plan of exploration.

criteria pollutant – any one of the six pollutants for which the U.S. Environmental Protection Agency has developed National Ambient Air Quality Standards under the Clean Air Act.

critical habitat – designated area under the Endangered Species Act as essential to the conservation of an endangered or threatened species and that may require special management considerations or protection.

crude oil – petroleum in its natural state as it emerges from a well or after it passes through a gas-oil separator, but before refining or distillation.

crustaceans – aquatic invertebrates with jointed legs, such as crabs, shrimp, lobster, barnacles, amphipods, and isopods.

culture – socialized pattern of human behavior and understanding, which can help define a "sense of place." Culture comprises population, major industries and exports, terrain, and ways of life closely tied to lands, waters, and natural resources, because these cultural aspects could be impacted by offshore oil and gas activities.

current conditions – present environmental conditions and trends resulting from past and present actions that may be affected by the Proposed Action or alternatives; includes national- and regional-level resources and trends.

deferral – action taken by the Secretary of the Interior at the time of the area identification to postpone all or certain areas from a lease sale.

development – activities conducted to produce minerals following discovery of minerals in paying quantities; includes geophysical activity, drilling, platform construction, and operation of onshore support facilities.

development and production plan – plan describing the specific work to be performed on an offshore lease, including all development and production activities that the lessee proposes to undertake during the time period covered by the plan up to and including the start of production; includes descriptions of facilities and operations to be used, well locations, current geological and geophysical information, environmental safeguards, safety standards and features, time schedules, and other relevant information. All lease operators are required to submit these plans to and obtain approval from the Bureau of Ocean Energy Management before development and production activities may begin; see requirements in 30 CFR 550.241–285. In the western Gulf of Mexico (areas on the Outer Continental Shelf in the Gulf of Mexico west of 87°30'W longitude), a similar plan is referred to as a Development Operations Coordination Document.

discharge – liquid, gas, or other substance that flows out from where it has been confined. Flow rate of a fluid at a given instant is expressed as volume per unit of time.

dispersion – distribution of finely divided particles in a medium.

distinct population segment (DPS) – smallest division of a taxonomic species permitted to be protected under the Endangered Species Act.

drilling mud – special mixture of clay, water or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the wellbore and to control downhole pressures that may be encountered; also called drilling fluid.

drillship – self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

economically recoverable reserves – portion of the identified oil or gas resources that can be extracted under current technological constraints.

ecoregion – areas differentiated by species composition and oceanographic features, such as bathymetry, hydrography, productivity, and trophic relationships.

eddy – swirling movement of water, counter to the main current, which causes a whirlpool-like motion. In the ocean, eddies often form at the edges of currents.

effluent – liquid waste of sewage and industrial processing.

El Niño-Southern Oscillation (ENSO) – irregular large-scale meteorological event that leads to changes in atmospheric and oceanic temperature and circulation, primarily affecting the tropics and subtropics, particularly around the Pacific Ocean.

endangered or threatened species – any species that is in danger of extinction throughout all or a significant portion of its range and has been officially listed by the appropriate Federal agency. A species is determined to be endangered (or threatened) under the Endangered Species Act based on any of the following factors: (1) present or threatened destruction, modification, or curtailment of its habitat or range; (2) over-utilization for commercial, sporting, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or man-made factors affecting its continued existence.

environmental assessment – concise public document required by the National Environmental Policy Act. In the document, a Federal agency proposing (or reviewing) an action provides evidence and analysis for determining whether it must prepare an environmental impact statement, which it must unless it finds there is no significant impact (i.e., Finding of No Significant Impact).

environmental impact (or **effect**) – measurable alteration or change in environmental conditions.

environmental impact statement (EIS) – statement required by the National Environmental Policy Act for a proposed major action significantly affecting the human environment.

essential fish habitat (EFH) – waters and substrate designated under the Magnuson-Stevens Fishery Conservation and Management Act as necessary to fish for spawning, breeding, feeding, or growth to maturity. Includes areas that are currently or historically used by fish, or that have substrate such as sediment, hard bottom, bottom structures, or associated biological communities required to support a sustainable fishery.

estuary – semi-enclosed coastal body of water that has a free connection with the open sea and within which seawater mixes with freshwater.

ethnographic – relating to the scientific description of cultures.

eutrophication – enrichment of water by excess nutrients, frequently due to runoff, which usually leads to excessive algae growth. This process also can lead to low oxygen levels in the water.

exclusion – action taken by the Secretary of the Interior to remove certain areas or blocks from inclusion within any lease sale scheduled in a national program.

Exclusive Economic Zone (EEZ) – maritime region adjacent to the territorial sea, extending 200 nmi (370 km) from the baseline of the territorial sea, in which the U.S. has exclusive rights and jurisdiction over living and nonliving natural resources.

exploration – process of searching for minerals. Exploration activities include (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the presence of such minerals; and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made, and the drilling, after such a discovery, of any additional well that is needed to delineate a reservoir and enable the lessee to determine whether to proceed with development and production.

exploration plan (EP) – plan submitted by a lessee (30 CFR 550.211–235) that identifies all the potential hydrocarbon accumulations and wells that the lessee proposes to drill to evaluate the accumulations within the lease or unit area covered by the plan. All lease operators are required to obtain approval of such a plan by a BOEM Regional Supervisor before exploration activities may commence.

exploratory well – well drilled in unproven or semi-proven territory for the purpose of ascertaining the presence of a commercially producible deposit of petroleum or natural gas.

fault – fracture between two zones of rocks.

fauna – animals of a particular region, habitat, or geological period.

fish – animals that live in water (whether fresh or saltwater) and use gills to breathe.

fixed or bottom founded – permanently or temporarily attached to the seafloor.

flyway – established air route of migratory birds.

formation – bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

front – boundary between two water masses that move in different directions.

frontier – areas with oil and gas resource potential that is highly uncertain or considerably lower than *mature* or *intermediate* areas, limited infrastructure in place, and highly uncertain leasing patterns.

future baseline conditions – condition of the affected environment over the next 40 to 70 years resulting from ongoing and future stressors; includes consideration of how the current conditions are expected to change over time.

geologic hazard – feature or condition that, if unmitigated, may seriously jeopardize offshore oil and gas exploration and development activities. Mitigation may necessitate special engineering procedures or relocation of a well.

geologic play – group of pools that share a common history of hydrocarbon generation, migration, reservoir development, and entrapment.

geophysical – of or relating to the physics of the Earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

geophysical data – facts, statistics, or samples that have not been analyzed or processed, pertaining to gravity, magnetic, seismic, or other surveys or systems.

geophysical survey – exploration of an area during which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

gyre – large system of circulating ocean currents.

habitat – specific place that is occupied by an organism, a population, or a community based on that place’s physical or biological components.

Habitat Area of Particular Concern (HAPC) – type of essential fish habitat (EFH) designated in areas that are considered to be high priority for conservation because of their importance to ecosystem function.

harassment – term used in the definitions of “take” in the Endangered Species Act and Marine Mammal Protection Act; generally meaning to injure or disturb.

haul-out area or **haulout** – specific locations where pinnipeds come ashore or on ice and concentrate in numbers to rest, breed, and/or bear young.

herbivore – animal whose diet consists of plant material.

highly migratory species – marine fishes that travel long distances and often cross domestic and international boundaries; includes species of tunas, sharks, swordfish, and billfish.

human environment – areas in which people reside, their cultures, and the ways in which they interact with the physical and biological environment.

hydrocarbon – any of a large class of organic compounds containing primarily carbon and hydrogen; comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons; and occurring, in many cases, in petroleum, natural gas, coal, and bitumens.

hypoxia – depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

ichthyoplankton – free-floating eggs and larvae of fish.

impact-producing factor (IPF) – activity or process that could cause impacts on environmental or socioeconomic resources.

important bird areas – areas identified using an internationally agreed set of criteria as being globally important for the conservation of bird populations.

incidental take – take of an Endangered Species Act-listed fish or wildlife species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted or authorized by a Federal agency or applicant (see *take*).

indirect effects – effects caused by activities that are stimulated by an action but are not directly related to the action.

information to lessees – information included in the Notice of Sale to alert lessees and operators of special concerns in or near a lease sale area or regulatory provisions enforceable by Federal or state agencies.

infrastructure – man-made structures and public works that facilitate industrial growth in the onshore, nearshore, and offshore environments (e.g., roads, ports, platforms).

intermediate – areas with oil and gas resource potential, but variation in existing infrastructure, leasing patterns, and operational barriers, such as water depth.

isobath – line on a map or imaginary line connecting all points having the same depth below the water's surface.

jack-up rig – barge-like floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water; a drilling platform with retractable legs that can be lowered to the sea bottom to raise the platform above the water.

land use – how communities use natural resources and infrastructure in their region.

landfall – site at which a marine pipeline comes to shore.

lithotope – area or surface of uniform sediment, sedimentation, or sedimentary environment, including associated organisms.

low frequency – acoustic waves with longer wavelengths or lower pitch; in this document, low frequency describes sounds with energy < 1 kHz (**Appendix B**).

macroalgae – multicellular algae, i.e., algae that can be seen with the naked eye (unlike phytoplankton).

macrofauna – invertebrates (at least 0.4 in [1 cm] in size) that live in or on the sediment or attached to hard surfaces; key components of marine benthic ecosystems.

macroinvertebrate – animals such as worms, clams, or crabs that are large enough to be seen without the aid of a microscope.

marine mammal – mammals that spend all or part of their lives in the ocean, including semi-aquatic mammals (such as seals, sea lions, walrus, sea otters, and polar bears) and fully aquatic mammals (such as manatees, baleen whales, and toothed whales).

marine sanctuary – area protected under the Marine Protection, Research, and Sanctuaries Act of 1972.

marshes – persistent, emergent, nonforested wetlands characterized by vegetation consisting predominantly of cordgrasses and rushes.

mature – areas with high potential for oil and gas resource development, access to existing infrastructure, and existing leases or established patterns of leasing.

minerals – mineral resources such as sand and aggregates, phosphates, manganese nodules, cobalt crusts, metal sulfides, and other marine mineral resources not including oil and gas that are found on the Outer Continental Shelf.

minority population – a readily identifiable group of people living in geographic proximity with a population that is 50% minority or greater. The population may be made up of one minority or a number of different minority groups; together the sum is 50% or more; or, a minority population may be an identifiable group that has a meaningfully greater minority population than the adjacent geographic areas, or may also be a geographically dispersed or transient set of individuals, such as migrant workers or Native American and Alaska Native peoples.

mitigation – actions, practices or rules that are used to reduce or eliminate environmental impacts on resources; including, but not limited to, government laws or statutes, regulatory restrictions, or best practices.

mixed layer – layer of the ocean in which active turbulence has mixed the water sufficiently so that it has relatively homogenous properties.

mollusks – animal phylum characterized by soft body parts; includes clams, mussels, snails, squid, and octopus.

natural gas – hydrocarbons that are in a gaseous state at standard atmospheric temperature and pressure.

nearshore waters – offshore open waters that extend from the shoreline out to the limit of the territorial seas (12 nmi [22 km]).

nonattainment area – area that is shown by monitoring data or air quality modeling calculations to exceed primary or secondary ambient air quality standards established by the U.S. Environmental Protection Agency.

oil spill contingency plan – plan submitted by the lease or unit operator (along with or prior to a submission of an exploration, development, or production plan) to detail provisions for fully defined specific actions to be taken following discovery and notification of an oil spill occurrence.

operator – person or company engaged in the business of drilling for, producing, or processing oil, gas, or other minerals and recognized by the Bureau of Ocean Energy Management as the official contact for the lease owners and responsible for the lease activities or operations.

organic matter – material derived from living plant or animal organisms.

Outer Continental Shelf (OCS) – submerged lands, subsoil, and seabed, lying between the seaward extent of the states' jurisdiction and the seaward extent of Federal jurisdiction.

pelagic communities – planktonic organisms that inhabit the water column of the open ocean.

pelagic environment – water column in open-water areas of the ocean, beyond the coast.

petroleum – an oily, flammable, bituminous liquid that occurs in many places in the upper strata of the Earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

physical environment – non-biological aspects of the Outer Continental Shelf and adjacent waters and lands (e.g., topography, currents, water, air).

phytoplankton – microscopic, free-floating, photosynthetic microalgae that drift passively in the water, e.g., diatoms, cyanobacteria, and dinoflagellates.

pinniped – aquatic carnivorous mammals (e.g., seals, sea lions, sea otters, walrus) with all four limbs modified into flippers.

plankton – passively floating or weakly motile aquatic plants and animals; usually refers to both phytoplankton (algae and plants) and zooplankton (animals).

planning area – administrative subdivision of the Outer Continental Shelf (OCS) used for planning in the National OCS Oil and Gas Leasing Program. The OCS comprises 26 planning areas.

platform – steel, concrete, or gravel structure from which offshore oil and gas wells are drilled.

population-level effect – impacts or consequences of activities that affect an entire population of a single species or multiple populations of species (e.g., changes to reproduction and fitness).

potential impact (or **potential effect**) – range of alterations or changes to environmental conditions that could be caused by an action.

primary production (or **primary productivity**) – production of carbon by a plant through photosynthesis over a given period of time.

produced water – total water produced from the oil and gas extraction process; may contain soluble and non-soluble organics, suspended and dissolved solids, and various chemicals used in the production process; can be discharged after treatment, reinjected, or treated and stored onshore.

production – activities for the removal of minerals, including removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and workover drilling.

program area – area within which one or more lease sales is proposed at any stage of National Outer Continental Shelf Oil and Gas Leasing Program development; a program area may include all of or portions of a Bureau of Ocean Energy Management planning area.

refining – fractional distillation, usually followed by other processing (e.g., cracking).

reserves – portion of the identified oil or gas resource that can be economically extracted.

reservoir – subsurface, porous, permeable rock body in which hydrocarbons have accumulated.

resources – something of value in the physical, biological, or human environments (e.g., air quality, marine mammals, commercial fisheries). When referring to the oil and gas industry, this term is also used to describe concentrations of naturally occurring materials that are currently or potentially extractable to produce energy.

rig – structure used for drilling an oil or gas well.

right-of-way – legal right of passage; easement; specific area of route for which permission has been granted to place a pipeline and ancillary facilities and for use in transportation.

rookery – nesting or breeding grounds of gregarious (i.e., social) birds or mammals; also a colony of such birds or mammals.

sale area – geographical area of the Outer Continental Shelf being offered for lease for the exploration, development, and production of mineral resources.

scoping – process prior to environmental impact statement preparation to determine the issues and alternatives to be addressed in the analysis for each proposed major Federal action.

sea turtles – turtles that spend most their lives at sea and come to shore only to lay eggs; upon hatching, young turtles immediately move back to the sea.

seagrass beds – mostly continuous mats of submerged, rooted marine flowering vascular plants occurring in shallow tropical and temperate waters.

sediment – naturally occurring material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

seeps (hydrocarbon) – gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes through connected porous rocks.

seismic – geophysical survey method that uses the principles of seismology to estimate the properties of the Earth's subsurface from reflected sound waves generated by a towed acoustic sound source.

sense of place – either the intrinsic character of a place, or the meaning and importance people give to it, or both.

shunting – method used in offshore oil and gas drilling activities where expended drill cuttings and fluids are discharged near the ocean seafloor rather than at the surface, as in the case of normal offshore drilling operations; mitigates impacts on biota at the surface.

spawn – fish or other non-mammalian species release or deposit their eggs and sperm to produce offspring.

stipulations – specific measures imposed upon a lease as conditions of sale. Stipulations are attached as a provision of a lease; they may apply to some or all tracts in a lease sale. For example, a stipulation could limit drilling to a certain time period of the year or certain areas within a lease.

stratification – formation of water layers based on salinity and temperature.

stressors – ongoing and future human activities or natural phenomena that could change the condition of the affected environment over the next 40 to 70 years. These stressors result from current, already planned, or reasonably foreseeable future actions and do not include activities associated with the 2023–2028 Program.

subsidence – gradual caving in or sinking of an area of land owing to subsurface movement of Earth materials.

subsistence uses – customary and traditional uses by residents of wild resources for personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handcraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; or for customary trade.

take – term defined under the Endangered Species Act and Marine Mammal Protection Act. The Endangered Species Act defines the term to mean to harass, harm, pursue, hunt, shoot, wound, kill, capture, or collect a threatened or endangered fish or wildlife species, or attempt to engage in any such conduct that disrupts normal behavior patterns. The Marine Mammal Protection Act classifies take as either Level A or Level B harassment.

thermocline – steep temperature gradient in ocean waters.

threatened species – see *endangered or threatened species*.

toothed whales – group of Odontocete whales (including dolphins, porpoises, and other whales) that have teeth and hunt live prey.

tourism – practice of traveling for recreation and engaging in activities such as wildlife viewing, hiking, hunting, camping, diving, sailing, sightseeing, and commercial cruises.

traditional knowledge – knowledge passed down through generations about the natural world, often involving subsistence resources.

trawl – large, tapered fishing net of conical shape, which typically is actively towed.

trophic – hierarchy of organisms from photosynthetic plants to carnivores in which organisms at one level are fed upon by those at the next higher level (e.g., phytoplankton eaten by zooplankton eaten by fish).

turbidity – reduced water clarity resulting from the presence of suspended matter.

upwelling – process in which deep, cold water rises to the surface.

vascular plants – plants possessing specialized food- and water-conducting structures.

viewshed – view of an area from a specific vantage point; extent of the view can vary depending on distance, height of object, elevation of viewer, and weather conditions (e.g., fog, haze, rain).

volatile organic compound (VOC) – any reactive organic compound that is emitted to the atmosphere as a vapor.

vulnerability – likelihood of being damaged by external influences; sensitivity within a system and resilience to recover from hazards and disasters.

vulnerable coastal communities – historically marginalized, low-income, or "minority" communities as defined by Executive Orders 12898 and 13175.

water quality – condition or environmental health of water, reflecting its particular biological, chemical, and physical characteristics and the ability of a waterbody to maintain the ecosystems it supports and influences.

weathering – aging of oil due to its exposure to the atmosphere and environment, causing marked alterations in its physical and chemical makeup.

wetlands – low-lying habitats where water accumulates long enough to affect the condition of the soil or substrate and promote the growth of water-tolerant plants.

zooplankton – animal plankton, mostly dependent on phytoplankton for its food source; small, free-floating animals that may be passive drifters or motile, and include fish larvae, small jellyfish, krill, copepods, amphipods, and pteropods.

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Appendix M: List of Preparers

BUREAU OF OCEAN ENERGY MANAGEMENT (BOEM)

Name	Education and Experience	Contribution
Tamara Arzt	J.D./M.P.A., ESA, NEPA, MMPA, and CZMA, Environmental Law and Policy; 20 years of experience working on a variety of national, state, and local environmental policy and legal issues	Cooperating Agency Coordination
Mark Belter	B.S., Biology (Marine); 12 years of experience in fish habitat restoration, fisheries research, and environmental impact assessment	Project Management Team
Kimberly Bittler	M.S., Marine Science; 6 years of experience in environmental science and policy	Stressors
Jennifer Bosyk	B.S., Biology; M.E.M., Coastal Environmental Management; 13 years of experience in environmental policy, conservation biology and impact assessment	Project Management Team, Exclusions
William Brown	B.A., M.A.T., Biology; J.D., Law; Ph.D., Zoology; 45 years of experience in diverse issues of environmental and cultural science, law, and policy	Project Direction and Review
Jennifer Bucatari	B.S., M.A., Ph.D., Marine Biology; 20 years of experience in marine ecosystems and impacts associated with oil in the marine environment	Writing Team for Affected Environment and Environmental Consequences; Potential Impacts from Oil Spills
Brandi Carrier	B.A., History; B.A., Sociology (Minor Anthropology); M.A., Archaeology and Prehistory; 19 years of experience in terrestrial and marine archaeology, project and contract management, and environmental compliance	Technical Writing and Review
Paulina Chen	B.S., Product Design Engineering; Over 15 years of experience in Federal environmental policies and programs; over 15 years of experience in graphic design and editing	Project Management Team, Technical Editing, Graphic Design, Document Production
Mary Cody	B.A.; 28 years of experience in seabird and marine mammal research, NRDA and Recovery monitoring, MMPA, NEPA, OCS Lands Act, and ESA consultation	Project Management Team, Purpose and Need, Potential Exclusions, Alternatives, Scoping Meetings and Comments, Technical Writing and Review
Kim Coffman	M.P.P., Government in the Private Economy (emphasis on Economic and Inter-disciplinary Analysis of Public Policy); 28 years of experience working on OCS 5-Year Program issues; 18 years of experience with socioeconomic models	Generalized Impacts on Employment and Revenues

Name	Education and Experience	Contribution
Deborah Cranswick	B.S., Geology; 39 years of experience with the OCS Oil and Gas Program, including 16 years as an Environmental Protection Specialist doing impact assessment and technical writing and editing	NEPA Guidance, Technical Writing and Review
Megan Davidson	B.S., Marine Science; B.S., Biology; M.S., Biological Oceanography; PMP; 18 years of experience in biological oceanography working on a variety of environmental related issues and field work	Project Management Team, Potential Exclusions, Appendices, and Review
Amardeep Dhanju	M.A., Public Policy; Ph.D., Marine Policy; 14 years of experience in marine and energy policy and regulation	Writing Team for Potential Environmental Exclusions
Courtney Elliton	B.S., Marine Science; M.S., Oceanography and Coastal Science; 7 years of experience in marine and coastal science, and environmental science and compliance	Writing Team, Technical Writing and Review
Stephanie Fiori	B.S., Environmental Science; B.A., Policy and Management Studies; M.Sc., Environmental Sciences and Policy; 22 years of experience in marine, environmental, and watershed science and policy, oil spill response and restoration, and fuel quality and vehicle emission standards and policy	Project Management Team, Writing Team, Review and Comment Coordination Team
Sara Guiltinan	B.A., Environmental Science; M.S., Environmental Science and Management; 10 years of experience in environmental science and compliance	Technical Writing Human Environment, Pacific Region Review
Deena Hansen	M.S., Marine Science; 9 years of experience in marine and fisheries ecology, in the field and for desktop analyses, especially in the context of NEPA, ESA, MSFCMA, and OCS Lands Act regulations	Writing Team for Affected Environment and Environmental Consequences, Scoping, Species Names, and EFH Appendices
Keely Hite	B.S., Environmental & Social Science; 12 years of experience NEPA OCS Programs, Sociocultural and Socioeconomic subject matter expert	Writing Team for Affected Environment and Environmental Consequences, Potential Environmental Exclusions
Brian Jordan	B.A., Anthropology; M.Sc., Wood Science; Ph.D., Natural Resource Science and Management; 25 years of experience in underwater archaeology and historic preservation	Supervision, Document Planning and Preparation Support
Paul Knorr	Ph.D., Geology; 18 years of experience including marine sediments, carbon flux, and environmental remediation	Scoping Meetings, GIS
J. Jacob Levenson	B.S., Zoology/Marine Science; M.S., Criminal Justice; 17 years of experience in commercial and recreational fisheries in Federal fisheries management at NMFS, as charter vessel captain, and in conducting independent science on fishes, marine mammals, sea birds, and sea turtles	Scoping Meetings, Review Coordination, Potential Environmental Exclusions
Jill Lewandowski	M.S. and Ph.D., Environmental Science and Policy; 23 years of experience in protected species assessment	Supervision, Reviewer
Jessica Mallindine	B.S., Marine Biology and Environmental Science; M.S., Marine Biology; 12 years of experience in planning and environmental impact analysis, compliance, and monitoring	Technical Reviewer, Comment Resolution

Name	Education and Experience	Contribution
Laura Mansfield	B.A., Petroleum and Socio-Economic Development; M.A.L.D. International Environment and Resource Policy; 10 years of experience with energy policy and socio-economic impacts of extractive industries	Writing Team, Technical Writing and Review
Kimberly Marshall McLean	B.A., Psychology/Sociology; M.S., Biology; Ph.D., Environmental Science & Policy; 10 years of experience conducting endangered species population monitoring (sea turtles); 17 years of experience in commercial fisheries sustainability and oil spill restoration (NMFS); 3 years of studying cultural identity of Tribal communities	Writing Team Human Environment, Technical Writing and Review
Robert Martinson	B.S., Biological Science; M.S., Zoology; 38 years of experience working on NEPA, ESA, CWA, aquatic ecology, wetlands, estuarine ecology, and coastal restoration	Project Management Team, Scoping Process, Exclusions, Potential Significant Impacts Risk Evaluation
Victoria Phaneuf	B.A., Cultural Anthropology, French, and Middle Eastern Studies; M.A., Ph.D., Sociocultural Anthropology; 13 years of experience conducting social science analyses	Technical Writing, Human Environment
Michael Rasser	B.A., Environmental Studies; M.S., Forest Resources and Conservation; Ph.D., Marine Science; 18 years of experience in marine, coastal, and terrestrial ecology	Project Management Team, Writing Team Lead, Technical Writing and Review, Scientific Illustrations Coordination
Andrew Remsen	B.S., Zoology; Ph.D., Marine Science; 25 years of experience in marine biology, oceanography, and emerging technology	Writing Team, Technical Writing and Review
Katherine Segarra	B.S., Environmental Science; Ph.D., Marine Sciences; 14 years of experience in marine and coastal science and policy	Project Management Team, Writing Team Lead, Technical Writing and Review
Stephanie Sharuga	B.Sc., Biology and Earth Sciences; M.S., Environmental Management and Sustainability; M.B.A.; Ph.D., Oceanography and Coastal Sciences; 15 years of experience in marine and coastal sciences, oceanography, and environmental sciences, management, and policy	Writing Team, Technical Writing and Review
Erica Staaterman	B.S., Biology; Ph.D., Applied Marine Physics; 13 years of experience in bioacoustics and marine biology research	Writing Team for Affected Environment and Environmental Consequences, Scoping and Acoustics Appendices
Kristen Strellec	B.S., M.S., and all Ph.D. coursework, Energy, Environmental, and Mineral Economics; 20 years of experience with socioeconomic models and economic analysis	Generalized Impacts on Employment and Revenues
Timothy White	B.S., Biology; MPhil, Biology (Ecology, Evolution, and Behavior); Ph.D., Biology (Ecology, Evolution, and Behavior); 15 years of experience in the field of avian ecology and at-sea mapping of apex marine predators	Potential Environmental Exclusions, Technical Writing and Review
Geoffrey Wikel	M.S., Marine Science; MPP; 20 years of experience in oceanography	Supervision, Document Planning and Preparation Support

Name	Education and Experience	Contribution
Eric Wolvovsky	B.S., Meteorology; M.S., Geographic Information Systems; M.S., International Development Management; 10 years of air quality experience	Writing Team for Affected Environment and Environmental Consequences, Air Quality, Climate Change, GIS, Scoping Meetings
Russell Yerkes	B.F.A.; 12 years of experience in the Department of Defense (4 years military, 4 years Federal contracting, 4 years Federal Government); 12 years of experience in graphic design (publication and print graphics, infographics and charts, presentations, large- and small-scale printing)	Chart and Graph Design, Layout Design

CONTRACTORS

Company	

U.S. Department of the Interior

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

Bureau of Ocean Energy Management

The mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way. The bureau promotes energy independence, environmental protection, and economic development through responsible management of these offshore resources based on the best available science.