

Comprehensive Synthesis of Effects of Oil and Gas Activities on Marine Mammals on the Alaska Outer Continental Shelf

Technical Summary

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Project Manager(s)	Anne Southam
Affiliation of Project Manager(s)	ECO49 Consulting, LLC
Address of Project Manager(s)	2618 NW Marken Street, Bend, Oregon 97703
Principal Investigator(s)	Anne Southam, Sue Ban, Mike Payne, Doug DeMaster
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BACKGROUND AND PURPOSE OF THE STUDY

The Bureau of Ocean Energy Management (BOEM) must comply with numerous environmental statutes, regulations, and executive orders to carry out its mission including but not limited to the National Environmental Policy Act (NEPA), Marine Mammal Protection Act (MMPA), and Endangered Species Act (ESA). Compliance with these statutes requires evaluating and disclosing potential effects of oil and gas activities on marine mammals. Preparing a meaningful synthesis is not just compiling a list of summary findings from various sources but requires an understanding of the underlying science and relevant context. To that end, this synthesis is intended to summarize in a single document more than 20 years of available literature, reports, and information into concise statements that reflect the findings of representative literature on this topic in order for BOEM analysts to prepare future analyses. A retrospective summary of mitigation and monitoring measures that have been implemented between 2000 and 2020 to avoid or minimize adverse impacts to marine mammals is included and, to the extent practical, an evaluation of the efficacy of these measures. Finally, this meta-analysis also reveals specific information needs related to the impacts of oil and gas activities on marine mammals in the U.S. Arctic and Cook Inlet.

The purpose of this synthesis is to provide an enhanced understanding of the potential direct, indirect, and cumulative effects of oil and gas resource development on marine mammals in the U.S. Arctic, defined as the Alaskan Beaufort and Chukchi seas, and Cook Inlet within the context of other human activities and natural factors in these areas for the period 2000–2020.

OBJECTIVES

BOEM requires ready access to information that can be used in future NEPA and other analyses. In conducting this study, the following objectives were met:

- Synthesize information about the direct, indirect, and cumulative impacts of oil and gas resource development in the U.S. Arctic and Cook Inlet on marine mammals.
- Present findings within the context of other anthropogenic and natural factors.
- Compile a list of mitigation and monitoring measures and, to the extent possible, evaluate their efficacy.
- Summarize and incorporate traditional knowledge regarding potential effects of oil and gas activities and the associated mitigation and monitoring measures that have been implemented.

METHODS

Key sources of information were identified from peer-reviewed articles, scientific publications, technical reports produced by federal agencies, state agencies, industry, and other stakeholders, applications for rulemaking along with proposed or final rules published in the Federal Register, and public comments. Of particular focus were documents produced by the Alaska regional offices of BOEM, United States (U.S.) Fish and Wildlife Service (USFWS), and the Nation Marine Fisheries Service (NMFS) Alaska Region, as well as the NMFS Office of Protected Resources in Silver Spring, Maryland as part of regulatory analyses, compliance, and reporting required by statutes including the MMPA, ESA, and NEPA. Each information source was screened for key terms primarily including marine mammal species, oil and gas activities, and the geographic areas of interest (*i.e.*, Cook Inlet and Beaufort and Chukchi seas). Out of nearly 1,000 scientific, government, and industry reports, journal articles, and publications screened with regard to BOEM's objective, 615 articles covering 230 topics were identified as applicable to the oil and gas activities and marine mammals in the regions of interest. Study selection bias was minimized by having multiple analysts assess the relevance and quality of literature.

Information sources identified as applicable were grouped into eight categories known as “bins”: 1) Biological Opinions (BiOps), 2) MMPA Rules, 3) Major NEPA Documents, 4) Mitigation and Monitoring Reports, 5) Subsistence and Traditional Knowledge, 6) Climate Change, 7) Scientific Studies, and 8) Oil Spill Incidents, Preparedness and Response. Each document was reviewed and annotated by one of four Principal Investigators, and then entered into EndNote (Version 20), a searchable citation database designed primarily for managing bibliographies, citations, and references. EndNote provides pre-defined fields for recording basic reference information including reference type (journal or report), year, author(s), title, institution, and document or identification number. Any of these fields can be searched within the EndNote database. Annotations prepared specifically for this project were entered into the EndNote “notes” data field. Portable document format (PDF) files for each information source is also attached to the citation in the EndNote. This allows users to open the PDF of the complete document directly from EndNote, if needed. In some cases, there may be multiple PDF attachments to a single citation (*e.g.*, a proposed rule and a final rule). Checklists categorizing the types of species were created for each bin to allow for cross referencing issues and marine mammals of interest to BOEM analysts.

Principal Investigators used the screened and categorized reports and literature to develop a comprehensive synthesis of marine mammal impacts from oil and gas activities. The information in the screened and annotated reports was used to develop descriptions of oil and gas activities in the Alaskan Outer Continental Shelf (OCS) including: the history of those activities and specific operations associated with oil and gas exploration and development projects (Chapter 3); types of potential effects on marine mammals of these

activities without mitigation (Chapter 4); the regulatory framework (Chapter 5); mitigation and monitoring measures used in the Alaskan OCS (Chapter 6); documented effects of oil and gas activities with mitigation in place (Chapter 7); effects on subsistence uses (Chapter 8); the effectiveness of the mitigation and monitoring measures used to date (Chapter 9); the effects of other activities and natural factors on Alaskan OCS marine mammals (Chapter 10); and lastly key findings and information needs (Chapter 11).

In Chapter 11, Tables 11-1 and 11-2 provide cross-references for sections in this document that describe the four main categories of potential effects to marine mammals (*i.e.*, behavioral disturbance, physiological effects, mortality, and habitat alteration), their mechanisms, effects actually documented, subsistence information, and mitigation measures to individual sections and subsections of this report. These tables allow the report user to quickly find specific information related to an effect, mitigation measure, or species.

RESULTS

Table TS-1 provides a summary of key findings by species of this synthesis. This information is summarized from more detailed descriptions of the documented effects, or lack thereof, of oil and gas activities on marine mammals in the Chukchi and Beaufort seas and Cook Inlet, Alaska during the period 2000–2020. Observations from marine mammal subsistence users are provided in detail in Chapter 8 and summarized here.

As described in Chapter 7, there is evidence that seismic activities (specifically the use of airguns) and some vessel noises have elicited behavioral responses from marine mammals including but not limited to swimming away or diverting an area. However, there is also evidence that behavioral response is contextual. In other words, animals that are foraging may not respond to seismic activities. More often than not, however, there is general acknowledgement that marine mammals more frequently try to avoid seismic activities by moving away (see Chapters 7 and 11). Traditional knowledge also supports this finding. For example, NMFS (2012d) stated:

Iñupiat subsistence whalers have stated that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and, thereby, is interfering with the subsistence hunt at Barrow (Ahmaogak 1989). Whalers have reported reaction distances, where whales begin to divert from their migratory path, on the order of 10 mi (T. Albert cited in USDOI, MMS 1995) to 35 mi (F. Kanayurak in USDOI, MMS 1997). Kanayurak stated that the bowheads...are displaced from their normal migratory path by as much as 30 miles.

Observations by subsistence hunters documented in Stephen R. Braund & Associates (2010a) have commented on noise disturbing seals stating:

Point Hope is having hard time catching seals. There was a little seismic operation that went on in the Arctic a few years back, and our seals haven't come back yet – Earl Kingik, Point Hope (NMFS 2011a).

Other oil and gas activities (besides seismic) appear to result in more minor behavioral reactions, although documenting behavioral responses is still challenging given the environmental conditions where monitoring programs occur (*i.e.*, animals may only be visible on the water surface). Based on a review of literature available for the period 2000–2020, acoustic disturbance associated with other types of oil and gas activities (other than seismic) does not appear to cause major, population-level effects on marine mammals in the U.S. Arctic or Cook Inlet. However, additional research is needed to better assess potential long-term effects of behavioral responses to acoustic stimuli. In addition, there are species for which abundance and population trend data are lacking (*i.e.*, Pacific walrus and ice seals); therefore, population-level effects are more difficult to assess.

While a large oil spill has not occurred in the Chukchi and Beaufort seas or Cook Inlet during the period 2000–2020, if a large oil spill occurs, the potential effects on marine mammals and their habitats could be major (see Section 4.6). Despite the assurances provided in a Conflict Avoidance Agreement (CAA), potential threats to whaling activities have been a major cause for anxiety about offshore oil gas development for people in Nuiqsut, Kaktovik, and Utqiagvik (BOEM 2018). These concerns were highlighted by the Village of Nuiqsut in their comments on the potential impacts of the Liberty Development Project, which stated “Potential effects to subsistence whaling practices and harvest patterns and potential effects to the community of Nuiqsut...are largely independent of potential negligible biological impacts to the bowhead population and its migration route” (as referenced in BOEM (2018)).

Traditional knowledge has indicated that changes in sea ice (independent of any oil and gas activities) may affect the timing of bowhead whale migration. Quakenbush *et al.* (2010) noted that whalers from Wainwright have observed sea ice forming later in the fall (December instead of October) and when this occurs, there is less multi-year ice and ice is also generally thinner. This thinner ice then breaks up earlier than it has in the past (late March/early April rather than late April). Utqiagvik whalers also noted the spring bowhead migration is earlier now (Huntington and Quakenbush 2009; as cited in Quakenbush *et al.* (2010)).

In addition to concerns about climate change, cumulative effects are also worrisome to Alaska Native subsistence communities and the topic is frequently acknowledged in the scientific literature as one of the most challenging issues to evaluate and address. In the May 2020 Eastern Bering Sea Beluga Whale Newsletter¹ published by ABWC, a resident of Unalakleet was cited as stating:

Beluga has always been an important food source for indigenous people of northern Alaska. We understand that most if not all our food sources are under attack from global warming or industrial activities. It is the duty of all people to protect all species from becoming extinct so that our children and grandchildren too will come to enjoy and appreciate our way of life (Frank Katchatag, Native Village of Unalakleet).

Huntington *et al.* (2016b) also commented that based on interviews with subsistence hunters in coastal Alaska industrial activity (e.g., shipping and oil and gas development) causing marine mammals to avoid areas important to the hunters was of concern.

Based on an evaluation of two decades of mitigation and monitoring reports (2000–2020), it is clear that monitoring is an essential component of any mitigation protocol required by NMFS or USFWS (Chapter 9). In many cases, the marine mammal sightings data from monitoring programs are useful for describing the presence or absence of marine mammals in a given area. Continued improvements to mitigation and monitoring protocols for greater consistency both interannually and among holders of Incidental Take Authorizations (*i.e.*, Letters of Authorization and Incidental Harassment Authorizations) will support future assessments. Where practical, rigorous application of state-of-the-art observation and recording practices should be implemented. Further, while a common practice, the absence of marine mammal sightings during periods of on-effort observations should be quantified and reported, given it serves as a valuable source of information.

Table TS-1 provides summary information on each of these topics with specific details provided in Chapters 1 – 11 of the full report.

¹ <http://www.north-slope.org/departments/wildlife-management/co-management-organizations/alaska-beluga-whale-committee/abwc-newsletters>; (Accessed September 8, 2021).

Table TS-1. Summary of Key Findings by Species

Species	Effects Due to Oil and Gas Activities in the Alaskan OCS				Mitigation Summary
	Mortality and Serious Injury	Physiological Effects and Behavioral Disturbance	Changes in Habitat	Effects on Subsistence	
Bowheads and Other Baleen Whales	Based on a comprehensive review of more than 40 MMPA monitoring reports and published literature for the period 2000–2020, no mortality or serious injury of bowhead or other baleen whales has been documented as a result of interactions with oil and gas activities in the U.S. Arctic or Cook Inlet.	• Direct evidence of physiological effects from oil and gas activities on bowhead and other baleen whales is lacking. While there is the potential that certain sound sources, such as seismic airguns, could cause hearing (auditory) injury or permanent threshold shift if operated in close proximity to whales, most whales are expected to move away from sounds that could cause injury. • Effects of Level B harassment to bowhead whales and other marine mammal species beyond the immediate behavioral response is a matter of ongoing investigation. Based on statistical analyses of Northstar acoustic monitoring data (2001-2004), there was an apparent shift in localized bowhead whale calls during those years (McDonald <i>et al.</i> 2012; Richardson <i>et al.</i> 2012). • Seismic survey noise and some vessel noises have been shown to influence the behavior of bowhead whales during migration. • Bowhead whales avoid areas around operating seismic vessels, but the distance of avoidance is variable and depends on the time of year, location, and whale activity during the exposure. • A broad scale comparison of sighting rates during periods of exploration drilling activity versus non-activity seems to indicate some level of avoidance response by bowhead whales. • The number of bowhead whale calls detected using passive acoustic monitoring is not indicative of the number of whales in the area and whales may have higher or lower rates of calling during certain periods or varying distances offshore. • In contrast to the general trend of avoidance, minke whales have occasionally been observed to approach active airgun arrays where received sound levels were estimated to be near 170–180 dB re 1 µPa. • Fin whales also demonstrate very little behavioral change resulting from exposure to noise from seismic surveys. • Based on the evidence available, the North Pacific right whale is not likely to be exposed to active seismic, active sonar, drilling operation noise, or pollutants and contaminants because this species only occurs in the Bering Sea, far from the exposure zones of the other stressors. • Effects on large cetaceans from oil and gas vessels in the transit route are not likely.	• Review of the more than 50 MMPA authorizations and associated BiOps for oil and gas activities that have been authorized in the Beaufort and Chukchi seas between 2000 and 2020, no significant adverse effects on baleen whale habitat have been documented. • A very large oil spill would likely result in adverse effects on marine habitats; however, such an event has not been documented in the U.S. Arctic or Cook Inlet during the period 2000–2020. • With decreased sea ice, observations of tagged bowhead whales lingering in the Chukchi Sea through December have been noted. The distribution and movements of other baleen whales as relative to prey and oceanographic conditions would likely be similar. • Sound energy generated from seismic operations has not been observed to negatively impact the diversity and abundance of zooplankton. Any mortality or impacts on zooplankton as a result of seismic operations is minimal, as compared to the naturally-occurring reproductive and mortality rates of these species. • The most likely manner in which oil and gas activities can affect bowhead whale habitat is by acoustically limiting their “communication space” due to increased noise levels. • Increased anthropogenic noise may affect the acoustic habitat available to baleen whales by limiting their “communication space”.	• CAAs have been one of the most effective tools for minimizing potential effects of industrial activities on subsistence whale hunting in the Beaufort and Chukchi seas. • Yearly bowhead harvests are affected by environmental conditions (e.g., wind speed and direction, fog, and temperature), stability of shorefast ice, and sea ice concentration, type, and movement. The success of each hunt, and therefore, the yearly totals, are affected by these environmental factors, and show considerable annual and regional variation. • Evidence of harvest disruption from oil and gas activities in Kaktovik and Nuiqsut has been documented based on respondent data collected in 1985, 1986, 1992, 1993, and 1998. • Nuiqsut whalers expressed general concerns about oil and gas development based on their experiences in the 1980s and 1990s, but since that time, an overall positive effect of mitigation during the period 2000-2020 can be attributed to the success of the CAA and the ability of the whalers and industry. • Based on CAAs between subsistence hunters and industry, and the agreement by industry to mitigate potential effects on subsistence hunters, NMFS has determined that oil and gas activities would not have an unmitigable adverse impact on the availability of bowhead whales to Alaska Native subsistence hunters • Yupik whalers of St. Lawrence Island expressed that changes in environmental conditions appeared to influence the distribution of bowhead whales relative to the Island.	• NMFS and USFWS have developed mitigation and monitoring requirements to ensure that authorized takes of marine mammals (including bowhead whales) do not result in serious injury or mortality. • Current NMFS regulatory thresholds for acoustic disturbance are used to identify and minimize potential threshold shift. • The use of protected species observers (PSOs), shutdown zones, ramp up, and ramp down procedures during seismic surveys and construction activities have reduced the incidence of impacts on bowheads and other baleen whales have reduced effects. • Vessel management measures, such as the use of PSOs, and speed and course adjustments when whales are observed in transit routes or in the vicinity of oil and gas operations, have reduced encounters and effects. • Mitigation measures implemented under the MMPA and ESA have been designed to avoid or minimize adverse effects associated with oil and gas activities and have generally resulted in a negligible level of effect on baleen whales over the period 2000–2020.

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	Mortality and Serious Injury	Physiological Effects and Behavioral Disturbance	Changes in Habitat	Effects on Subsistence	
Beluga Whales	The most recent information shows there was no human-caused mortality or serious injury of Cook Inlet beluga whales between 2014 and 2018.	• Cook Inlet beluga whales use habitat in Knik Arm despite disturbance and underwater noise from many sources including maritime operations; maintenance dredging; aircraft operations; and pile-driving. • Small, toothed whales, such as belugas, tend to move away or maintain a greater distance from a seismic survey vessel when a large airgun array is operating, thereby avoiding exposure to injurious sound levels. • The highest noise levels from oil drilling platforms have frequencies generally below 10 kHz. Underwater noise produced at the Tyonek oil platform in Cook Inlet is audible to beluga whales but unlikely to cause physiological effects due to temporary hearing threshold shifts. • Data from the Mackenzie Estuary during summer suggest that animals were not overtly disturbed by noise produced during drilling operations. • At least 17 groups of beluga whales appeared to alter migration paths in response to underwater sound from an ice breaker. • Beluga whale responses to helicopters were more common than to fixed-wing aircraft and included immediate dives, changes in heading, changes in behavioral state, and apparent displacement of belugas	• Effects in the Arctic on habitat would be similar to those described above for bowhead and other baleen whales. • Anthropogenic noise was found to be high and variable throughout Cook Inlet, but was loudest and most common in the vicinity of the Port of Alaska and lower Knik Arm. This is important passageway habitat for belugas moving into Knik Arm to seasonally forage.	• Hunters in Kotzebue Sound, to the south of Kasegaluk Lagoon, have observed that belugas avoid areas of high boat traffic, noise from the shore, or frequent overflights by aircraft. • There is no subsistence hunt for belugas in Cook Inlet at present.	Mitigation measures summarized above for bowhead whales apply, plus: • Timing and area restrictions on exploration drilling in Cook Inlet beluga whale critical habitat areas have reduced impacts on beluga whales. For example, certain activities must cease noise producing activities near high-value foraging habitat for belugas.
Other Cetaceans	Incidences of serious injury or mortality of other cetacean species (killer whale, Dall's porpoise, harbor porpoise, and sperm whales) due to oil and gas operations have been recorded.	• As described for bowhead whales, direct evidence of physiological effects from oil and gas activities on cetaceans is lacking; most whales are expected to move away from sounds that could cause injury. • Small, toothed cetaceans tend to move away or maintain a greater distance from a seismic survey vessel when a large airgun array is operating, thereby avoiding exposure to injurious sound levels. • The effect of Level B harassment marine mammal species beyond the immediate behavioral response is a matter of ongoing investigation. • The majority of monitoring reports from oil and gas activities in the Chukchi and Beaufort seas do not ascribe any behavioral response of these species due to noise from oil and gas activities or presence of vessels. • Toothed cetaceans typically display similar behavior to baleen whales in response to noise generated from seismic surveys. Various studies have shown that toothed whales move away or maintain a somewhat greater distance from the vessel, and stay farther away from seismic sources, during periods of airgun operation versus silent periods. • In Lower Cook Inlet, Dall's porpoise had two types of reactions to gun testing and seismic activity: bowride and splash. No visible reactions of killer whales or harbor porpoises were recorded by PSOs during the monitoring program. • Effects on large cetaceans from oil and gas vessels in the transit route are not likely.	• Effects on habitat would be similar to those described above for bowhead and other baleen whales.	• Subsistence hunting of minke whales is rare but has occurred. Officially, Alaska Natives are not authorized to take minke whales for subsistence purposes, as a harvest limit for this species in this region has not been approved by the International Whaling Commission. • There are no reports of subsistence harvest of killer whales in Alaska or Canada. • Subsistence hunters in Alaska are not authorized to take from the Central North Pacific stock of humpback whales, and no takes were reported between 2013 and 2017. • Subsistence hunters in Alaska and Russia have not been reported to take fin or North Pacific right whales. • In Cook Inlet, there has been no harvest of harbor porpoise since the early 1900s.	Mitigation described above for baleen whales and belugas also apply for other cetaceans.

Species	Effects Due to Oil and Gas Activities in the Alaskan OCS				Mitigation Summary
	Mortality and Serious Injury	Physiological Effects and Behavioral Disturbance	Changes in Habitat	Effects on Subsistence	
Ice Seals	There has been one documented seal mortality associated with an on-ice vibroseis program in the late 1990s. No other mortality or serious injury or ice seals has been associated with oil and gas activities.	- During an open-water seismic survey in the Chukchi Sea in 2007, sighting rates for bearded, spotted, and unidentified seals were greater during non-seismic than seismic periods, and, for most species, post-seismic sighting rates were also greater than those during seismic periods. - Considering all species combined, the seal sighting rate for non-seismic periods was significantly greater than the seismic rate. - Within a few meters of Northstar Island, ringed seal breathing holes and lairs were established in the landfast ice before and during development and construction activities. Ringed seal lairs were still actively being used in late May. - Snow machines at distances 0.5 to 2.8 kilometers (km) resulted in seals departing lairs while vibroseis and associated equipment at a distance of 644 meters (m) caused a seal to exit a lair. In all cases, seals that departed lairs, eventually returned, and hauled out, indicating the disturbance is likely short-term and minor. - Twelve ringed seals were observed during low-altitude helicopter overflights at Northstar Island in June and July 2000. One seal showed no reaction to the aircraft while the remaining 11 either by looking at the helicopter or by departing from their basking site. - Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They have been observed to rush into the water when an aircraft flies by at altitudes up to 300 to 750 m, and occasionally react to aircraft flying as high as 1,370 m at lateral distances as far as 2 km or more.	- Environmental factors such as time of year, water depth, ice cover, meltwater, and percent cloud cover had the most significant effects on seal sighting rates compared to any anthropogenic impact of industrial activities on ringed seals. - Minor changes in ringed seal habitat (physically altered ice cover) due to Northstar activities were documented during the peak of construction in early 2000. The altered comprised a small fraction of the sea ice habitat available in the Beaufort Sea for ringed seals and effects to habitat were deemed negligible compared to the natural factors. - Changes in climate are likely a significant factor for long-term habitat availability and quality for ice seals. - Other impacts on habitat due to noise effects on prey species, changes in sea ice, and impacts from oil spills are as described above for bowhead and baleen whales.	- Approximately 64 Alaska Native communities in western and northern Alaska, from Bristol Bay to the Beaufort Sea, regularly harvest ice seals. - In 1978, researchers noted that densities of ringed seals decrease in the vicinity of coastal villages and these decreased densities apparently are due to disturbance by snowmachines and general village activities rather than by hunting. The same general trends are seen around villages whether or not much hunting is accomplished by the residents of the village. - A Point Hope resident noted that after seismic operations up north, tomcod were not coming back. “The nursery for Bristol Bay fisheries are up north and we are losing lots of fish, maybe due to the seismic activity.”	- Arctic ringed seals and their breeding habitat are protected by seasonal restrictions for ice road and trail development and operations. - In 2020, NMFS published a final rule requiring implementation of specific mitigation and monitoring measures during sea ice road, trail, and pad activities along the Beaufort Sea coast. Measures include but are not limited to vehicles do not stop within a 50 m radius of an identified seal lair or within 150 m of a seal; no initiation of ice road or trail construction if a ringed seal is observed within 50 m of the action area after March 1 through May 30 of each year; and monitoring of construction areas to detect the presence of seals before beginning construction activities. - In the Chukchi Sea, most oil and gas activities do not start until late June to early July, minimizing the potential overlap with the bearded seal breeding season. Considering that vessels largely avoid areas of pack ice, where communication and mating occurs for this species, or transit these areas outside the breeding season, effects were determined to not be significant.
Pacific Walrus	No Pacific walrus have been seriously injured or killed by oil and gas activities in the U.S. Arctic. From 2009 through 2020, industry reported no direct interactions with walruses at all.	- During the 2012 and 2015 drilling seasons in the Chukchi Sea, the most common observation by walrus was “no response” to vessel activities regardless of sound levels recorded. - Seventy-five percent of Pacific walruses within 1 km of vessels in the Chukchi Sea exhibited no reaction. Pacific walruses in water generally showed little concern for approaching vessels but did dive or swim away if a vessel approached. - Individual walrus responses to aircraft can range from orientation (<i>i.e.</i>, looking at the aircraft) to leaving a haulout. In general, small herds on haulout sites (terrestrial and pack ice) seem more easily disturbed than large groups, and adult females with calves are more likely to enter the water during an aircraft disturbance. Stronger reactions occur when the aircraft is flying low, passes overhead, or causes abrupt changes in sound. - To date, oil and gas activities have not been associated with disturbance of walrus hauled on terrestrial sites in large numbers.	- The low density of walruses in the Beaufort Sea where offshore oil development has occurred, and the ability of benthic habitats to recover from disturbance due to oil industry dredging or screeding activities, or discharge of drilling fluids during exploration activities, indicates that there have been limited effects to walrus habitat or prey species. - Large numbers of Pacific walrus haulout on land in the northeastern Chukchi Sea. Concerns have been raised that aggregations of walrus could be disturbed by anthropogenic activity such as nearshore seismic studies or aerial and vessel traffic. - Other impacts on habitat due to noise effects on prey species, changes in sea ice, and impacts from oil spills are similar to those described above for bowhead and baleen whales.	- Villages along the Chukchi Sea coast have access to hunt walrus each summer. Occasionally, Beaufort Sea villages may also hunt walrus. - Harvest levels since 2006 are lower than long-term averages. It is not known whether recent reductions in harvest levels reflect changes in walrus abundance or hunting opportunities, but hunters consistently state that more frequent and severe storms are affecting hunting effort. Other factors affecting harvest levels included: 1) the cessation of Russian commercial walrus harvests after 1990; and 2) changes in political, economic, and social conditions of subsistence hunters in Alaska and Chukotka.	Regulations have been put in place by the USFWS to avoid disturbance of hauled walrus. Monitoring programs are required to identify areas where walrus haul on land, and to subsequently establish adequate mitigation measures.

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	Mortality and Serious Injury	Physiological Effects and Behavioral Disturbance	Changes in Habitat	Effects on Subsistence	
Other Pinnipeds	- Despite the preponderance of the vessel traffic in and around rookery and haulout locations near Dutch Harbor, there have been no reported incidents of ship strike of Steller sea lions in Alaska. - No California sea lion or harbor seal mortalities or series injuries have been reported during oil and gas activities for the period 2000–2020.	- Sixty percent of Steller sea lion sightings in Lower Cook Inlet occurred during periods of no seismic activity, while 40% of sightings were observed during seismic activity including full array. - Thirty-three percent of live harbor seal sightings in Lower Cook Inlet CI occurred during periods of no seismic activity, while 67% of live sightings occurred during periods of seismic activity, including full array. - Marine mammal sighting data during the Apache seismic surveys in Cook Inlet reported the most common behavior of harbor seals during non-seismic periods was “look/sink” followed by “travel,” whereas during periods of active seismic shooting, “travel” was more common than “look/sink”. - Cook Inlet is generally out of the range of California sea lions. Only one sighting of one California sea lion was reported during Apache’s 3D seismic study. No California sea lions were observed during monitoring for the Lower Cook Inlet seismic survey in 2019 or the Cook Inlet Pipeline Project in 2018.	No direct evidence is available from the literature regarding changes in acoustic habitat as related to oil and gas and potential effects on sea lions and harbor seals. Similarly, there is no direct evidence that oil and gas activities in Cook Inlet have affected Steller sea lion or harbor seal prey species.	- Subsistence hunting for harbor seals is conducted opportunistically and at low levels among Alaska Natives who may be fishing or traveling in Upper Cook Inlet near the mouths of the Susitna River, Beluga River, and the Little Susitna River. Generally, the timing and location of subsistence harvest of Cook Inlet harbor seals would not overlap with oil and gas activity. - Seven communities on Kodiak Island and 15 communities in Southcentral Alaska have been known to hunt for Stellar sea lions, with the majority of the animals taken near Kodiak and outside of Cook Inlet waters.	The use of PSOs, shutdown zones, ramp up, and ramp down procedures during seismic surveys and construction activities have reduced potential impacts on harbor seals in Cook Inlet.
Polar Bear	Five polar bears have been killed at oil and gas industrial sites in Alaska since the late 1960s: one in winter 1969, another in 1990 at the Stinson exploration site in western Camden Bay, one bear in 2011 (killed accidentally during a hazing event), and two in 2012. No polar bears were lethally taken by industry from 2013–2017.	- Polar bears were not commonly observed during open-water seismic surveys in the Chukchi Sea, but four were observed during seismic surveys in there 2006, three of which responded to the vessels by moving away. - During seismic studies in the Chukchi Sea in 2015, four polar bear movements relative to the vessel were recorded as “neutral” and one was recorded as “swimming away” from the vessel. - In the Beaufort Sea during an open-water seismic survey near Spy Island, strong behavioral reactions by polar bears to the presence of seismic source vessels were not observed. - In 2006, 2009, 2010, and 2011, polar bears established dens prior to the onset of industry activity within 500 m or less of the den site, remained in the den through the normal denning cycle, and later left with cubs. - Prolonged or repeated overflights of fixed-wing aircraft or helicopters used in support of offshore operations could disturb transient polar bears if flights occur at low altitudes.	As identified in the final rule listing the polar bear as a threatened species under the ESA, the decline of sea ice habitat due to changing climate is the primary threat to polar bears (73 FR 28211). However, on shore oil and gas developments may affect or remove some amount of polar bear denning habitat.	- Alaska Natives can legally harvest polar bears under the MMPA and ESA. Polar bear harvests are managed through the Inuvialuit–Iñupiat Agreement, a voluntary Native-to-Native agreement between the U.S. and Canada. - The current management protocol for lethal takes of polar bear from sources such as subsistence harvest by Alaska Natives does not allow for any additional lethal take under the MMPA from other sources, such as those that could occur during seismic surveys or other oil and gas activity. - A commenter at a public meeting in Kaktovik in 2019 stated “The polar bear situation is because of climate change... They are coming ashore, and that’s directly related to the oil situation. The fact that we have climate change, the oil is open—the ocean is open, and the bears have to come ashore...”	- Surveys to locate polar bear dens are required before activities begin and activities are excluded 1.6 km around dens. Areas where gravel is placed for pads or roads would likely be avoided as potential maternal denning habitat because of the presence of the facilities and associated human activity. - Bureau of Land Management also includes requirements to minimize the development footprint to limit coastal habitat alteration or loss.

Species	Effects Due to Oil and Gas Activities in the Alaskan OCS				Mitigation Summary
	Mortality and Serious Injury	Physiological Effects and Behavioral Disturbance	Changes in Habitat	Effects on Subsistence	
Sea Otters	There have been no recorded deaths or severe injuries of sea otters directly attributed to oil and gas operations in Cook Inlet or in the vicinity Dutch Harbor.	• Given sea otters' underwater hearing ability and limited time spent below the water's surface, seismic survey noises are expected to result in only localized and temporary disturbance effects to a few individual sea otters. • Behaviors exhibited by sea otters during a seismic survey in Lower Cook Inlet included: mill, travel, swim, look, rest, feed, surface active, and dive. Forty-six percent of live sea otter sightings were recorded during periods of no seismic activity, while 54% were observed during periods of seismic activity, including full array. • Minor and short-term behavioral responses of mustelids to helicopters have been documented in Alaska. • Sea otters have been shown to avoid areas with high vessel traffic but return when seasonal traffic subsides; for example, sea otters in the water were prone to swim away, hauled out sea otters entered the water and dispersed, and feeding sea otters began to periscope or dive.	• Vessel traffic (which may include oil and gas) has not likely impacted or caused destruction of northern sea otter critical habitat around Dutch Harbor, where habitat is already degraded due to the presence of infrastructure. • Underwater noise generated during seismic surveys is not likely to decrease the availability of sea otter prey sources such as crustaceans and mollusks or modify otter critical habitat. • Researchers have documented long-term adverse effects on sea otter habitat due to the Exxon Valdez oil spill in 1989, which occurred well outside of Cook Inlet. No large oil spill has occurred in Cook Inlet during the period 2000–2020.	Sea otters are taken by subsistence hunters. However, the majority of the harvest occurs outside of Cook Inlet in the Kodiak Archipelago and eastern Prince William Sound.	• The use of PSOs, shutdown zones, ramp up and ramp down procedures during seismic surveys and construction activities have reduced potential impacts on harbor seals in Cook Inlet. • During seismic surveys in Cook Inlet, before ramping up the airguns during the seismic work, a PSO or trained crewmember must clear a 50-m sea otter exclusion zone using vessel lights.

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INFORMATION NEEDS

A large volume (1,000+ sources) of scientific literature, assessments (*i.e.*, NEPA or BiOps), and marine mammal monitoring reports were reviewed for this study. The analysis demonstrates a concerted effort to predict and assess the potential interactions between marine mammals and oil and gas activities and any associated effects of those interactions. However, 10 key data information needs have been identified through this process:

- Comprehensive, species-specific data on marine mammal abundance, density, and population trend data is needed to assess the health and sustainability of marine mammal populations and the potential effects of human activities. This data is not currently up-to-date or available for certain species.
- Additional species-specific data for total human-related mortality, including mortality associated with subsistence hunting.
- Data to assess the biological significance of marine mammal behavioral responses to underwater sounds associated with oil and gas activities and other sources.
- Underwater sound measurements of anthropogenic activities including but not limited to vessel traffic (shipping), oil and gas activities, and construction.
- Additional social science data on marine mammal subsistence practices including results by species over time. This could include a comprehensive periodic evaluation of subsistence hunting activities by region and by species.
- Additional social science data to monitor community perceptions regarding potential effects on marine mammal subsistence species or practices due to external stressors such as climate change.
- Periodic comprehensive evaluations across all marine mammal monitoring programs conducted for oil and gas and reporting of results by region and species. This could be done using artificial intelligence systems (machine learning algorithms to automatically analyze monitoring data to uncover hidden trends by species and/or region of activity).
- Geospatial and temporal visualizations of anthropogenic activities in the Chukchi and Beaufort seas and Cook Inlet overlain with marine mammal distribution patterns and habitats to assess the potential for increased interactions.
- Continued development of emergency response protocols and communications related to mitigating the impacts of a significant oil spill in the U.S. Arctic or Cook Inlet. Development of techniques to mitigate the impacts of an oil spill in sea ice should be a high priority.
- Quantitative methods for assessing cumulative effects on marine mammal populations in the Chukchi and Beaufort seas and Cook Inlet.
- Through this review, it became apparent that improved coordination among federal, state, and local agencies; industry; regional subsistence organizations; and local communities is needed when designing and implementing monitoring and research programs. In addition to the 10 key information needs summarized above, five suggested improvements to future monitoring programs include but are not limited to:
 - Standardizing marine mammal monitoring forms among all monitoring entities (industry, state, federal, and local agencies, and research organizations).

- Communicating monitoring plans (*i.e.*, dates, times and locations of aerial, ground, or vessel surveys) with local communities.
- Integrating industry monitoring programs with scientific research programs and using integrated program designs and statistical analyses to enhance the detection of potential effects of oil and gas activities on marine mammal behavior, populations, and distribution.
- Cooperating with all entities on the use of aircraft, vessels, and ground transportation.
- Holding periodic planning meetings to communicate and coordinate monitoring and research among operators and agencies. This would support developing a periodic comprehensive review of monitoring and research programs as well as facilitate an adaptive management approach for future programs.
- Lastly, a coordinated effort to improve response and remediation capabilities and effectiveness for potential oil spills in Arctic and sub-Arctic waters is needed. An effort to coordinate this work with international partners (*e.g.*, Norway, Russia, Canada, and Denmark/Greenland) would be beneficial. Future research and coordination may determine ways to improve mitigation efforts in ice-infested waters, including but not limited to:
 - Methods to recover oil in waters with ice-cover or broken ice.
 - Timing and possibly pre-approvals for *in situ* burning of surface oils or mechanical recovery.
 - Hazing of marine mammals for the purpose of moving them to regions outside of the discharge zone.

CONCLUSIONS

This synthesis of 20+ years of available literature has identified the following eight overall conclusions regarding the primary effects of oil and gas activities (with mitigation measures enacted) on marine mammals in the Chukchi and Beaufort seas and Cook Inlet:

- Mortality or serious injury directly attributable to oil and gas activities has not occurred in either region between 2000 and 2020.
- Avoidance behavior during seismic activities and impact pile-driving has been observed in marine mammals, but for those species with sufficient population abundance and trends data, there is no evidence that the magnitude of avoidance has resulted in biologically significant or population-level effects.
- Disturbance due to underwater sounds from exploration and operational drilling, vessel and aircraft traffic, or geotechnical surveys occurs. Behavioral reaction of marine mammals to these underwater sounds is highly variable across species, and there is no current evidence of long-term population-level or biologically significant effects for those species that have sufficient data on population status and trends.
- For species such as Pacific walrus and ice seals, population status and trends are unknown and definitive conclusions regarding potential effects are uncertain.
- Extensive compliance monitoring data are available and are valuable for assessing the efficacy of mitigation of effects associated with oil and gas activities. Monitoring reports provide data on the presence or absence of species, seasonal distribution, or migratory behavior, and may provide data

on behavioral responses, although monitoring efforts across projects and regions are not standardized.

- Improvements and standardization of monitoring protocols for future activities will promote continued assessment of the effects of oil and gas activities on marine mammals, building on more than 20 years of monitoring data.
- Changes in habitat use by marine mammals are primarily driven by broader-scale ecological forcing, such as those associated with loss of sea ice, ocean warming, and ocean acidification.
- Quantitative methods for assessing cumulative effects are currently lacking. At present, for marine mammal species where adequate information exists, trends in abundance or changes in use patterns are likely the best indicator of cumulative effects not otherwise detected.

Conclusions regarding subsistence efforts and community concerns include:

- Subsistence communities continue to successfully hunt bowhead whales, seals, and walrus in the Chukchi and Beaufort seas. Harbor seals and sea otters continue to be successfully hunted in Cook Inlet.
- The ability to subsistence hunt marine mammals is extremely important to Alaska Native communities in terms of food security, cultural significance, and overall mental and physical well-being.
- The potential threat of a very large oil spill is cause for anxiety among subsistence communities along the U.S. Arctic coast.
- Concerns that oil and gas activities are affecting marine mammal subsistence hunting are still expressed during public comment periods and other public forums related to oil and gas activities.
- Cumulative effects and climate change are common concerns expressed by communities that subsistence hunt for marine mammals, particularly those located in the U.S. Arctic.

STUDY PRODUCT(S)/DELIVERABLES

1. Report Entitled “Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities on the Alaskan Outer Continental Shelf”.
2. Annotated bibliography of more than 1,000 reports, assessments, monitoring summaries, Environmental Assessments, Environmental Impact Statements, and published literature, presented as Appendix B of the report.
3. A cross-reference table (Appendix A) that categorizes the literature contained in each bin to allow for easy identification of specific issues and species of interest.
4. The EndNote literature database incorporating more than 800 citations along with PDFs of each piece of literature used in the synthesis.

MAP OF STUDY AREA

Figures TS-1 and TS-2 for the U.S. Arctic and Figure TS-3 for Cook Inlet provide maps of the study areas.

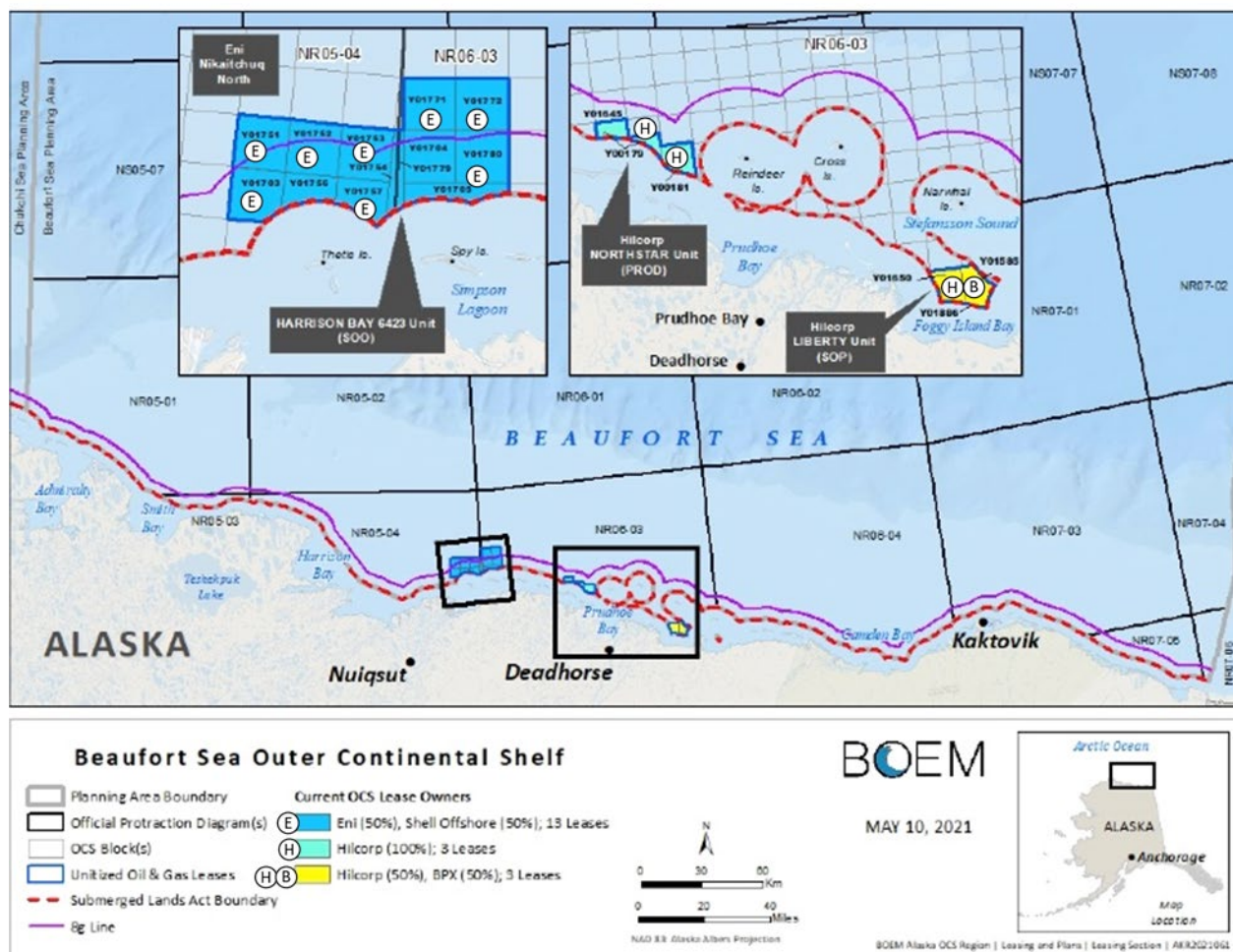


Figure TS-1. Current Beaufort Sea Oil and Gas Lease Owners

Source: <https://www.boem.gov/sites/default/files/documents/environment/AKR2021061-ActiveLease-BFT%20SEA.pdf>; (Accessed August 16, 2021)

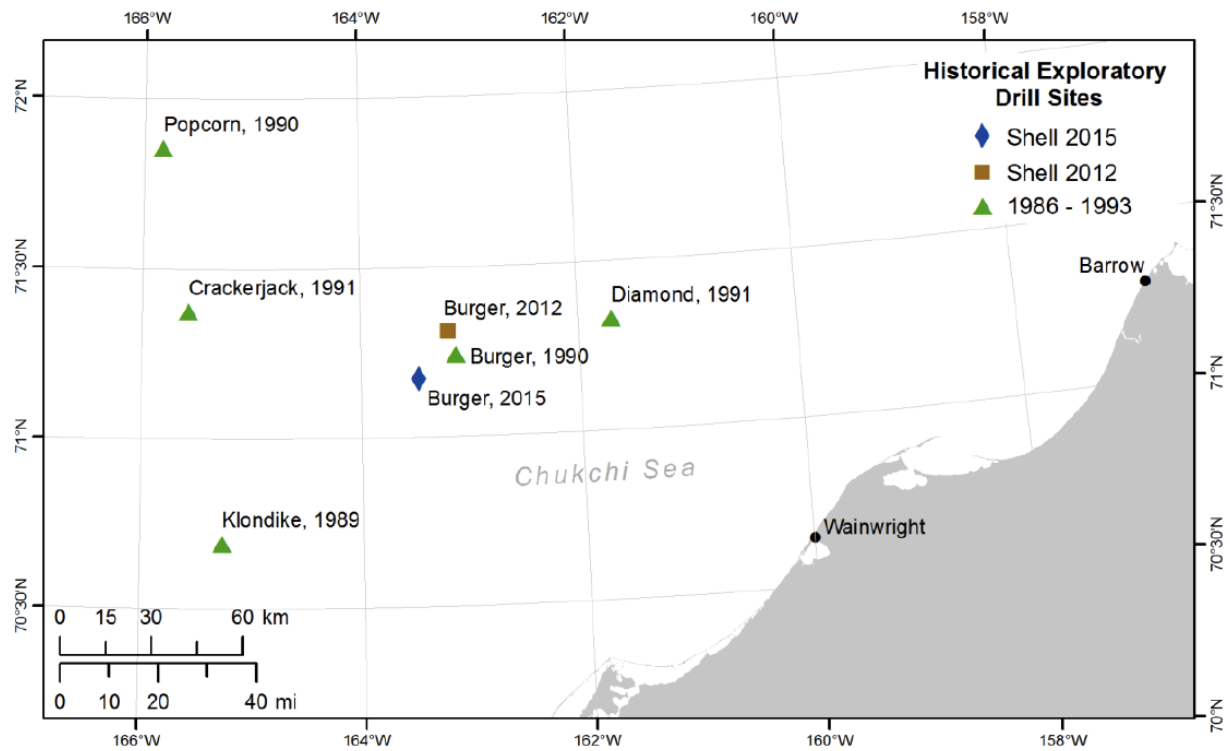
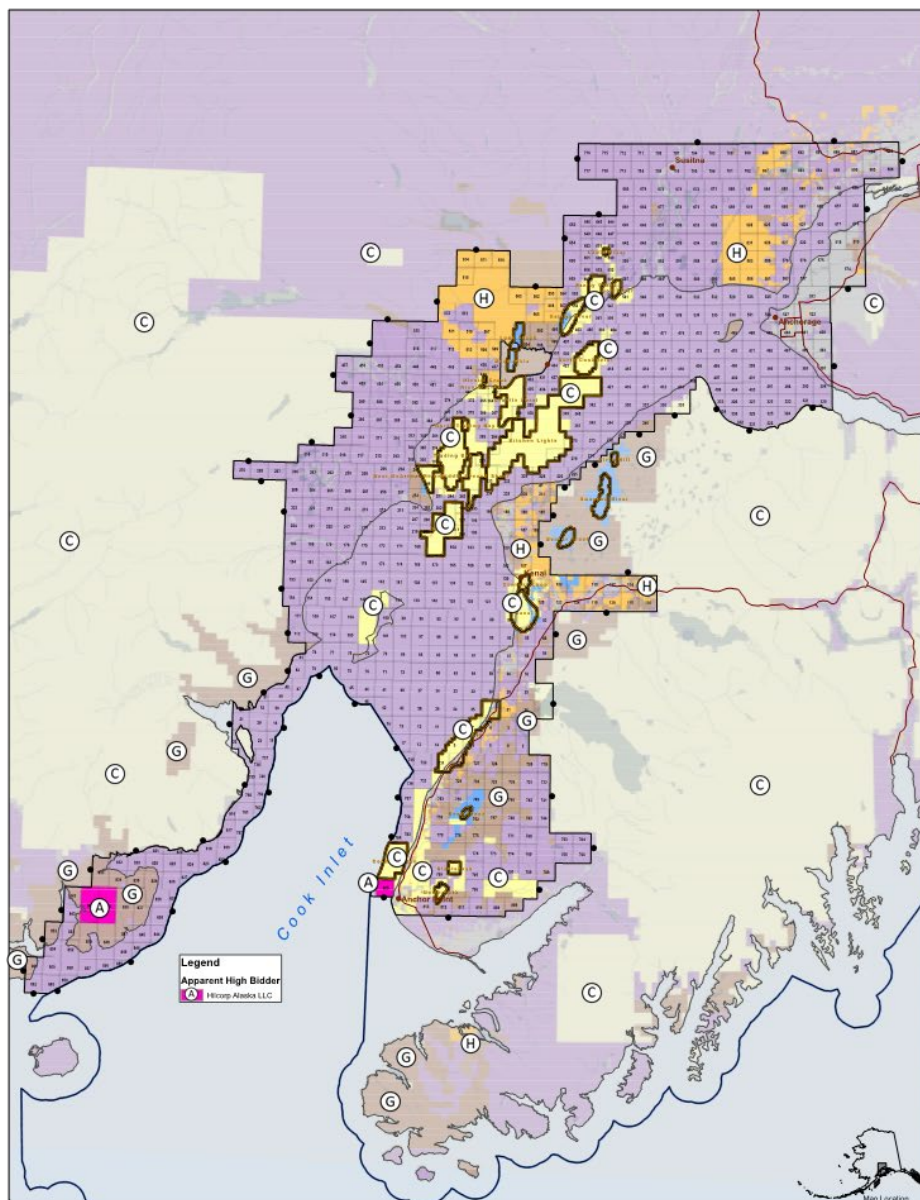


Figure TS-2. Offshore Exploratory Drill Sites in the Alaskan Chukchi Sea 1989 – 2015²

Source: Ireland *et al.* (2016)

² The most recent federal OCS lease sale in the Chukchi Planning Area was held in February 2008 (Lease Sale 193).

Cook Inlet Areawide 2019W **Competitive Oil and Gas Lease Sale Regional Tract Map** June 17, 2020



This map was created, edited, and published by the State of Alaska, Department of Natural Resources, Division of Oil and Gas, and is for informational purposes only. This state of Alaska makes no representation or implied warranties (including warranties of merchantability and fitness for a particular purpose) in connection with the use of this product or its appropriateness for any user's purpose. It is not to be used for any purpose other than that for which it was intended. The user assumes all liability for any damages suffered by the user or any other person or entity arising from use of the product, any data derived or otherwise, and is not to be held liable for the State of Alaska's liability to you or anyone else who used the map for the product.

Legend
 Apparent High Bidder
 Hicorp Alaska LLC

Available Lease Sale Tract
 Unleased State-Owned Oil and Gas
 Current State Oil and Gas Lease

Unit Boundary
 Areawide Boundary
 Federal Land
 Native Land
 Other Ownership
 Alaska Seaward Boundary

Bidders are cautioned to verify and file, and available for leasing, and acreage within a tract prior to bidding. The regional tract map displays general mineral rights ownership, oil and gas lease activity, and water sale tract boundaries and is subject to change. This map is not intended to provide a detailed depiction of land status or ownership interests. For land status, ownership, and land survey information consult land records of the following agencies:

State of Alaska Department of Natural Resources
<http://dnr.alaska.gov/landmanagement/>
 US Department of Interior Bureau of Land Management
<http://blm.dnr.gov/>

Land ownership and status on this map are depicted as of the date of publication. Bidders may also wish to consult the Alaska Department of Natural Resources, Division of Oil and Gas, for more information on the lease sale area. Bidders may also wish to consult the Alaska Department of Natural Resources, Division of Oil and Gas, for more information on the lease sale area. Bidders may also wish to consult the Alaska Department of Natural Resources, Division of Oil and Gas, for more information on the lease sale area. Bidders may also wish to consult the Alaska Department of Natural Resources, Division of Oil and Gas, for more information on the lease sale area.



Bidders are solely responsible for determining the availability of acreage prior to submitting a bid. Various state and federal restrictions apply to portions of the lease sale area. Complete details regarding this lease sale are available on the Division of Oil and Gas website: <http://dog.dnr.alaska.gov>

Figure TS-3. Cook Inlet Areawide 2019w Lease Sale Results

Source: https://dog.dnr.alaska.gov/Documents/Leasing/SaleDocuments/CookInlet/2020W/2020-04-17_Tract_Map_CIA_2020W.pdf; (Accessed August 16, 2020)