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Environmental Risks with Proposed Offshore Oil and Gas Development off Alaska's North Slope

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In August 2012, Royal Dutch Shell Oil (Shell) plans to begin exploratory drilling in the Arctic Ocean off Alaska's northern coast. If Shell finds oil, it and other oil companies will return to the Arctic for additional exploration in the future. Within ten years, we could see the beginning of oil production that could last for several decades in the Arctic region. This paper argues that drilling and related industrial activity would create an unacceptable risk of irreparable damage to this unique part of the planet and should be postponed until comprehensive research can be performed and a credible system for responding to spills is put into place.

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EXECUTIVE SUMMARY

In August 2012, Royal Dutch Shell Oil (Shell) plans to begin exploratory drilling in the Arctic Ocean off Alaska's northern coast. This paper argues that drilling and related industrial activity would create an unacceptable risk of irreparable damage to this unique part of the planet and should be postponed until comprehensive research can be performed and a credible system for responding to spills is put into place. More specifically, there are at least eight good reasons to call a time out:

1. The oil industry has a long history of spills on the North Slope, and the likelihood of future spills is high. In fact, there has been a spill of oil or associated chemicals once a day, on average, since oil and gas development began on the North Slope.[1] Many of the accidents involved pipelines, and development in the Chukchi and Beaufort would result in laying a network of pipelines from the wells to shore, up to 75 miles away. To make matters worse, ocean currents can move oil and chemicals hundreds of miles.[2]

2. Cleaning up oil spills in the Arctic Ocean would present immense challenges. According to the International Tanker Owners Pollution Federation, "containment and recovery at sea rarely results in the removal of more than a relatively small proportion of a large oil spill, at best only 10 to 15 percent and often considerably less."[3] To date, no technology exists to clean up oil in sea ice conditions and late-season spills would remain until the following year.[4] Moreover, cold water breaks down oil much more slowly than does warm water. Another hindrance is the lack of infrastructure for rapid response to a spill.

3. The Arctic Coast, running along the biological heart of the Arctic National Wildlife Refuge, is unique. The Beaufort's coastline along the Arctic Refuge is the number-one land denning site in America's Arctic for female polar bears and is designated as critical habitat for this threatened species. The Chukchi Sea features a vast, shallow floor, and its seasonal ice cover is vital to a variety of marine mammals.[5] Endangered bowhead whales migrate through the area in the fall, when drilling would occur. Birds migrate hundreds—and sometimes thousands—of miles to breed and nest in this area. These and other species are tightly bound together in an ecosystem that depends on sea ice and a complicated food chain that begins with tiny phytoplankton.

4. Too little is known about Arctic ecosystems to predict response to spills. In 2003 the National Research Council (NRC) created a list of data gaps for the oil industry to tackle.[6] A 2011 U.S. Geological Survey (USGS) report found that many of those gaps remain, and new ones have arisen.[7]

5. Shell's offshore oil and gas activities threaten vulnerable wildlife. Climate change has dramatically weakened the foundation on which Arctic ecosystems function.[8] Major industrialization would increase the challenges faced by phytoplankton—at the base of the food chain—and would create a range of other problems. Species particularly at risk include walruses, polar bears, beluga and bowhead whales, ringed seals, and coastal birds.[9]

6. Damage to wildlife and the ecosystem undermine Inupiat quality of living and culture. For more than a millennium, Inupiat and other Alaska Natives have developed ways of life—from hunting, fishing, and gathering food, to culture—that could be endangered if the natural world they depend on suffers further damage.

7. The region is already compromised by climate change. Nowhere on Earth has climate change had so much impact.[10] In recent decades, temperatures in the region have increased almost twice as fast as the world average. As a result, in the approximately three decades since the National Snow and Ice Satellite Monitoring System began recording sea ice data, Arctic sea ice extent has declined 12 percent per decade.[11] This melting led to the lowest summer-ice minimums and most open water ever recorded, allowing for increased commercial activity, and, in turn, creating additional stress on this ecosystem. Extensive coastal erosion is forcing whole villages to relocate.[12]

8. Arctic drilling will create more greenhouse gases (both through production and the eventual use of hydrocarbons) at a time when we are trying to reduce such emissions. The United States and other nations are struggling to reduce emissions that are changing the Earth's climate. Unfortunately, this effort is falling behind schedule, according to the International Energy Administration (IEA), which projected in May 2012 that the planet will warm by an average of six degrees Celsius by the end of this century. Offshore oil exploration and development in the Arctic Ocean would further compromise this effort.

INTRODUCTION

Over the next two years, Royal Dutch Shell Oil (Shell) intends to drill six wells in the Chukchi Sea's lease sale area 193, 70 miles off the coast, and four oil wells in the Beaufort Sea, 16 to 20 miles off the coast of the Arctic National Wildlife Refuge. This summer, Shell is identifying likely routes for permanent pipelines to shore. These are the first steps in what the company hopes will be an extensive development effort in both the Chukchi and Beaufort Seas and along nearby coastlines.

If Shell finds oil, undoubtedly the company will return to the Arctic for additional exploration. ConocoPhillips and Statoil are planning similar exploration drilling in the near future. Additional oil companies may follow. Within ten years, we could see the beginning of oil production that could go on for several decades.

Damage from oil spills and other industrial activities could be drastic and long-lasting. And, the vessels associated with oil and gas development threaten wildlife in various ways. An increase in collisions is inevitable, and the noise generated by the vessels can both disturb marine species and mask the sounds that they need to hear in order to be successful in foraging, reproducing, and avoiding predators. The noise created during seismic exploration, which has the intensity of explosives every 10 to 12 seconds for weeks or months, is yet another major problem for marine wildlife.

It is critical that Shell proceed cautiously. There is almost no margin for error as the Arctic is transformed.[13] New and risky industrial activities should not begin until Arctic ecosystems are sufficiently protected; a comprehensive system of marine sanctuaries should be established, and careful scientific study and assessment needs to produce convincing evidence that any new industrial activities pose little threat to the environment.

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CHAPTER I. ONSHORE ARCTIC OIL DEVELOPMENT HAS LONG RECORD OF SPILLS

The oil industry's North Slope footprint sprawls across more than 17,202 square miles, from the National Petroleum Reserve—Alaska, east of the Arctic National Wildlife Refuge, and inland from the Beaufort coast, to the base of the Brooks Range. That includes 9,069 square miles of gravel pads, roads, and gravel extraction;[14] nearly 621 miles of roads; 287 airplane strips; 450 miles of pipeline corridors; 1,690 miles of pipelines; and hundreds of oil wells; as well as other infrastructure. Another 154 square miles are in gravel-based islands/pads in offshore production or exploration islands.[15] Gravel for these structures has come mainly from riverbeds, and the extraction process has destroyed fish spawning and feeding areas, due to siltation and elimination of habitat.[16]

This massive operation has resulted in hundreds of spills a year. Based on data in a 2003 report by the NRC, the number of spills of crude oil and petroleum products climbed from about 130 in 1977 to roughly 340 in 1999 on the North Slope alone, not including those from the Trans-Alaska Pipeline or the marine terminal at Valdez.[17] The NRC did not include the 1989 Exxon Valdez disaster, which dumped 31.5 million gallons of North Slope crude into Prince William Sound, causing huge short- and long-term impacts.[18]

Moreover, Alaska Department of Environmental Conservation (ADEC) data from July 1995 through January 2011 indicate that the frequency of oil plus other hydrocarbon and other toxic spills combined was nearly double that for oil spills alone.[19] Since 1995, there have been more than 6,000 such spills in the North Slope oil fields, with a toxic spill occurring, on average, more than once a day (about 450 per year).[20]

The former Minerals Management Service (MMS) estimates that oil development resulting from Chukchi Sea lease sale 193 alone will result in as many as 174 exploratory, production, and service wells; up to 200 miles of offshore pipelines; and 300 miles of onshore pipeline to reach the Trans-Alaska Pipeline.[21] Further offshore oil development would likely require similar pipeline support.

Since offshore drilling is likely to rely so heavily on pipelines to move oil to the coast, it is important to study the history of pipeline accidents. Most of the onshore leaks were associated with pipelines, and the NRC's report documented three major spills from the North Slope segment of the Trans-Alaska Pipeline.[22] For example, in 2006 a BP pipeline broke at Prudhoe Bay, releasing 276,000 gallons. It was the largest land-based oil spill on the North Slope. BP later reported that there had been severe corrosion, with losses of 70 percent to 81 percent in the 3/8-inch-thick walls of the pipe, and attributed it to cost-cutting and poor maintenance.[23] Discovery of the leak took five days.

Offshore, pipelines will be subject to more severe and novel stresses. Unstable sea floor sediments are common in the Beaufort and Chukchi Seas. Erosion of sediments could expose buried offshore pipelines, leaving them vulnerable to ice gouging damage.[24] Due to climate change, there will be higher sea levels and waves, more storms, and greater erosion, all of which will threaten pipeline integrity.[25] Higher temperatures, along with the warmth of the moving oil, will put permafrost at risk of melting, leading to subsidence of pipelines. No matter how carefully designed the pipelines might be, there is always the risk of human error—in manufacturing, installation, operation, and leak-detection.

The most significant onshore pipeline spills, had they occurred from offshore pipelines, would have left long stretches of oil in the water. Assuming a 6-millimeter layer that was 6 meters across, the spill lengths would have been 3.5 miles (1993 spill), 5.0 miles (1989), and 35.7 miles (2006).

The historic BP Deepwater Horizon blowout in 2010 killed 11 workers, and capping the well took months, highlighting the hazards involved in offshore drilling. Shell, which in August 2011 was responsible for the largest North Sea spill in a decade, has tried to allay fears of a major spill in the Arctic by claiming that the risks are minimal because the water is shallower.[26] But in 2007, MMS reported that 19 of the 39 Outer Continental Shelf blowouts between 1992 and 2006 occurred in the most shallow water category (water less than 200 feet deep).[27]

CHAPTER II. ARCTIC OCEAN OIL SPILLS PRESENT IMMENSE CHALLENGES

"Containment and recovery at sea rarely results in the removal of more than a relatively small proportion of a large oil spill, at best only 10 to 15 percent and often considerably less," according to the International Tanker Owners Pollution Federation.[28] After the Exxon Valdez disaster, for example, the recovery rate was closer to 8 percent.[29] Stopping the Deepwater Horizon spill took three months. Only a small percentage of the crude released into open water was burned or recovered even though the disaster occurred in the relatively calm waters of the Gulf of Mexico near U.S. Coast Guard stations, and state-of-the-art cleanup equipment and abundant shore-side support were employed.[30]

Yet, in a March 2010 filing with Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), Shell claimed that even in ice-ridden Arctic Ocean waters, up to 95 percent of the lost oil could be recovered.[31] Shell has since revised its remarks and now claims that it will "encounter" up to 95 percent of lost oil. Recovery of 95 percent of lost oil would be a stunning improvement in industry capabilities, especially under what would be dramatically more difficult Arctic conditions.[32] Shell has yet to field-test its wellhead capping stack for emergency well control in Arctic waters, promising to do so before drilling. The company did perform tests in the Puget Sound, near Seattle, but these tests did not adequately account for the dangers and difficulties likely to be presented by ice-covered (partially or fully) Arctic waters.

How large a spill should Shell be prepared to tackle? The federal government has modeled a "Very Large Oil Spill" from the Chukchi Sea drilling program that would continue for 74 days, spill more than 2 million barrels of oil, cover more than 200,000 square miles (an area larger than the state of California), and leave oil along at least 850 miles of shoreline, potentially spreading into Russian waters. Conversely, Shell's approved oil-spill-response plan for the Chukchi Sea features a "worst-case" blowout that is much less serious: a flow rate of just 25,000 barrels per day (bpd) over 30 days, for a total discharge of 750,000 barrels. (For the Beaufort, Shell's numbers are 480,000 barrels and 16,000 bpd.) Also, Shell's documents do not include an effective or confirmed solution for separating oil from ice, especially in heavily iced areas.[33]

There are many reasons why it would be far more difficult to clean up an oil spill in the Arctic Ocean than it would in a place like the Gulf of Mexico. The area features frigid temperatures, ice, extensive darkness (except in the summer), gale-force winds, and rough seas. Cold water breaks down oil much more slowly than does warm water. In addition, due to climate change, more extreme weather is likely. Major storm tracks typical of the North Pacific and Bering Sea are shifting north by several degrees, increasing storm frequency and intensity.[34] Spring and summer fogs have become more frequent and persistent, and are expected to worsen.[35] (It is important to note that aircraft, essential to direct any clean-up operation, need at least a kilometer of visibility.)

According to Shell's plans, drilling will continue until September 23, 2012 in the Chukchi, and the end of October 2012 in the Beaufort, so any spill late in the season would face particularly challenging natural conditions and may be treatable only briefly before the ocean freezes. Shell claims it will have significant capacity to recover oil throughout the winter and, if that is not possible, will postpone cleanup until the following spring—yet still be successful. There is no precedent for this. Nor is there any knowledge of what impact the oil would have if left there for half a year or longer.

A report by the U.S. Geological Survey includes a summary of oil recovery techniques:[36]

- **Mechanical means.** Assuming the presence of ice, mechanical means could capture only 1 to 20 percent of spilled oil. Booms and skimmers are only marginally effective in water that is more than 10 percent ice-covered.
- **In-situ burning (ISB).** While some sources believe ISB is more promising,[37] its effectiveness is highly dependent on the weather, ice conditions, oil thickness and type, and would likely eliminate only a few percentage points more of oil.[38] ISB can have a major impact on air quality; high concentrations of respirable particles and toxic gases result from the burning of oil.[39] In addition, there is concern about the toxicity of chemicals used to aid the burning of oil slicks and, in any event, winds stronger than 20 miles per hour make it impossible to burn oil slicks.[40]
- **Breaking up slicks with dispersants.** Creating a surface area of emulsified oil that is 5 to 50 times greater than the original spill, dispersants quickly release 5 to 50 times the volume of toxic aromatics, especially "polycyclic aromatic hydrocarbons," into the surrounding ocean and atmosphere.[41] If the waves are higher than 3 meters, dispersants cannot be used. A 2011 USGS report recommended: "substantial scientific and technical work as outlined by various expert groups still must be done before dispersants can be considered a practical response tool for the Arctic."[42]

In a study commissioned by Canada's National Energy Board, S.L. Ross Environmental Research took those limits and compared them to actual Arctic conditions during the open-water season, based on 20 years of weather data.[43] The company found that in the Beaufort Sea, even in June, the most favorable month, weather and ocean conditions would prevent the use of these three clean-up methods nearly 20 to 84 percent of the time.

In contrast to the Gulf of Mexico, the Chukchi and Beaufort are far away from the equipment and personnel needed during such an emergency. The U.S. Coast Guard would oversee cleanup, and its nearest base is in Kodiak, more than 1,000 miles away. "We have extremely limited Arctic response capabilities," Admiral Robert J. Papp, Jr., testified before a U.S. Senate subcommittee in August 2011. "We do not have any infrastructure on the North Slope to hangar our aircraft, moor our boats or sustain our crews. I have only one operational icebreaker."[44] The closest cache of clean-up equipment is in Seattle—2,000 miles away.

CHAPTER III. THE ARCTIC SEACOAST IS UNIQUE

The Arctic Ocean is Earth's most extreme ocean, featuring year-round ice and major changes in light from season to season. Because of the special natural qualities now at such risk, the Natural Resources Defense Council (NRDC) and the International Union for Conservation of Nature have identified the most ecologically valuable and vulnerable spots in the Arctic, and recommended that they be protected as part of a system of marine sanctuaries.[45] The list represents the findings of an international workshop held at the Scripps Institution of Oceanography in 2010, attended by top scientists from around the Arctic and leaders of indigenous communities.

Helping make this part of the world unique are the Alaska Natives who live along the coast. One of the oldest continuously occupied Inupiat areas in Alaska, Point Hope, with a population of about 700, lies on a gravel spit that juts several miles into the Chukchi Sea. These people depend on fishing and whaling for survival. Former Mayor George Kingik has said that anything that threatens his constituents' way of life is not worth the risk: "The whole community depends on our ocean, so that's what we need to protect."[46]

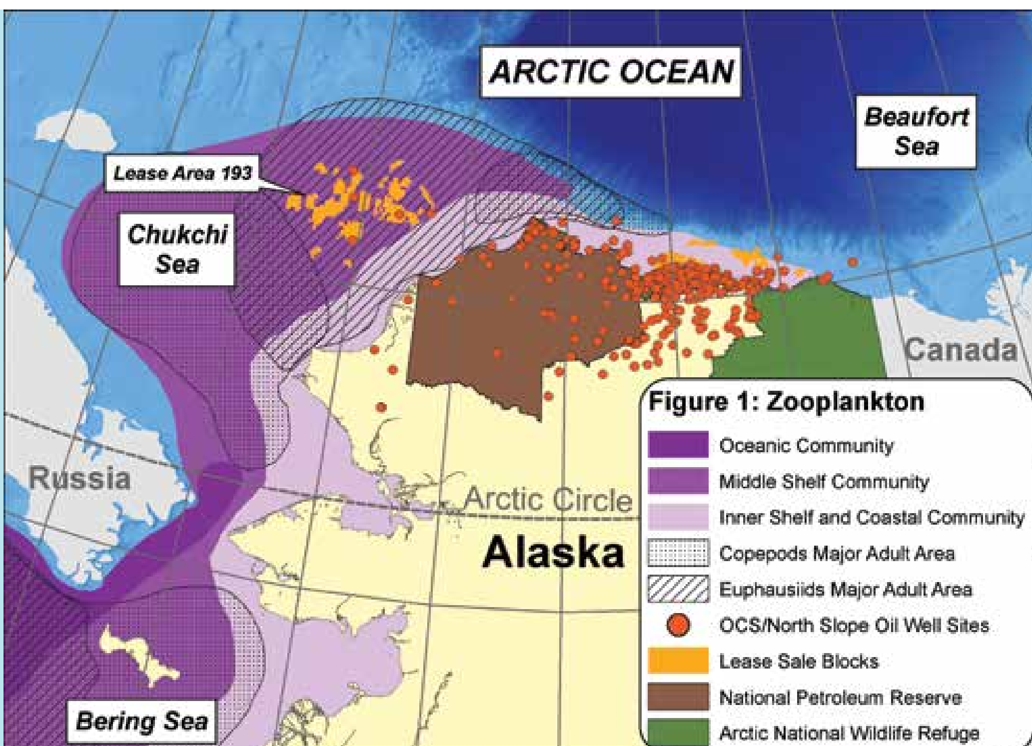
The Chukchi and the Beaufort, like other parts of the Arctic, feature species highly adapted to this unique environment. Bowhead whales, for example, are the only animals in the world adapted to break through heavy sea ice.[47] In the spring, on the Chukchi Sea continental shelf, the first direct exposure to sunlight causes a major bloom of algae and phytoplankton near the ice edge (figure 1).[48] Microzooplankton quickly begin consuming phytoplankton, prompting large zooplankton (mainly copepods) to ascend from their winter homes on the sea floor and feed. Unbound carbon, critical nutrients, dead phytoplankton and waste products drift down to the sea floor, where they sustain an array of species, such as mollusks and amphipods, which in turn are eaten by epifaunal invertebrates and small fish living just above.[49] These invertebrates are the principal food for walruses and other marine wildlife.

Pacific walrus are among the species that migrate to this region each spring. They arrive from the Bering Sea as the ice melts. Other migrants include beluga and gray whales, and four species of ice seals: ringed, bearded, ribbon, and spotted. Millions of birds, travelling from virtually every continent, fly to the area to breed, feed, and nest. The list includes spectacled eiders, king eiders, yellow-billed loons, and Arctic terns. The U.S. portion of the Chukchi is home to 18 Important Bird Areas (IBAs), as identified by BirdLife International (figure 2).[50]

Year-round residents include the polar bear. All of the nation's remaining polar bears depend on this ecosystem, with some biologists predicting that, without intervention, this population will vanish by mid-century (figure 3).[51]

FIGURE 1

Comprising the base of the food web and ecosystem in the Chukchi and the Beaufort Seas, many forms of zooplankton would be threatened by industry and potential oil spills. Copepods are small crustaceans typically one to two millimeters in size and usually the predominant members of the zooplankton community: they a major food source for fish, whales, seabirds and larger crustaceans such as krill (euphausiids).



Sources: National Oceanic and Atmospheric Administration (NOAA), Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, "Bering, Chukchi and Beaufort seas coastal and ocean zones strategic assessment data atlas,"1988.

FIGURE 2

The U.S. portion of the Chukchi is home to numerous Ecologically or Biologically Significant Areas (EBSAs) and Important Bird Areas, including significant breeding habitat and migration flyways for the declining King Eider. Most of the coastal areas of the southern Beaufort Sea are also internationally recognized for their status as EBSAs because of their continent-wide or globally-significant wildlife and habitat.

Sources: EBSAs were determined at a workshop held at the Scripps Institution of Oceanography in La Jolla, California on November 2 to November 4, 2010. The La Jolla workshop utilized criteria developed under the auspices of the Convention on Biological Diversity to identify ecologically significant and vulnerable marine areas that should be considered for enhanced protection in any new ecosystem-based management arrangements. King Eider migration data from: National Oceanic and Atmospheric Administration (NOAA), Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, "Bering, Chukchi and Beaufort seas coastal and ocean zones strategic assessment data atlas,"1988; S. Oppel, "King Eider migration and seasonal interactions at the individual level," Dissertation, University of Alaska Fairbanks 2008; and Audubon Alaska, 2009. King Eider, GIS feature class.

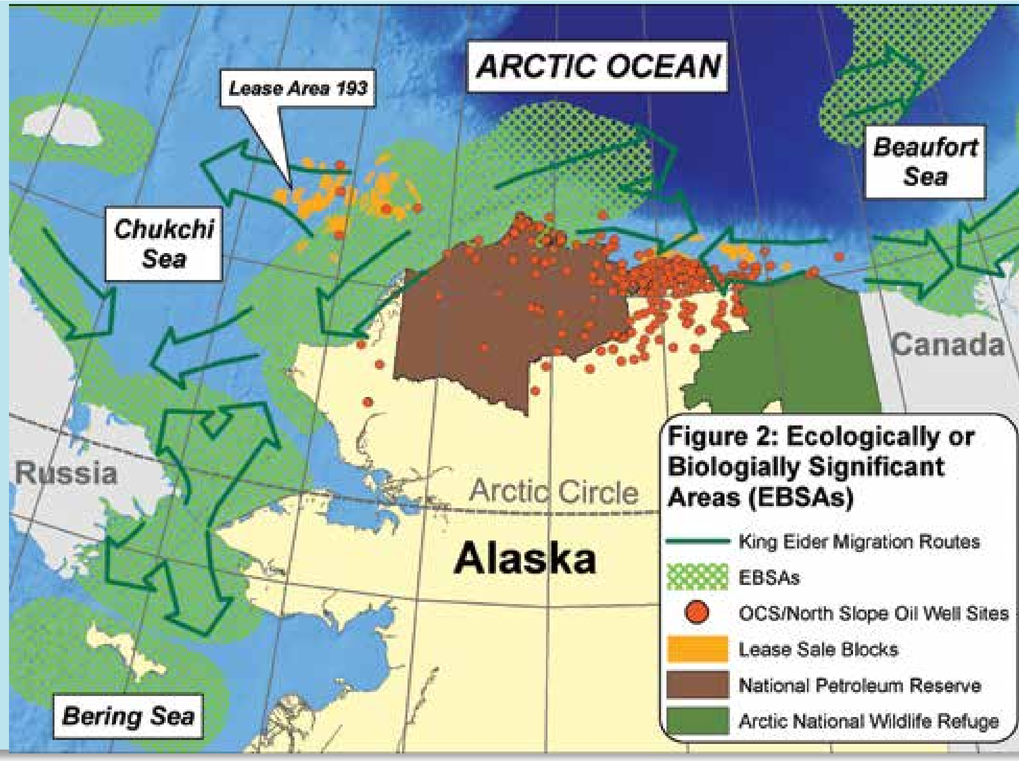
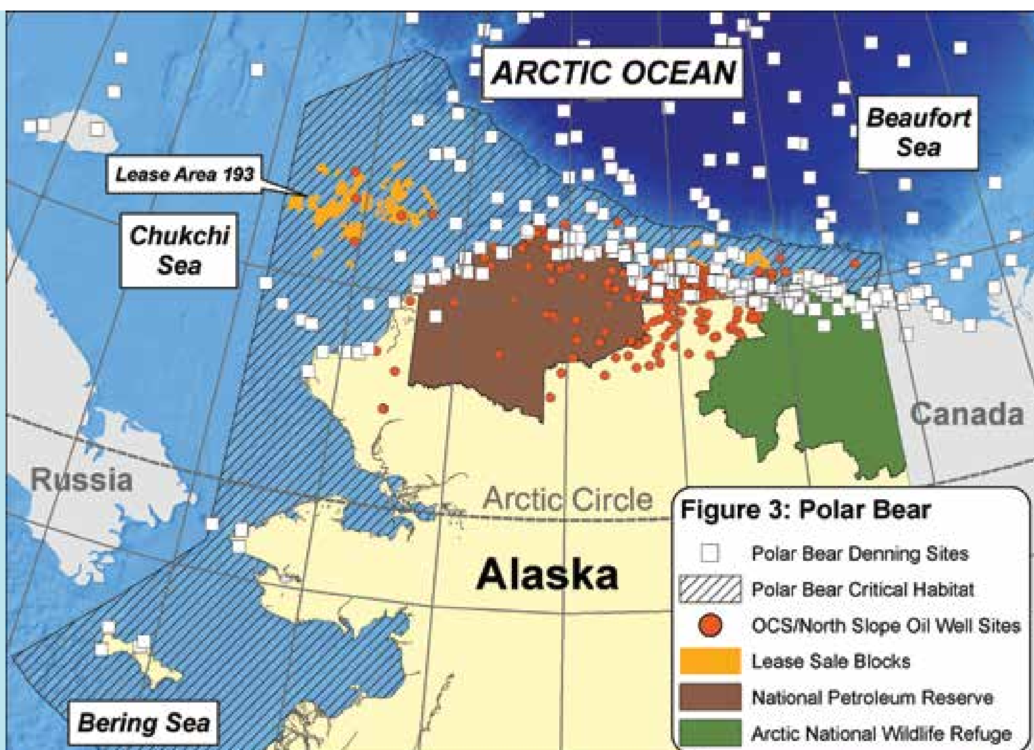


FIGURE 3

A vast area stretching from the Bering to Beaufort seas has been identified as critical habitat for imperiled polar bears.

Sources: Critical habitat data obtained from the U.S. Fish and Wildlife Service Critical Habitat Portal (http://criticalhabitat.fws.gov/crithab/), and observed polar bear den site locations obtained from the George M. Durner, Anthony S. Fischbach, Steven C. Amstrup, and David C. Douglas, "Catalogue of Polar Bear (Ursus maritimus) Maternal Den Locations in the Beaufort Sea and Neighboring Regions, Alaska, 1910–2010," U.S. Geological Survey, (http://pubs.usgs.gov/ds/568/).



CHAPTER IV. TOO LITTLE KNOWN ABOUT ARCTIC ECOSYSTEMS TO PREDICT RESPONSE TO SPILLS

"The Arctic Ocean is the least well known ocean on the planet," the U.S. Arctic Research Commission said in 2005. "We know more about the topography of the planets Venus and Mars than we do about the bathymetry of the Arctic Ocean."[52] Because the Arctic is unique, remote and less accessible, scientists know less about what lives there and how the ecosystem functions. Even less is known about the offshore areas. As a result, the likely and potential impacts of large-scale development are a matter of speculation.

In 2003, the NRC created a list of data gaps for the oil industry to tackle, and a USGS report in 2011 found that many of those gaps remain, while new ones have arisen.[53] The USGS addressed four basic topics: climate change, oil spills, the effect of noise on marine mammals, and cumulative impacts. The agency found that although there is a great deal of scientific information on many aspects of these four topics, it "is not synthesized and is not integrated." In other words, we still need to put all the pieces together to understand how things really work in Arctic waters and which questions should be asked.

Top scientists in the U.S. and worldwide agree. In a January 2012 letter, 573 of them called on President Obama and Interior Secretary Salazar to act on the USGS recommendations before authorizing new oil and gas activity in the Arctic Ocean. The many unanswered questions include:

- How is climate change remaking the Arctic, particularly in the structure of the food web and the populations of fish, marine mammals, birds, and other species?
- With less summer sea ice serving as a base for marine mammals and the ice-benthos coupling ecosystem diminished, will bowhead whales and other original coastal North Slope species be able to compete with other baleen whales for limited resources?
- How will such impacts be affected by proposed expansion of oil and gas drilling and other commercial activity?
- With the continental shelf areas now free of summer ice, will oil spills jeopardize more of the surface-area feeding hot spots?
- How will the area's unique ocean currents and weather patterns affect spills and their cleanup?
- How will the limited infrastructure of the North Slope be able to accommodate the influx of personnel and equipment necessary to respond to a "worst case scenario" type spill?
- How can oil effectively be separated from sea ice, or from sea ice containing waters?
- What effects would lingering oil have on the Arctic ecosystem if the arrival of winter forces a months-long halt in cleanup activity?
- What socio-cultural and socio-economic impacts are foreseeable for the indigenous people who rely on a healthy Arctic environment?
- Even if some of the individual impacts of climate change and oil drilling can be determined reasonably well, what are the likely cumulative effects of all this rapid change?

Much of the critical research is based on the current context of a relatively pristine Arctic.[54] Therefore, according to the USGS report mentioned previously, the research results could be used to create an ecological baseline from which to assess further human-induced changes. However, this reference point is shifting rapidly. Research should include input from indigenous residents and their Local Traditional Knowledge (LTK).

CHAPTER V. OFFSHORE OIL AND GAS DEVELOPMENT THREATEN VULNERABLE WILDLIFE

The potential of a large spill causing long-term damage to the environment—and to the industries that depend on it—was made clear by the Exxon Valdez accident of 1989, which killed an estimated 100,000 to 250,000 seabirds, at least 2,800 sea otters, 300 harbor seals, 247 bald eagles, and 22 orcas, and destroyed billions of salmon and herring eggs.[55] In subsequent years, sea otters and harlequin ducks suffered higher death rates, in part because they ate prey from contaminated soil and ingested oil residues on their bodies while grooming.[56] Prince William Sound and other places in the vicinity have yet to recover fully.[57]

Since North Slope oil tends to rise, it will make its way to open water surrounded by ice—areas known as "polynyas" (figure 4)—which are critical resting, breathing, and feeding areas for thousands of birds and marine mammals.[58] Even small amounts of leaked or spilled oil could kill many animals. Most of the coastal areas of the southern Beaufort are internationally recognized (for example, by the International Union for Conservation of Nature) for their EBSA or Super EBSA status (Ecologically and Biologically Significant Area; figure 2) because of their continent-wide or globally-significant wildlife and habitat.[59]

Furred and feathered animals suffer from contact with oil, both initially and afterwards. Spills immediately eliminate animals' thermal insulation, weigh them down, and lead to hypothermia or drowning. Some animals can die quickly from the initial toxic effects. Others suffer for weeks and months as the toxins damage their adrenal or immune systems, liver, lungs, kidneys, and other organs.[60]

Phytoplankton, zooplankton, other invertebrates, and their consumers, such as larger zooplankton and fish, can be destroyed immediately on contact by oil and are especially vulnerable during extended periods of exposure.[61]

Even when oil does not quickly kill an animal, it can damage its eyes or cause skin irritations. Such problems can compromise the animal's ability to reproduce, avoid predators, and find food and shelter. Survival becomes more of a challenge.

The impact of a spill is likely to be magnified by ocean currents (figure 4), which can move oil and chemicals substantial distances. Oil could be carried from Shell's Burger site, for example, 57 miles to the Kasegaluk Lagoon/ Wainright region on Alaska's northwestern coast. The area from the lagoon to Barrow Canyon and beyond was recently designated as critical habitat for polar bears and implemented in January 2011(figure 3).[62]

The many species that would face increased risks from drilling in the Chukchi and Beaufort include (see appendix A):[63]

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Pacific walrus: The reduction in sea ice is a serious threat to this species, which relies on sea ice for avoiding predators, resting, giving birth, and other activities. In recent years, in response to this loss of ice, many walruses have been hauling out onshore west of Barrow, often in groups estimated to range from 10,000 to 20,000 animals.[64] When numbers are this large, there can be significant mortality from the crushing of young, especially by large males, as groups panic in response to industry-related sounds, aircraft, and other disturbances.[65] Ice-breaking activity associated with offshore drilling has disturbed walrus up to 15 kilometers away.[66] Walruses are particularly at risk from oil spills because the benthic invertebrates that are so critical to their diet accumulate hydrocarbons.[67] According to an MMS analysis of potential spills in the Chukchi, there is up to a 58 percent chance that the oil could reach Hanna Shoal, an important feeding area for Pacific walrus.[68]

Polar bear: This species depends on sea ice, particularly when hunting for ringed and bearded seals, the number-one staple in its diet. Many polar bears are striving to reach distant offshore ice—farther than 500 kilometers in some areas (figures 3 and 4)—and not reaching it. Some bears have drowned, apparently due to exhaustion from the long swim, and some young have washed up dead.[69] Oil reduces the insulating capacity of a bear's fur and also tends to be ingested during grooming. With the USGS and the U.S. Fish and Wildlife Service predicting that the U.S. polar bear population will not survive beyond the middle of this century, the additional threats posed by oil drilling in the Arctic Ocean make the outlook even gloomier.[70]

Bowhead whale: A species of baleen whale, the bowhead eats low on the food chain on dense concentrations of zooplankton, especially copepods.[71] Shell's lease sites sit in the feeding and migration pathway of bowheads (figure 5). Based on the experience of the bowhead's close relation, the right whale, along the East Coast of the United States, collisions with vessels associated with Arctic oil development could be the greatest contributor to bowhead mortality.[72] These whales are critical to the Inupiat.

Ringed seal: The smallest seal species, the ringed seal uses summer ice as a resting and foraging platform and thus is facing uncertainties due to the reduction in that ice. Ringed seals primarily eat fish in the midwater and demersal zones; any loss of that source due to spilled oil would pose a serious threat.[73] There is already concern that the climate-related changes in the region may prompt some seals, including ribbon seals, and several baleen whale species to extend their ranges north, where they might compete with ringed seals for food.[74]

Eiders: All four of these sea duck species (spectacled, common, Steller's, and king) use the Alaskan coastal plain from the Canadian border west at least to Point Lay (Kasegaluk Lagoon) for breeding, molting, and/or foraging (figure 2). Aircraft and vessel disturbance from travel back

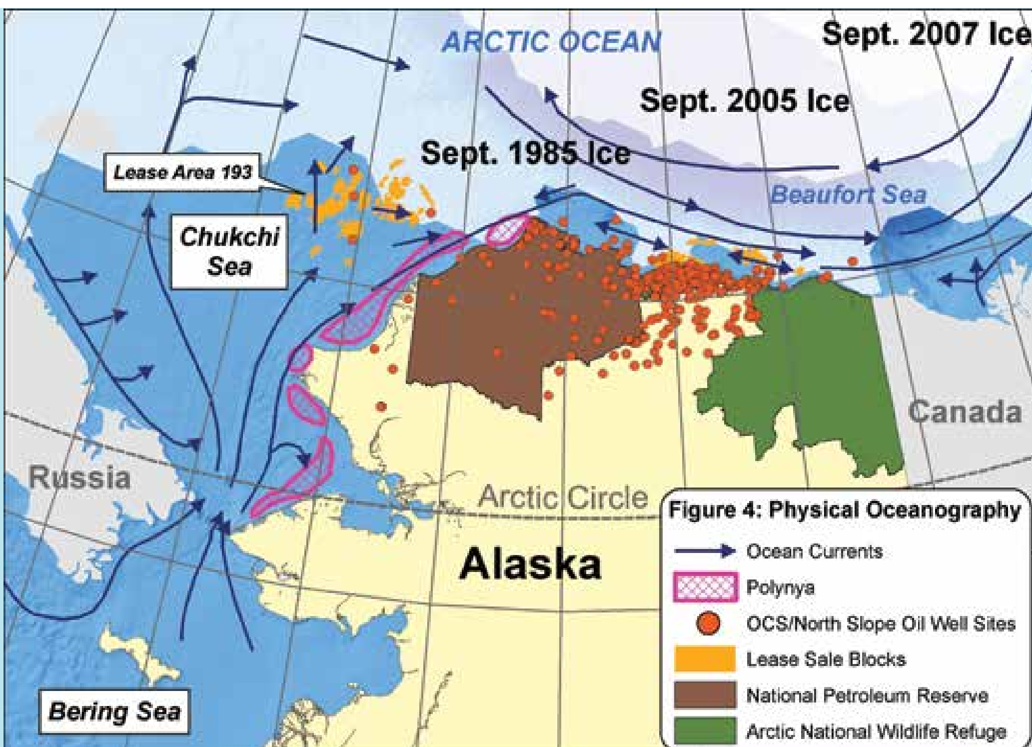


FIGURE 4

Oil from a spill in the North Slope would rise and travel to open water surrounded by areas of sea ice, including areas of special ecological significance—such as polynyas, zones of unfrozen sea within the ice pack often occurring with seasonal regularity—critical to the resting, breathing, and feeding of many marine mammals and birds. The impact of an oil spill would be magnified by ocean currents, which can move oil and chemicals substantial distances.

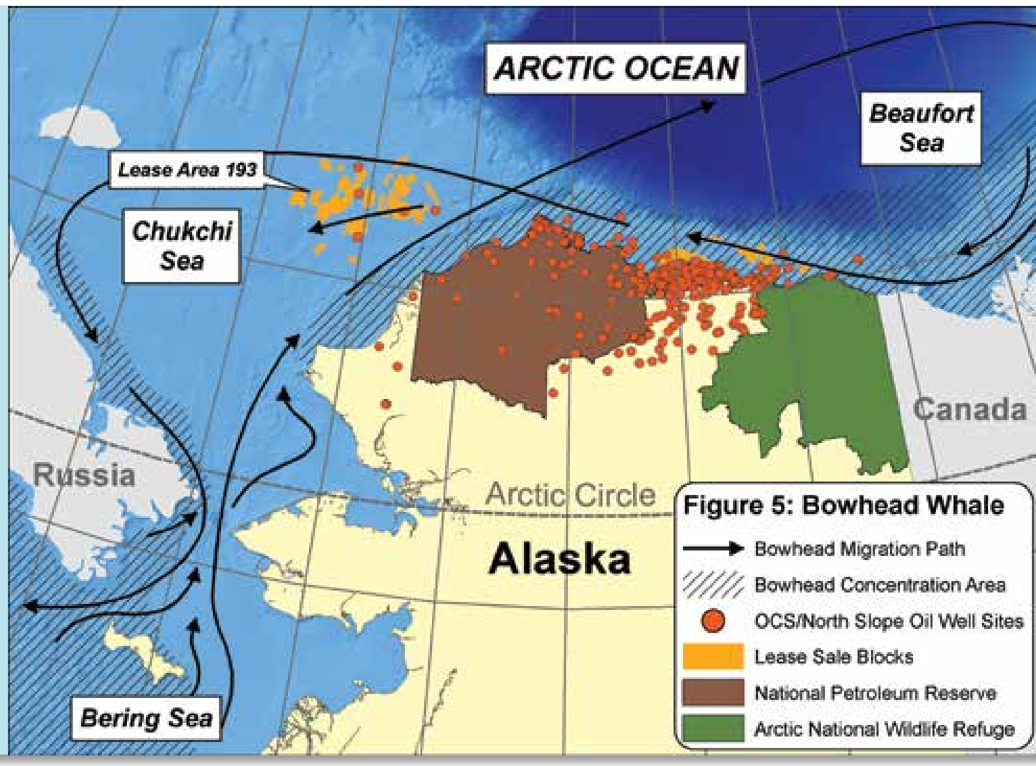
Sources: Historical measurements of sea ice extent from the National Oceanic Atmospheric Administration (NOAA), ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/shapefiles/Sep/shp_extent/; Source for arctic currents from the Audubon Marine Synthesis: Atlas of the Chukchi and Beaufort Seas, January 2010; Polynya extents along the Chukchi coast of Alaska from Arctic: Vol. 41, Groves and Stringer, 1991.

and forth between the coast and the drilling areas would coincide substantially with those critical eider activities. In addition, ocean currents could carry drilling muds, chemicals, and spilled oil from the Chukchi/Hanna Shoal region to the coastal areas from Cape Lisburne to Barrow (figure 4). According to a U.S. Fish & Wildlife Service analysis of the proposed lease sale 193 development, if oil were to reach the spring lead system in the Ledyard Bay Spectacled Eider Critical Habitat Area, which Steller's eiders use to migrate up to their nesting areas, most Alaska-breeding Steller's eiders could be killed, which would be a "catastrophic population-level mortality event for this listed species."[75] With a decline of 96 percent in the North Slope common eider population and decreases of more than 50 percent for other species of eiders and long-tailed ducks, additional threats to these ducks need to be kept to a minimum.[76]

FIGURE 5

Shell's lease sites sit in the feeding and migration pathway of bowhead whales, critical to the Inupiat people. Collisions with vessels associated with Arctic oil development could be the greatest contributor to bowhead whale mortality.

Sources: Bowhead whale migration data obtained from the National Center for Atmospheric Research Earth Observatory Laboratory (http://data.eol.ucar.edu/codiac/dss/id=106.310); Bowhead whale concentration areas from National Oceanic and Atmospheric Administration (NOAA), Strategic Assessment Branch, Ocean Assessments Division, Office of Oceanography and Marine Assessment, "Bering, Chukchi and Beaufort seas coastal and ocean zones strategic assessment data atlas,"1988; S.E. Moore and K. L. Laidre, "Trends in sea ice cover within habitats used by bowhead whales in the Western Arctic," Ecological Applications 16 (3) 2006, 932-944; NOAA, Environmental Sensitivity Index, version 3.0, Seattle, Washington, 2002; and Audubon Marine Synthesis: Atlas of the Chukchi and Beaufort Seas, January 2010.



CHAPTER VI. INUPIAT DIET AND CULTURE COULD BE UNDERMINED

For more than a millennium, Inupiat and other Alaska Natives living along the coast have developed diets and ways of life that could be substantially diminished if the natural world they depend on suffers significant damage from oil and gas activities. Bowhead whales are a primary source of subsistence food and are central to North Slope Inupiaq cultural identity.[77]

Recognizing the importance of subsistence resources to the Alaska Native communities, BOEM incorporated LTK into the Final Supplemental Environmental Impact Statement (EIS) for lease sale 193, requiring a finding of significance be triggered whenever “adverse impacts disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.”[78] However, corrective measures may not be sufficient to safeguard Alaska Natives’ subsistence rights as legally provided by the Alaska National Interest Lands Conservation Act of 1980, and recognized by the United Nations as human rights. Article 1 in both the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social and Cultural Rights reads, “In no case may a people be deprived of their own means of subsistence.”

Traditional hunters with LTK understand that bowhead whales are extremely sensitive to noise. Extreme quiet is observed during subsistence hunts, as even the ‘ping’ made by an oar hitting the side of a boat can diminish the success of the hunt.[79]

Further study is required to understand how bowhead whales will react to the seismic exploration, as well as drilling and various industry noises involved in oil and gas development in the Chukchi and Beaufort Seas. Failure to adequately understand these variables may reduce Alaskan Natives’ access to subsistence resources and ultimately violate their human rights.

CHAPTER VII. THE ARCTIC IS ALREADY COMPROMISED BY CLIMATE CHANGE

With temperatures increasing faster in the Arctic than anywhere else on Earth, the area is undergoing physical changes at an alarming rate. Summer sea ice off Alaska's North Slope is melting at the fastest rate ever recorded, dramatically weakening the foundation on which Arctic ecosystems function.[80] Major industrialization would increase the challenges faced by phytoplankton, at the base of the food chain, and potentially threaten many species that have evolved in this difficult environment.

Open water now extends more than 310 miles offshore in some areas during the summer, a 25 percent increase since 1985. This expansive open water sets the stage for greater wave energy and height. In the Chukchi and Beaufort Seas and sub-Arctic areas through the Bering Strait, climate change has eroded coastlines, exposing and melting permafrost at an ever-increasing rate.[81] Waves and wind now push more water onshore, hastening permafrost melt and increasing freshwater drainage to nearshore waters, thereby reducing salinity and raising temperatures of coastal lagoons and estuaries, and restructuring coastal ecosystems.[82]

In addition, earlier melting and formation of open water allows more time each year and greater area for solar radiation to reach the sea surface. This now-open water provides less insulation to maintain the low water temperatures to which sea life is accustomed. The earlier melting also advances, by several weeks, the bloom of primary production and grazing by microzooplankton.[83] This has direct consequences across the food web. One result is less zooplankton for bowhead whales and many species of fish. Another result is fewer ice-associated small fish, which are important to ringed seals. Significant changes are also likely for bottom- and near-bottom-feeding walrus, bearded seals, gray whales, and numerous fish species.[84]

With the decline of ice cover, vessel traffic has begun to increase, and various interests—shipping, tourism, and mining—are promoting rapid growth in commercial ventures besides oil and gas drilling.[85] Ships and smaller vessels already navigate regularly through the Bering Strait.[86] In 2009, the Arctic Council issued the first major report focusing on Arctic vessel traffic and cited several environmental concerns:[87]

"The most significant threat from ships to the Arctic marine environment is the release of oil through accidental or illegal discharge. Additional potential impacts of Arctic ships include ship strikes on marine mammals, the introduction of alien species, disruption of migratory patterns of marine mammals and anthropogenic noise produced from marine shipping activity. Changes in Arctic sea-ice will not only provide for possible longer seasons of navigation, but may also result in increased interaction between migrating species and ships. Black carbon emissions from ships operating in the Arctic may have regional impacts by accelerating ice melt. Other ship emissions during Arctic voyages, such as SOx and NOx, may have unintended consequences for the Arctic environment and these emissions may require the implementation of additional IMO environmental regulations."

Due to coastal erosion, flooding, and the melting of permafrost, a dozen villages are at some stage of moving.[88] In 2009 the U.S. Army Corps of Engineers' Alaska District concluded that 26 villages required immediate action to deal with problems caused by erosion, while another 69 should be monitored closely.[89] Kivalina, located on a barrier island that as recently as 1953 comprised 54 acres, now is down to 27 acres.[90] A single storm, according to a report by the Alaska Village Erosion Technical Assistance program (AVETA), can erode up to 15 feet of land along the Alaskan coastline.[91] That report estimated that it would cost $95 million to $125 million to move Kivalina alone.[92] The impact on the livelihoods and culture of Alaska Natives is more difficult to measure.

Perhaps the overriding consequence of climate change in the Arctic is that it has increased the ecological vulnerability to other impacts.[93] Because of the toll already taken on wildlife, landforms, ecosystems, and humans, there is probably less capacity to absorb damage from oil and gas development. Such stresses and the cumulative effects will have a proportionally greater impact than they would have had absent climate change.[94]

CHAPTER VIII. ARCTIC DRILLING GENERATES GREENHOUSE GASES

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The planet's climate is changing at a dramatic pace. The United States and other nations are trying, with mixed success, to reduce the emissions considered responsible for climate change. Unfortunately, the International Energy Administration (IEA) projected in May 2012 that the planet will warm by an average of six degrees Celsius by the end of this century.[95]

North Slope oil facilities generate 24,000 metric tons of methane and 7 million to 40 million metric tons of carbon dioxide, annually.[96] Drilling in the Chukchi and Beaufort will drive up those totals. The production process, in addition to the energy consumed during exploration, construction, transportation, and other phases of the industrial project, will burn enormous quantities of fossil fuels.

If the United States and other nations are serious about slowing climate change—and we do need to be serious about it—the vast sums being sunk into Arctic drilling should be invested in clean energy sources. Wind energy is an affordable, efficient, and inexhaustible source of electricity. It is pollution-free and cost-competitive with energy from new coal- and gas-fired power plants. By the end of the decade, solar energy could become cheaper than conventional electricity in many parts of the country, and the continued growth of the industry could create hundreds of thousands of American jobs.[97]

CONCLUSION: TOO LITTLE KNOWN, TOO MUCH AT RISK

It is premature to proceed with oil and gas exploratory drilling and other oil and gas activities in the Beaufort and Chukchi Seas. Scientists still have much to learn about the remote area where Shell and other oil corporations want to drill. The intricate workings of Arctic Alaska's unique ecology remain mysterious in many ways. Perhaps even less is known about the likely effects of accidents that would result from large-scale oil and gas drilling. But there will be accidents; nowhere on Earth has oil development occurred without spills and other incidents. Even if there were no such calamities, vessel traffic and other commercial activity generated by oilfield development would take a toll on the environment and the Alaska Natives tied to the natural world. In addition, it would be ironic, as well as tragic, for this nation to undertake a project that will exacerbate climate change in the very place where the dangerous impacts of this phenomenon are most obvious.

Given the uncertainties and the high stakes, further development should be postponed until:

- Spill response methods and technology are proven to be effective
- Necessary infrastructure is in place for timely spill response
- There is significantly greater understanding of the ecosystem and how it may be affected by oil spills
- Wildlife populations and indigenous subsistence have been assured of absolute protection
- A substantial permanent reserve system has been established both on-shore and off-shore
- It can be demonstrated that oil and gas activities do not increase or exacerbate potential harm to the life in and around the Beaufort and Chukchi Seas

It will never be possible to answer every last question, but at this point, far too many critical questions remain.

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APPENDIX A

Status of Selected Arctic Wildlife and Sensitivity to Human Activities off Alaska's North Slope and the Beaufort and Chukchi Seas							
Species	**Endangered or Threatened Status**	**Overlap of Alaska Population with Imminent/OGD and Lease Areas:** Nil ~0 Low=Less than 25% Medium=25% to 49% Moderate=50% to 74% High=Greater than or equal to 75%	**Habitat Protection Status**	**Present Population and Trends**	**Most Critical Threats**	**Ice Dependency:** Nil Low Medium Moderate High	**Cumulative Effects Threshold:** Well below Rising Approaching Exceeded
Polar bear	Threatened; suggested endangered by biologists but U.S. government stalling; MMPA protected IRL	**High** coastally from entire North Slope, east to Canada and Chukchi, including lease area 193	USFWS Proposed Critical Habitat across entire Chukchi/ Beaufort coast and continental shelf, including all present lease areas	Chukchi/Bering Sea stock approximately 2,000; Southern Beaufort Sea population approximately 1,500	Loss of Sea ice; oil spills; industrial disturbance; loss of snow cover critical for denning areas; loss of coastal denning due to sea level rise	**High** Ice-obligate	**Exceeded** Many scientists predict extinction in 30 years due to dependency on sea ice and recent extreme ice loss rates
Pacific walrus	Proposed for threatened status; MMPA protected	**High** from Smith Bay/ Barrow to Wainright from coast west and northwest across lease area 193, Hanna shoals to Russian border	None Designated	World (Alaskan/ Russian) population approximately 200,000	Present ice loss trends; acidification threatens benthic prey; vulnerable to disturbance on coastal haul outs	**High** Ice-obligate	**Exceeded** Dependency on sea ice; recent extreme ice loss rates; acidification rates affecting prey base
Bow-head whale	Endangered; MMPA protected	**High** along all Alaskan coast and shelf areas of the Beaufort **Moderate** beyond continental shelf, westward in the Chukchi Sea including lease area 193	Alaskan Eskimo "quiet" areas centered around Kaktovik, Stefansson Sound/Prudhoe Bay, Barrow/ Smith Bay and others	World population between 9,000 and 10,000; population of 1,900 in Beaufort/ Chukchi recovering over last 20 years after severe overharvesting	Direct disturbance from seismic, drilling, and other industry noise; collisions with vessels especially other expanding activities in Arctic; oil spills; ocean acidification could destroy prey base	**High** Predator avoidance and prey associated with ice	**Rising** Dependency on sea ice; recent extreme ice loss rates; acidification rates affecting prey base
Beluga whale	MMPA protected	**Moderate to High** from barrow and Smith Bay east to Canadian border, especially. OCS area including Shell lease areas during spring to fall	None designated	Combined eastern Chukchi and eastern Beaufort stocks; Approximately 35,000 population trend unknown	Ice loss; coastal estuary degradation from coastal oil spills; industrial noise disturbance; degradation of prey related to climate change	**High** Loose annual pack ice, polynyas, leads	**Rising** (see Critical Threats section)
Ringed seal	MMPA protected	**Highly** concentrated in all past and present lease areas from coastal plain and out across OCS along all Alaska's north and west coasts to lower Bering Sea and concentrated on Hanna Shoals and lease area 193	None Designated	Alaska stock is approximately 250,000; world population is essentially in a continuum across Arctic Ocean year round; trend unknown but likely declining rapidly due to ice loss	Ice loss; coastal and continental shelf oil spills; ocean acidification; diminishing prey base	**High** Needs snow lairs on ice for young and to hide from polar bears	**Rising (fast)** Especially due to ice loss (see Critical Threats section)
Bearded seal	Under ESA review; MMPA protected	**Highly** concentrated across entire continental shelf to shelf break from Canada west out past U.S./Russian border in the Chukchi incl. Hanna Shoal and lease area 193	None designated	Alaska population is approximately 275,000; trend not known	Ice loss acidification	**High** Migration, resting, pupping, molting on ice; follow ice edge in summer; rarely haul out on land	**Rising** (see Critical Threats section)

Status of Selected Arctic Wildlife and Sensitivity to Human Activities off Alaska's North Slope and the Beaufort and Chukchi Seas							
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Stellars eider	Threatened (ARL; IRL)	**High** with breeding population on Prudhoe Bay area **Moderate** elsewhere; summer breeding, nesting from Kasegaluk Lagoon to Prudhoe Bay	None designated	Worldwide population is 220,00 and declining; 150,000 over winter on western Alaskan coast; 2,000 breed along Alaskan coastal plain	Disturbance from industrial sound; acidification effects on benthic prey; habitat loss; coastal oil spills; increased predation supported by industry waste in settlements	**Low** (during summer) **High** within Polynyas in winter	**Rising or Approaching** declining trend (see Critical Threats section)
Spectacled eider	Threatened (ARL)	**High** in Prudhoe to Camden area **Moderate** elsewhere: spend all year in Arctic/subarctic; summer breeding, nesting from Kasegaluk Lagoon to Camden Bay	USFWS Critical Habitat Norton Sound to Ledyard Bay	Worldwide population of 360,000 saw 96% decline between 1970 and 1993 on the Yukon/ Kuskokwim Delta	Disturbance from industrial sound; acidification effects on prey; oil spills; poisoning from hunter's lead shot; increase in predation subsidized by waste in communities	**Low** (during summer) **High** within Southern polynyas in winter	**Exceeded** 96% decline in some areas
King eider	Threatened (ARL)	**High** from Prudhoe to Wainright area; **Moderate** in Chukchi feeding areas **Low** elsewhere; east into Canada; breeds all along North Slope and Wainright east to Canada; along Alaskan west coast and south to Washington state	None designated	Worldwide population is 1 million; 45,000 in Alaska; Barrow migration count decreased 55% during first era of hydrocarbon development between 1976 and 1996	Disturbance from industrial sound; acidification effects on benthic prey; habitat loss; coastal oil spills; increased predation supported by industry waste in settlements	**Low** (during summer) **High** within southern polynyas in winter	**Exceeded** 55% decline in migration counts off Barrow
Long-tailed duck	ESA ARL	**High** in Prudhoe and east **Moderate** elsewhere; breeds from North Slope and east along coastal plain to Canada; winters along Alaskan west coast and south to Washington state	None designated	Worldwide population is 6.5 million; 1.5 million in North America; 200,000 in Alaska; decreased more than 50% in first oil and gas era between 1975 and 1998	Vulnerable to single impact events	**Low** (during summer off Alaska)	**Exceeded** More than 50% decline in Alaska
Ivory gull	Near Threatened (ESA; ARL; IRL) Endangered (SARA) SARA endangered	**High** in Hanna Shoal area near lease area 193; summers in Chukchi and Beaufort Seas generally offshore; poorly known	None designated	World population is 28,000 (after 80% decrease since 1990)	Preys on ice-associated fish, invertebrates; great concern relative to ice loss; likely high risk in Hanna Shoals related to important feeding concentrations located at lease area 193	**High** Summer feeding areas offshore (Hanna Shoal/ Chukchi)	**Exceeded** 80% world population decline; and extreme ice melting in Beaufort and Chukchi Seas

Column 3 overlap percentage generally seasonal. Estimates acknowledge quality and gaps in data. ESA=Endangered Species Act; MMPA=Marine mammal Protection Act; ARL=Alaska Aud. Red List (Vulnerable + Declining); IRL=IUCN Red list; SARA=Canada's Species At Risk Act.; OGD=oil and gas development.

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