Chukchi 2010 Seismic Marine Survey Cumulative Effects Analysis Chukchi Sea, Alaska

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Prepared for

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ACRONYMS AND ABBREVIATIONS

bbl	Barrels
CPAI	ConocoPhillips Alaska, Inc.
cu m	Cubic Meters
dB	Decibels
EA	Environmental Assessment
EED	Environmental Evaluation Document
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ft	Feet
GHG	Greenhouse Gas
HAPs	Hazardous Air Pollutants
hr	Hour(s)
IHA	Incidental Harassment Authorization
ITR	Incidental Take Regulations
km	Kilometer(s)
LOA	Letter of Authorization
m	Meter(s)
MARPOL	International Convention on the Prevention of Pollution from Ships
mi	Mile(s)
MLC	Mud-lined Cellar
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
M/V	Marine Vessel
NAAQS	National Ambient Air Quality Standards
nm	Nautical Miles
NMFS	National Marine Fisheries Service

NPDES	National Pollutant Discharge Elimination System.
NSB	North Slope Borough
NWAB	Northwest Arctic Borough
PM	Particulate Matter
PSD	Prevention of Significant Deterioration
PTS	Permanent Threshold Shift
OCS	Outer Continental Shelf
OSR	Oil Spill Response
sq ft	Square Feet
sq m	Square Meters
TSS	Total Suspended Solids
TTS	Temporary Threshold Shift
USCG	U.S. Coast Guard
USFWS	United States Fish and Wildlife Service
VGP	Vessel General Permit

INTRODUCTION

This Cumulative Effects Analysis document expands on the Cumulative Effects section of the Environmental Evaluation Document (EED) for Statoil's Chukchi 2010 Marine Seismic Survey. Statoil submitted the EED in April 2010 to the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and Minerals Management Service (MMS). The EED supports the environmental analyses for the Incidental Harassment Authorization (IHA), Letter of Authorization (LOA), and Geological and Geophysical (G&G) permit. The information in the EED on physical, biological, and sociocultural resources is integral to this Cumulative Effects Analysis. The EED also includes:

- A more detailed project description for Statoil's 2010 Chukchi Marine Seismic Survey;
- The affected environment, including the physical and biological environment and socioeconomic resources in the vicinity of Statoil's proposed seismic activities; and
- An extensive discussion of the environmental consequences anticipated as a result of Statoil's proposed seismic survey.

The resource information in the EED is not replicated here; the EED is needed as a reference to the Cumulative Effects Analysis.

Three figures are included at the end of this Cumulative Effects document. Figure 1 depicts Statoil's three-dimensional (3D) marine seismic survey area along with the two-dimensional (2D) track lines, bathymetry, or water depths, and distance from the survey area to Chukchi communities. Figure 2 depicts the Statoil, 3D and 2D marine seismic survey areas, Shell's 2010 Chukchi exploration plan proposed drillsites, 2010 ecosystem baseline study areas, and historic exploration drillsites. Figure 3 depicts Statoil's project area in relation to Chukchi communities, Polynya Zone, and for resupply at Nome.

Cumulative impacts (effects) are defined in 40 CFR 1508.7 as:

> *The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*

As part of the MMS Chukchi Sea Oil and Gas Lease Sale 193 Environmental Impact Statement (EIS), the MMS prepared a cumulative effects analysis (MMS 2007a). The analysis considered oil and gas activities, as well as non-oil and gas activities, including sport and subsistence hunting and fishing, scientific surveys, and marine transportation. MMS evaluated the past, present, and reasonably foreseeable activities within the next 20 years. The types and level of activity in the Chukchi covered in the EIS were:

- Six seismic surveys from June to November; and
- Exploration or delineation drilling operations of up to four wells per drilling rig per year from June to November (although it was determined that realistically only one to two wells could be drilled, tested, and abandoned during a single season).

The EIS stated that a total of 5 exploration wells have previously been drilled on the Chukchi shelf, and estimated that 7–14 additional wells will be needed to discover and delineate the first commercial field.

The level, type, and location of the Statoil 2010 Chukchi Marine Seismic Survey and Shell's 2010 Chukchi proposed exploration activities are well within the range of activities described in the Lease Sale

193 EIS. Shell's Exploration Drilling Program for the Chukchi Sea is also within the range of activities covered by the MMS analysis. The greater than 70-page discussion of cumulative effects ended in the conclusion that the evaluated activities would not result in any significant cumulative effects.

Statoil's 2010 Chukchi Marine Seismic Survey is the only seismic survey proposed for the Chukchi Sea in 2010. Up to four seismic-survey-related geophysical exploration permits in both the Chukchi and Beaufort seas were included in a Proposed Action under an MMS and NMFS programmatic environmental assessment (PEA) {2006}. Even though NMFS and MMS determined an EIS, which is described below, would be needed in the future due to increased levels of seismic beyond the 2006 levels–four seismic surveys–this increase is not the case for 2010.

The Statoil 2010 Chukchi Marine Seismic Survey Cumulative Effects Analysis considers the oil and gas activities only in the Chukchi Sea during July through October 31, 2010. The following discussion of the National Environmental Policy Act (NEPA) review process is excerpted from Section 2.1.2 of the April 2010 EED.

NEPA reviews are conducted at various levels of detail and scope, depending on the nature of the proposed action. Some activities with well-known environmental effects may qualify for a Categorical Exclusion from further NEPA analysis, while other activities trigger an Environmental Assessment (EA) or the most rigorous level of review, an Environmental Impact Statement (EIS), depending on the perceived level of impact associated with the project or action. If the proposed action or project is not categorically excluded and the reviewer is unsure of the level of impact, the agency will prepare an EA. At the completion of the EA, the agency will either determine a finding of no significant impact (FONSI) and issue a FONSI to that effect or determine there will be a significant impact and elevate the NEPA review to the EIS level.

There have been several oil and gas-related Alaska OCS NEPA reviews in the past few years. The MMS prepares EISs for their 5-year leasing plans, including the 2007–2012 plan (MMS 2007b) that contained Lease Sale 193. The leasing plan reviews for NEPA were conducted by MMS headquarters. The MMS Alaska OCS Region subsequently prepared a more detailed EIS (MMS 2007a) specifically for the Chukchi Sea Lease Sale 193 for oil and gas lease sales including exploration seismic survey activity. In 2006, the MMS prepared a Final Programmatic Environmental Assessment for oil and gas seismic survey activity on the Beaufort and Chukchi Seas OCS (MMS 2006) and an accompanying FONSI (MMS 2006b). In 2007, the MMS and NOAA Fisheries/NMFS prepared a Draft Programmatic EIS (DPEIS) for oil and gas seismic survey activity on the Beaufort and Chukchi Seas (MMS and NMFS 2007c). Subsequently, on October 28, 2009, NMFS and MMS announced they are withdrawing the 2007 DPEIS and will initiate a new NEPA process (NMFS 2009). And most recently, in October 2009 and December 2009, respectively, the MMS prepared EAs and accompanying FONSIs for Shell's 2010 Exploration Drilling Programs in the Camden Bay OCS (MMS 2009c, MMS 2009d) and in the Chukchi Sea OCS (MMS 2009e, MMS 2009f).

Consistent with the Lease Sale 193 EIS Purpose and Need statement, MMS, utilizing their NEPA implementing rules, will prepare an EA specifically evaluating the effects of Statoil's planned seismic survey activity as presented in their G&G permit application. Likewise, NMFS will also prepare an EA for non-lethal, incidental take authorization of whales and seals. USFWS will issue a Letter of Authorization for non-lethal take of polar bear and Pacific walrus under its 5-year regulations under MMPA and the ESA.

The term "take" for the purposes of an IHA or LOA is defined by the MMPA as any action to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. "Takes" as addressed in an IHA or LOA are Level A takes which correspond to sound energies at decibel (dB) levels

>180 dB or >190 dB, dependent upon species. Harassment means any act of pursuit, torment, or annoyance that:

- Has the potential to injure a marine mammal or marine mammal stock in the wild; or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

The federal agencies will evaluate the direct, indirect, and cumulative effects of the Statoil 2010 Chukchi Marine Seismic Survey project as these terms are defined in the implementing NEPA regulations found in 40 CFR Part 1508.

The Statoil 2010 Chukchi Marine Seismic Survey EED incorporates the 2007 MMS analyses in the review of potential cumulative effects from the proposed seismic survey activities. This Cumulative Effects Analysis document serves to assess the potential impacts of Statoil's proposed program along with the effects of other reasonably foreseeable oil and gas activities being planned that could act in a cumulative nature with each other. Reasonably foreseeable activities in this analysis are assumed to be those proposed to take place between July and October 2010. The nearest activity geographically during this timeframe is Shell's proposed exploration drilling program on their Burger, Crackerjack, and SW Shoebill Prospects (see Figure 2). The closest proposed drillsite on Burger is 30 kilometers (km) (18.5 miles [mi]) from Statoil's three-dimensional (3D) marine seismic survey area.

The other activity considered in the 2010 Cumulative Effects Analysis is the joint ConocoPhillips Alaska, Inc. (CPAI)/Statoil/Shell ecosystems-based baseline studies. These baseline studies will be conducted on Statoil's lease blocks and over the Burger and Devil's Paw prospects using two research vessels. See prospects in Figure 2. The baseline studies are scheduled during July through October 2010, during the same time that Statoil will be conducting its seismic survey and Shell may be conducting exploration drilling activities. The baseline studies will focus on physical oceanography, plankton ecology, benthic ecology, fisheries ecology, marine mammal population survey, and sea bird population surveys. The study area for the baseline studies includes Statoil's leases, the Burger prospect, and the Devil's Paw prospect. Figure 2 shows the Chukchi Sea 2010 activities in the vicinity of Statoil's marine seismic survey.

The effects of the studies on the environment will be negligible. Therefore, this analysis will focus mainly on the potential for cumulative effects resulting from Statoil's seismic surveys and Shell's exploration drilling activities.

A description of Statoil's 2010 Chukchi marine seismic survey and Shell's proposed 2010 Exploration Drilling Plan for the Chukchi Sea follows this introduction.

For the purposes of this document, aspects of the activities that can act in an additive nature to increase the effects to the environment will be considered. Effects from Statoil's activities potentially contributing to cumulative effects in the Chukchi Sea are those associated with:

- Vessel traffic;
- Air traffic; and
- Noise.

The contribution of past activities to cumulative effects are not considered in this analysis, because the last activities conducted in the Chukchi Sea related to oil and gas exploration occurred nearly 20 years

ago. Benthic and water chemistry studies at historic well sites in the Arctic have demonstrated insignificant levels of contaminants from drilling muds and cuttings (Trefry and Trocine 2009).

Statoil will implement mitigation measures to ensure that effects—when aggregated with effects from other activities, exploration drilling, and baseline studies—will not result in significant effects to the environment (MMS 2009a).

1.0 STATOIL'S PROPOSED 2010 MARINE SEISMIC SURVEY

Statoil's proposed marine seismic survey is a sound-source data acquisition project using a sound-source array towed by a seismic source vessel. This seismic source vessel, the M/V *Geo Celtic* and two support/environmental monitoring vessels will mobilize out of Dutch Harbor, Alaska with crew and marine mammal observers (MMOs) onboard to the project area in early August 2010; the actual departure date is dependent upon ice and weather conditions. These sound-source arrays cannot be towed in ice conditions; therefore, the Chukchi marine seismic survey is highly dependent on an ice free operational window.

Figure 1 shows Statoil's lease blocks 3D seismic survey area, and 2D seismic survey track lines. The project area encompasses ~2,370 km^2 (915 mi^2) in Statoil lease holdings in the MMS OCS Lease Sale 193 area in the northern Chukchi Sea (Figure 1). The approximate boundaries of the total surface area are between 71° 30' N and 72° 00' N and between 165° W and 162° 30' W (Figure 1). The water depth in the survey area varies from 30 to 50 m (100 to 165 ft). A total of four 2D well tie lines with a total length of 675 km (420 mi) are also planned to be conducted. None of the survey will take place in nearshore waters within ~100 km (60 mi) of the coast. Directly upon arrival in the survey area, depending on ice conditions, the M/V *Geo Celtic* will deploy the airgun array and hydrophone streamers and start operating their guns for the purpose of sound source verification measurements. Upon completion of these measurements actual seismic data acquisition in the Chukchi Sea will start and are expected to continue for 60 days and be completed in the first half of October, weather depending. The data acquisition is a 24-hour operation. Data acquisition will be prioritized. The acquisition order will be defined based on starting date of the survey and weather conditions.

It is anticipated that transit time to the project area will be approximately 5 days. Data acquisition is expected to take 60 days. Upon completion of data acquisition, all vessels will demobilize back to Dutch Harbor. Although data acquisition is expected to take 60 days, all permits have been requested for the period from July 15 to November 30, 2010, to allow for contingencies and weather delays. The project data acquisition activities will be conducted by Fugro-Geoteam, Inc.

The primary interest of the proposed seismic survey is to obtain more details of the geologic subsurface formations of the 16 Statoil Chukchi leases (Figure 1). To achieve full data coverage in the area of interest, a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The size of this zone has been reduced to an absolute minimum and covers 2,370 square kilometers (km^2) or 915 square miles [mi^2] (Figure 1). The activities consist of 3D seismic data acquisition and a 2D tie line survey as a second priority program. Although the survey area is almost 100 miles offshore from the closest Chukchi coastal village of Wainwright, the 2D line will be transited well before the fall bowhead subsistence hunt begins.

The seismic source vessel M/V Geo Celtic is a modern vessel equipped with pollution controls. All vessels will use ultra low sulfur fuel. The M/V Geo Celtic will tow an airgun array at approximately 6 meters (m) (20 feet [ft]) depth and at a distance of ~275 m (900 ft) behind the vessel. The array will consist of 26 (plus 10 spare) G-guns (4×60 in^3, 8×70 in^3, 6×100 in^3, 4×150 in^3, and 4×250 in^3) with a total discharge volume of 3,000 in^3. One of the smallest guns in the array (60 in^3) will be used as the

mitigation gun. The vessel will travel along pre-determined lines at approximately 4–5 knots while the airgun array discharges approximately every 8–10 seconds (shot interval is approximately 18.75 m). The streamer hydrophone array will consist of ten to twelve streamers of up to approximately 2.2 miles (mi) (4 kilometers [km]) in length, with a total of 20,000–25,000 hydrophones at 2 m spacing. This large hydrophone streamer receiver array, designed to maximize efficiency and minimize the number of source points, will receive the reflected signals from the airgun array and transfer the data to an on-board processing system.

The entire program, if it can be completed, will consist of ~3,100 km of production line, not including transits or other periods when the airguns are not operating. Water depth within the study area is ~30–50 m (100–165 ft). There will be additional seismic operations associated with airgun testing, start up, and repeat coverage of any areas where initial data quality is sub-standard.

The M/V *Geo Celtic* and chase/monitoring vessels will be self-contained and the crew will live aboard the vessel. There will be one crew change and resupply in Nome in September. The M/V *Geo Celtic* will serve as the platform from which vessel-based MMOs will watch for marine mammals during the transit to the survey area, airgun operations, and transit back to Dutch Harbor. One or more chase/monitoring vessels will be used to protect the streamer from damage, for supply and support and for monitoring activities as required. All chase/monitoring vessels will have MMOs onboard and will assist with the implementation of mitigation measures. Chase/monitoring vessels will not be introducing sounds into the water beyond those associated with normal vessel operations. Helicopter operations are not planned as a part of the seismic survey and would occur only in the case of an emergency.

2.0 SHELL'S PROPOSED 2010 EXPLORATION DRILLING ACTIVITIES

Shell is planning an exploration drilling program in the Chukchi Sea during July through October 2010. MMS approved Shell's Exploration Plan (EP) to conduct exploration drilling at up to three of five possible drill sites, more than 97 km (60 mi) offshore, to evaluate the oil and gas resource potential of three prospects on the company's Outer Continental Shelf (OCS) leases in the Chukchi Sea (Burger, SW Shoebill, and Crackerjack Prospects). Figure 2 shows where Shell's prospects are located in relation to where Statoil will be acquiring seismic data. The time available for drilling and ice and weather conditions will determine the total number of wells that could be drilled. MMS determined that the drill sites, which have all been surveyed by Shell, are clear of any shallow hazards or archaeological and historical resources (MMS 2009a).

Shell anticipates that each well will take approximately 37 days to drill. This includes one day to set anchors, five days for Mud-lined Cellar (MLC) construction, one day to remove anchors, and one day to move the drillship. A well in the Burger prospect is Shell's first priority, weather and ice conditions permitting. If the drill sites at the Burger prospect are not accessible, the second priority will be to drill at the SW Shoebill prospect (Figure 2). If the Burger and Shoebill drill sites are not accessible, Shell will drill at the Crackerjack drill site, if weather and ice conditions allow. If Shell is drilling at either the SW Shoebill or the Crackerjack drill site, and conditions improve to allow drilling operations at the Burger prospect, the focus will be shifted back to the Burger drill site. If conditions and results from the first well at the Burger prospect are favorable, a second well may be drilled at a second Burger drill site (MMS 2009a).

Shell's drilling operations will be conducted using the drillship M/V *Frontier Discoverer* (*Discoverer*) that has been retrofitted and ice reinforced for operations in the Chukchi Sea. Shell is also planning an exploration drilling program in Camden Bay in the Beaufort Sea at the Torpedo and Sivulliq prospects, as

shown in Figure 2. The *Discoverer* is the sole drillship that will be used for both drilling programs. Therefore, activities associated with Shell's drilling programs will be occurring in either the Chukchi Sea or the Beaufort Sea at any given time between mid-July and the end of October, but not both (MMS 2009a).

A minimum of six vessels are proposed to accompany the *Discoverer*. Two ice management vessels (an icebreaker and an anchor handler) will remain close to the drill site to manage ice conditions. An oil spill response fleet, consisting of an oil spill response vessel, a tank vessel, and two smaller work boats will also accompany the *Discoverer*. In addition to the oil spill response fleet that will remain nearby the drill site, an oil spill response barge and a tug will be located in waters near Wainwright. A resupply ship will travel between Wainwright and the *Discoverer*, as needed, and a helicopter will travel to and from the *Discoverer* once per day to provide additional support such as crew changes. Additional vessels may be deployed to the drill site to provide support for marine mammal monitoring operations. Shell plans to establish temporary shorebase facilities at Barrow and Wainwright during the entire drilling period for air and emergency support (MMS 2009a).

According to the MMS Environmental Assessment (EA) for Shell's 2010 Exploration Drilling Program in the Chukchi Sea (2009a), it is expected that upon transiting into the Chukchi Sea, the *Discoverer* will first travel to the Beaufort Sea to conduct their drilling program in Camden Bay. Shell plans to move out of the Camden Bay project area August 25, at the start of the fall bowhead whale hunt in the area. It is assumed that at this time, the *Discoverer* will transit to the Chukchi Sea to begin that portion of their drilling program, ice and weather permitting (MMS 2009a).

The Shell exploration drilling program is expected to be the closest industrial sound source to the Statoil seismic survey between July and October 2010. The Burger Prospect drill sites, Shell's first drilling priority in the Chukchi Sea, are located approximately 30 km (18.5 mi) from Statoil's proposed 2010 Chukchi 3D Marine Seismic Survey area. Figure 2 shows the targeted Shell lease blocks in relation to Statoil's seismic survey area. The ensonification zones for the Statoil seismic survey and the Shell exploration drilling will not overlap. According to Shell's 2010 Chukchi Exploration Plan and Incidental Harassment Authorization (IHA), the 120 dB ensonification zone around Shell's drillship is 2 km (1 mi). Assuming that the Statoil seismic 160 dB ensonification zone radius is 13 km, there should be a minimum of 15 km (9 mi) separation between the Shell (120 dB) and the Statoil (160 dB) ensonification zones.

The other Shell Chukchi Sea prospects, Crackerjack and SW Shoebill, are located more than 80 km (50 mi) away from the Statoil 2010 Chukchi 3D Marine Seismic Survey area (Figure 2).

More comprehensive analyses of Shell's proposed drilling programs in the Chukchi and Beaufort Seas are described in MMS's EA published in 2009 (MMS 2009a and MMS 2009b). MMS issued a Finding of No Significant Impact for each of Shell's two Exploration Drilling Plans. The MMS consulted with the NMFS and the United States Fish and Wildlife Service (USFWS) regarding potential effects to species listed as threatened or endangered under the Endangered Species Act (ESA). The MMS concluded that after reviewing the drilling activities and the best available scientific information, and after considering the mitigation measures incorporated into Shell's plans, no significant adverse effects are expected to occur as a result of the program activities.

Shell may not acquire the authorization to conduct exploration drilling activities in the Chukchi Sea this season. In the case of other scenarios, Shell could be present in the area during all or a portion of Statoil's activities. If Shell conducts all drilling activities in the Beaufort Sea, activities proposed by Statoil and Shell will not cumulatively contribute to environmental effects in the Chukchi Sea. If all of Shell's activities occur in the Chukchi Sea, there will be approximately a 60-day overlap of the drilling activities with Statoil's proposed seismic acquisition program. During this overlapping period of time, certain

effects from both operations could cumulatively contribute to impacts to the Chukchi Sea environment. It is assumed that the farther Shell's drilling activities are from Statoil's seismic activities, the less cumulative effects from both programs will contribute to effects to the Chukchi Sea.

3.0 OTHER ANTICIPATED OIL AND GAS ACTIVITIES IN THE BEAUFORT SEA

Other Alaska Arctic Beaufort Sea 2010 open water reasonable foreseeable activities expected to occur include Shell's shallow hazards survey work in Harrison Bay; Shell's Camden Bay exploration drilling activity; the joint Canadian/U.S. research seismic activity in the Beaufort Sea; and GX Technology's Beaufort Sea seismic survey at the end of the open water season (tentatively planned for October and November 2010) (Nachman 2010). These activities are of a sufficient distance from the Statoil and Shell projects in the Chukchi Sea to not be included in this analysis of cumulative effects.

4.0 CUMULATIVE EFFECTS ON PHYSICAL ENVIRONMENT

The environment within the project area is considered to be generally pristine, with few, if any, effects evident from past activities. The Statoil 2010 Chukchi Marine Seismic Survey is limited in geographic scope and duration and is expected to be completed within 60 days starting August 1, 2010. The effects from the proposed seismic survey activity will be correspondingly limited. The EED has extensive discussion of geology, climate, oceanography, and sea ice in Sections 3.1.1– 3.1.4. The proposed seismic survey project will have negligible to no direct effects on physical resources and, due to the abbreviated, temporary nature of the project, will have no indirect effects on physical resources. Cumulative effects on physical resources are anticipated to be negligible, as determined by the MMS (MMS 2009a).

MMS has reviewed Shell's Exploration Drilling Plan for the Chukchi Sea and has determined that negligible to minor incremental contributions to cumulative effects are expected from the exploration drilling activities (MMS 2009a). In the discussion below, a summary of the environmental effects expected for Shell's proposed Exploration Drilling Program for the Chukchi Sea and Statoil's proposed Seismic Acquisition Program are described. Cumulative effects will not significantly affect the environment as the result of Statoil's Seismic Acquisition Program adding incremental aggregate effects to the impacts of Shell's Exploration Drilling Program.

4.1 Water Quality

Water quality is considered to be generally pristine in the Chukchi Sea, with few, if any, effects of past human activities. There are no impaired water bodies listed in Section 303(d) of the Clean Water Act for the Alaskan Arctic region, including the Chukchi and Beaufort Seas (ADEC 2006).

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Sea Exploration Plan, Shell's proposed exploration drilling program in the Chukchi Sea could affect water quality. Potential impacts would result from the release of National Pollutant Discharge Elimination System (NPDES) permitted discharges from the *Discoverer* and associated support vessels. The release of existing sediments and drilling muds has the potential to temporarily increase total suspended solids (TSS) in the water column, which can decrease the amount of light penetrating the water column.

The majority of discharged solids form a plume that settles quickly to the bottom, while the remainder forms another plume consisting of fine-grained particles and soluble components in the upper water column (Ayers, Sauer, and Steubner, 1980; Ayers et al., 1980; Brandsma et al., 1980; NRC, 1983; Nedwed, Smith, and Brandsma, 2004; Smith, Brandsma, and Nedwed, 2004; Neff, 2005). The NPDES

General Permit limits the discharge of cuttings and fluids in water depths greater than 40 meters (m) (131 feet [ft]) to 1,000 barrels per hour (bbl/hr) (159 cubic meters per hour [cu m/hr]). All of Shell's drill sites in the Chukchi Sea are at depths greater than 40 m (131 ft). Neff (2005) estimated that the concentration of water-based drilling mud in the plume generally drops below the toxicity limit within two minutes of discharge and 15 m (49 ft) of the discharge location.

Statoil. The Statoil seismic survey activity will have some minor, local, and temporary water quality effects (turbidity and suspended solids) from the discharge of treated wastewater. No muds or cuttings will be discharged as this is a seismic acquisition project and drilling will not be conducted. The Statoil seismic survey fleet will meet all applicable Environmental Protection Agency (EPA), U.S. Coast Guard (USCG), and International Maritime Organization (MARPOL) Annex IV standards, including sanitary wastewater treatment and ballast water management. The Statoil seismic survey fleet vessels all have internal ballast water systems; thus, there will be zero ballast water discharge. The seismic survey fleet will not trigger the EPA Arctic Oil and Gas General Permit applicability, but may trigger the EPA NPDES Vessel General Permit (VGP) when within 5.6 km (3 nautical miles [nm]) of the Alaska shore. The seismic streamers contain no liquid kerosene and thus eliminate a possible adverse effect from a potential streamer line break.

The MMS (2009a) determined that the cumulative effects on local water quality resulting from anticipated oil and gas activities, including seismic activities are expected to be low and that regional effects are expected to be insignificant.

4.2 Sediments Quality

Sediment quality in the Chukchi Sea is considered good. Concentrations of metals in sediment samples collected at 31 locations within the Chukchi Lease Sale 193 area and further nearshore were considered low (significantly lower than levels thought to adversely affect the biological environment) (Naidu et al. 1997). The samples were collected 6 years after the last of five exploration wells were drilled in the Chukchi Sea.

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Exploration Plan, Shell's exploration drilling activities will potentially temporarily affect the quality of the seafloor sediment. Construction of MLCs and drillship mooring associated with the drilling program will disturb the seafloor. Excavation of each MLC will directly disturb about 29 square meters (sq m) (314 square feet [sq ft]) of seafloor sediments (Shell 2009). For each anchor set, about 197 sq m (2,124 sq ft) of seafloor will be disturbed. Each well will require eight anchors to be set (Shell 2009). During Shell's program, seafloor sediments will also be affected by the discharge of drilling wastes, but the effects will be limited to the immediate area around the wells. Shell expects most of the drilling discharges to settle within 50 m (164 ft) of the point of discharge (Shell 2009).

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey will not disturb the seafloor and, as a result, will have no effect on sediments except for the localized, temporary vessel anchoring. Since Shell will be the only other operator in the Chukchi Sea between July and October 2010, there will be no cumulative effects to sediment quality due to Statoil's Marine Seismic Survey.

4.3 Air Quality

The MMS (2007) determined the overall air quality on the Alaska North Slope was relatively pristine, despite considerable activity related to oil and gas during the past 40 years. EPA (2010) determined that the air quality along the Alaska Chukchi Sea shore and the Lease Sale 193 air quality met all National Ambient Air Quality Standards (NAAQS) for healthy air quality. Shell's 2010 exploration program with

drillship, ice management vessels, and support vessels requires an EPA air quality permit, while Statoil's seismic activity does not. Both operators plan to utilize ultra low sulphur fuel.

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Exploration Plan, emissions associated with Shell's proposed exploration drilling program would be in compliance with EPA annual and short-term standards during the drilling program, and the emissions would occur only as long as the drillship and support vessels are in the Chukchi Sea. The EPA approved screening dispersion modeling indicates that National Ambient Air Quality Standards (NAAQS) (and Prevention of Significant Deterioration [PSD] increment) would be met at the edge of the drillship and beyond even using the maximum projected emissions from all sources. Actual emissions are expected to be much lower.

Shell's primary source of emissions during their drilling program is the *Discoverer* drillship's and support vessel's combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emissions generated from the proposed exploration activities would include nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), and fine particulate matter less than 2.5 microns ($PM_{2.5}$). The project would also generate smaller quantities of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), ammonia, carbon dioxide (CO2), and lead (Pb).

Most of the emissions would be generated from the combustion of diesel fuel for power production from the movement of the ice-management and oil spill response (OSR) vessels. Ice-management vessel activity would account for more than 90 percent of support vessel emissions; thus, total emissions would be lower in favorable ice conditions (MMS 2009a).

Statoil. The only source of air emissions associated with the program will be the vessel fleet, which consists of newer, relatively smaller, and fewer vessels compared to an exploration drilling program. Statoil will use ultra low sulphur fuel for its fleet. There will be no ice-management vessels associated with Statoil's proposed seismic acquisition program.. Statoil's seismic survey operating window will potentially be shorter than Shell's drilling program in the Chukchi Sea. Statoil's seismic survey fleet will have a minimal effect on onshore O_3 concentrations due to its distance from other NO_x and VOC emission sources. The seismic survey activity, scheduled for July to November 2010, is expected to have no effect on Arctic haze, which is primarily a winter and early spring phenomenon. The emissions from the Statoil 2010 Chukchi Marine Seismic Survey project will have a minimal effect on the project area air quality and even a lesser effect on the Alaska Chukchi Sea shore air quality located more than 160 km (100 mi) distant. The seismic survey will not require an EPA construction permit or operating permit. The seismic survey vessel fleet will meet applicable MARPOL Annex VI standards to minimize NO_x and SO_2 emissions.

Results from cumulative emissions modeling performed by Shell indicated that the concentrations of emissions from cumulative sources in the Chukchi Sea would be within the Prevention of Significant Deterioration (PSD) Class II incremental limits and the NAAQS. Statoil's emissions will not substantively add to the cumulative effect on air quality. The potential for temporary cumulative effects exists only if Shell's exploration drilling program occurs simultaneously during Statoil's 60 day program starting in August.

The incremental contribution of greenhouse gases (GHGs) by Statoil's seismic survey fleet will have a negligible effect on the worldwide, U.S., and Alaska GHG inventories. The MMS (2008) determined projected GHG emissions from future Chukchi Sea oil and gas activity, including seismic surveys, would be approximately 0.005–0.007 percent of the 2005 U.S. nationwide total GHG emissions.

4.4 Acoustic Environment

The oil and gas activities present in the Chukchi Sea in 2010 will add sound energy to the marine environment that already receives sounds from numerous natural and anthropogenic sources. Natural sources of sound energy include movement from ice, wind, wave action, precipitation, subsea earthquake activity, and marine mammals, fish, and shellfish. Anthropogenic sources include coastal and maritime vessel movement, commercial fishing, subsistence hunting, and oil and gas seismic and exploration drilling activity.

The Shell exploration drilling program is expected to be the closest industrial sound source to the Statoil seismic survey between July and October 2010. The Burger Prospect drill sites, Shell's first drilling priority in the Chukchi Sea, are located approximately 30 km (18.5 mi) from Statoil's proposed 2010 Chukchi 3D Marine Seismic Survey area. Figure 2 shows the targeted Shell lease blocks in relation to Statoil's seismic survey area. The ensonification zones for the Statoil seismic survey and the Shell exploration drilling will not overlap. According to Shell's 2010 Chukchi Exploration Plan and Incidental Harassment Authorization (IHA), the 120 dB ensonification zone around Shell's drillship is 2 km (1 mi). Assuming that the Statoil seismic 160 dB ensonification zone radius is 13 km, there should be a minimum of 15 km (9 mi) separation between the Shell (120 dB) and the Statoil (160 dB) ensonification zones.

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Exploration Plan, Shell's proposed exploration drilling program will contribute sound energy to the Chukchi Sea environment (MMS 2009a). One sound source associated with Shell's proposed drilling program will be the drillship *Discoverer*. , Shell reviewed recorded sound levels from an analogous drillship, the *Explorer II, and* modeled the sound levels that might be generated by the *Discoverer* in the Chukchi in similar circumstances (Jasco 2009). The maximum reported source level for the *Explorer II* was 175 decibels [dB]). The maximum sound level was used in the model, as well as water depth, geoacoustic, and water sound speed profiles present at Shell's drill sites. The model was used to anticipate the received sound levels at various distances from the drillship (Shell 2009).

Shell's ice-management vessels will potentially produce the most intense sound energy associated with exploration drilling in the Arctic (MMS 2009a). Ice-breaking typically requires either pushing through ice at slow speed when the ice is thin, or more commonly repeated backing-up followed by ramming the ice. The sounds are generally 10 to 15 dB higher during ice-breaking than when simply underway in open water or "nudging" ice floes. The majority of the sound generated during ice-breaking is produced by cavitation of the propeller as opposed to the engines or by ice contacting the hull (Richardson et al. 1995).

Sound effects on marine mammals and monitoring and mitigation measures are discussed in a later Section 5.

Statoil. The Statoil seismic survey will produce sound energy from seismic airguns and vessel transit. Statoil will conduct the seismic survey activity in open water and will not use ice breakers for ice-management activity, thus eliminating one possible anthropogenic sound source. Potential direct effects on marine mammals from the Statoil seismic survey activity will be mitigated by conditions imposed in the National Marine Fisheries Services (NMFS) Incidental Harassment Authorization (IHA) and the US Fish and Wildlife Service (USFWS) Letter of Authorization (LOA) that will include reducing or stopping the seismic sound source if and when marine mammals get too close to the seismic source vessel.

The MMS (2007) determined that available information indicated that the cumulative effects of all other past or currently occurring anthropogenic sound sources have had no long-lasting physiological or other adverse effect on the bowhead whale. The MMS (2007) included oil and gas exploration, production and

development activity, and increased marine vessel movement in their cumulative effects analysis. The MMS (2007) determined that seismic survey activities could result in cumulative behavioral effects to the bowhead whale and that whales try to avoid vessels or seismic surveys if closely approached. The MMS (2007) found that the direct effect of oil and gas industry sound-producing activities would be a temporary, non-lethal avoidance behavior. The MMS determined that impacts to marine mammals from incremental additive sound energy from activities in the Chukchi Sea are expected to be negligible.

The Arctic Council (2009) Arctic Marine Shipping Assessment 2009 Report acknowledged an increasing potential threat of marine mammal migration patterns because of sounds produced by marine shipping activity, due in part to climate change enabling greater arctic shipping activity.

5.0 CUMULATIVE EFFECTS ON BIOLOGICAL ENVIRONMENT

The MMS (2007) determined that no significant cumulative effects would result from the planned Lease Sale 193 oil and gas activities when combined with exploration and development of North Slope and Beaufort Sea oil and gas fields. The proposed 2010 oil and gas activities in the Chukchi Sea will have negligible or minor and short-term effects on biological resources. Most direct effects on biological resources from the seismic survey project will be avoidance behavior resulting in a temporary displacement of birds, fish, and marine mammals.

5.1 Marine Mammals

Oil and gas activities in the Chukchi Sea, including seismic and drilling activity, are expected to result in no more than temporary and localized effects on marine mammals (MMS 2007a). MMS determined that cumulative effects as a result of oil and gas activities in the Chukchi Sea would have no more than a minor effect on marine mammals while mitigation measures are implemented (MMS 2007a). The Statoil 2010 Chukchi Marine Seismic Survey EED Section 3 contains extensive detail on marine mammals' distribution, life history, and abundance. According to a 2006–2008 joint monitoring program by Shell, ConocoPhillips Alaska, and GX Technology, the dynamics of the physical environment in the Beaufort and Chukchi seas can create temporal and spatial variability in conditions that affect marine mammals (LGL Alaska, Greenridge Sciences, Jasco Research 2009). There is an extensive description of the physical environment in the Statoil 2010 Chukchi Marine Seismic EED. The bathymetry and relatively close Hannah Shoals make for a rich and diverse ecosystem and feeding area for marine mammals such as walrus and several species of seal.

The term "take" for the purposes of an IHA or LOA is defined by the MMPA as any action to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. "Takes" as addressed in an IHA or LOA are Level A takes which correspond to sound energies at decibel (dB) levels >180 dB or >190 dB, dependent upon species. Harassment means any act of pursuit, torment, or annoyance that:

- Has the potential to injure a marine mammal or marine mammal stock in the wild; or
- Has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Exploration Plan, the main sources of disturbance to marine mammals associated with the drilling program will be from aircraft, the drillship, and support vessels which emit low-frequency sounds. Aircraft traffic could potentially result in temporary avoidance by marine mammals. Shell anticipates a maximum of one flight per day between shore and the *Discoverer*. Effects from sound energy associated with well drilling, ice

management, and vessel traffic could cause some temporary avoidance of the immediate area of a vessel by marine mammals, but these effects would be minor, short term, and localized. The potential effects of program air emissions are expected to be negligible. Small hydrocarbon spills, such as releases of diesel fuel from fuel transfer operations, could affect marine mammals, but any effects would affect only a small percentage of the total species population for all marine mammals, if any, and would be fleeting because of the limited duration of small spills. In MMS's analysis of the impacts from Shell's drilling activities, it was determined that a small liquid hydrocarbon spill would have a negligible effect on marine mammals (MMS 2009a).

Statoil. The proposed seismic activities' expected effects on marine mammals include temporary displacement of whales and seals within the ensonification zone. Physical effects such as injury or death are not expected from the seismic survey project. MMS determined that seismic survey activities such as Statoil's in conjunction with exploration drilling program, such as Shell's proposed program, are not expected to result in a significant effect on the species or stocks of marine mammals and should not affect the availability of species or stocks for subsistence uses (MMS 2009a). Baleen whales tend to avoid areas where airguns are in operation. Beluga whales have also shown avoidance of seismic vessels, while seals generally do not react to airgun sounds. The masking effects of pulsed airgun sounds on marine mammal calls and other natural sounds are expected to be limited. Exposure to sufficiently loud sounds can result in a shift in marine mammal hearing threshold. The shifts can be temporary threshold shift (TTS) or permanent threshold shift (PTS). The requirement included in the Marine Mammal Protection Act (MMPA) authorized IHA and LOAs to have onboard MMOs and monitoring safety radii; and the airgun ramp-up provision, coupled with the tendency of marine mammals to avoid the immediate area around operating seismic vessels, will minimize the potential of shifts in hearing threshold to nearby marine mammals. Thus, physical injuries of marine mammals resulting from sounds by Statoil's seismic survey are unlikely and not expected.

MMS anticipates that the incremental aggregate of effects on marine mammals from operations in the Chukchi Sea, including seismic activities, will be minimal and temporary (MMS 2009a).

Seals and Walrus. Because seals and walruses are dependent upon sea ice habitat, their presence and abundance in Statoil's and Shell's projects areas are dependent upon the presence of ice. If there is ice coverage, the seismic survey will not occur. Seal species include: bearded seal, ringed seal, spotted seal, and ribbon seal. Abundance of bearded seal in the eastern Chukchi are 4,863. Abundance of ringed seal in the Bering/Chukchi Sea stock are 230,673. There is an Alaska population of 59,214 of spotted seal. The abundance of ribbon seal is 90,000–100,000 in the Chukchi (See Table 3.2.6-1 in the EED for seal and walrus abundance information). The Joint Monitoring Program in 2006 through 2008 yielded 2,568 seal sightings comprised of 2,965 individuals recorded from ships in the Chukchi Sea.

There are spring and fall migrations of the bowhead whale, whose migratory paths are depicted in maps in the Section 3.2.4.6 of the EED. The Shell exploration program and Statoil seismic survey take place in August and September and so avoid the spring migration and spring subsistence hunting activities. Fall subsistence hunting activities occur in late August and September but the Shell and Statoil activities in the Chukchi are far offshore from the subsistence hunting areas. The fall bowhead migration moves in the vicinity of the Planning Area 193. The IHA applications for Shell and Statoil estimate the number of marine mammals, including bowhead whale that may be taken. These include:

- Shell Application for Incidental Harassment Authorization for the Non-Lethal Taking of whales and Seals in Conjunction with Proposed 2010 Exploration Drilling Program in the Chukchi, Sea
- Request for an Incidental Harassment Authorization by Statoil to Allow Incidental Harassment of Marine Mammals during a 3D Marine Seismic Survey in the Chukchi Sea, Alaska

5.1.1 Pacific Walrus

Pacific walrus are abundant in the Chukchi Sea and rarely occur in the Beaufort Sea. According to a population survey released by USFWS in 2010, the abundance of Pacific walrus in the Chukchi on pack ice, open water, and coastal haulouts numbered 129,000. The incidental take estimates determined for Statoil's 2010 Chukchi seismic marine survey are an average of 729 walrus (LGL Alaska 2010). A more detailed explanation of the incidental take estimates follows in this section.

The main sources of disturbance to walrus associated with Shell's proposed exploration drilling program will be from noise associated with aircraft and vessels. This type of equipment emits sound energy that may evoke walrus avoidance behavior. MMS determined that cumulative effects as a result of oil and gas activities in the Chukchi Sea would have no more than a minor effect on walruses while mitigation measures are in place (MMS 2009a).

In 2006, prior to USFWS promulgating 5-year regulations for issuance of LOAs, LGL completed an IHA application requesting incidental takes of walrus and polar bear for seismic surveys in the Chukchi Sea. At that time, the best available data on walrus densities during the open-water season came from monitoring reports of drilling activities in 1989. Brueggeman et al. (1990) reported walrus densities in open water areas near the ice edge of 0.0731 walrus/km^2 based on seven aerial surveys in June and July. Because these data were assumed to have been collected closer to the ice than seismic operations were likely to occur a density of 0.0010 walrus/km^2 was used as the average density in open water. Brueggeman et al. (1990) also reported densities from aerial surveys over the ice margin and within the pack-ice of 0.6169 walrus/km^2. This was used as an average density estimate for operations that might occur closer to the ice edge. As these were the only density estimates available they were both multiplied by 2 to produce maximum estimates.

Vessel based observations from 2006 to 2009 open-water seasons have provided more recent data on walrus densities in summer (July–August) and fall (September–October) seasons in the Chukchi Sea. These estimates are considered more relevant as they were generally collected at greater distances from the ice edge where seismic activities are more likely to occur. However, they do include effort from periods when vessels were scouting the ice edge or generally operating near to it. For that reason, LGL did not attempt to estimate separate open-water and ice-margin densities, as was done for species in the NMFS IHA application (LGL et al. 2009). Table 1 summarizes the annual density estimates during non-seismic periods from the most recent Joint Monitoring Program report (Funk et al. 2010).

In the IHA application to NMFS that LGL prepared for Statoil estimated the area of water ensonified to ≥160 dB by the 3D survey activities during summer and fall to be 2,799 km^2 and 4,695 km^2, respectively. Using the average summer and fall densities from Table 1 the takes estimates would be: summer = 188; fall = 88; Total = 276. Using the 2009 summer and 2007 fall estimates as maximums the take estimates would be: summer = 384; fall = 147; Total = 531.

For the 2D survey lines LGL estimated 9,568 km^2 ensonified to ≥160 dB in the summer and 2,392 km^2 in the fall. Resulting takes estimates based on average densities are: summer = 641; fall = 45; Total = 686. Maximum estimates are: summer = 1,313; fall = 75; Total = 1,388.

So the worst case take estimates would be the 2D lines in summer plus 3D in the fall for a total of **729** (average) or **1,460** (maximum).

TABLE 1
Pacific Walrus Non-Seismic Density Estimates from Vessel Based Observations During 2006-2009 Open-Water Seasons

		Season	
Year	**Operator**	**Summer**	**Fall**
2006	GXT - CPAI - Shell	0.0080	0.0201
2007	Shell	0.1147	0.0314
2008	Shell	0.0081	0.0184
2009	Shell	0.1372	0.0053
Average*	-	0.0670	0.0188

* Simple avarage that does not account for different levels of effort between years

Notes: (Funk et al. 2010). The summer season includes data from July-August while the fall season includes data from September to October.

Shell. Effects from sound energy associated with well drilling, ice management, and vessel traffic could cause some temporary avoidance of the immediate area of a vessel by walruses, but these effects would be temporary and limited to the project area. Air emissions from the vessels are not expected to affect walruses. Small hydrocarbon spills, such as releases of diesel fuel from fuel transfer operations, could affect walruses, but any effects would affect only a small percentage of the total stock, if any, and would be temporary because of the limited duration of spills of this size. In MMS's analysis of the effects from Shell's drilling activities, it was determined that a small liquid hydrocarbon spill would have a negligible effect on walruses when mitigation measures are implemented (MMS 2009a).

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey project may have a negligible to minimal direct effect on the Pacific walrus. The proposed seismic survey project will occur in areas of open water where Pacific walrus densities are expected to be relatively low. Walrus densities during historical Chukchi Sea OCS exploration activities were greater in the project area during heavy ice years (MMS 2009a). Seismic activity will not be conducted if there is heavy ice in the project area. If pack ice is present in feeding areas such as the Hannah Shoal area, walrus on ice floes could be affected. Expected effects would be limited to slight changes in walrus distribution, with some walrus avoiding the project area or retreating to the center of the ice floe. All such effects would be minor and temporary, lasting as long as the ice and walrus, which are moving with wind and current, are in the project area (MMS 2009a).

Statoil will employ monitoring and mitigation measures (MMOs, monitoring safety radii zone, walrus interaction avoidance plans) to avoid and minimize any behavioral displacement effect or potential hearing threshold effect. Vessel movement may temporarily displace walrus from preferred feeding areas or temporarily deflect them from migration routes.

Walruses tend to aggregate in large groups and, thus, are vulnerable to disturbance events. Walruses may flee haul-out locations in response to disturbance from aircraft and vessel transiting. Helicopters, which are likely to elicit responses from walruses, will not be used during the Statoil seismic survey operation except in the case of an emergency.

Potential effects of vessel movement on walruses will be reduced with mitigation measures requiring vessels to slow their speed or steer around groups of walruses. The MMS (2009a) determined that any cumulative effects resulting from Statoil's seismic acquisition activities and Shell's proposed exploration drilling program on walruses from seismic operations should be relatively short in duration and should have a negligible overall effect on the Pacific walrus population.

5.2 Threatened and Endangered Species

The listed or proposed listed threatened and endangered marine mammal species expected to occur in the area of the reasonably foreseeable oil and gas activities in the Chukchi Sea from July through October include the bowhead whale, the humpback and fin whales, and the polar bear. The Pacific walrus is under consideration for listing under the Endangered Species Act. Threatened and endangered birds in the area include the Steller's and spectacled eiders and the Kittlitz's murrelet. Statoil's seismic survey, along with Shell's drilling activities and baseline studies, are not expected to have a direct effect on Steller's and spectacled eiders due to the distance from the coast and nearshore molting areas, including the Ledyard Bay Critical Habitat Unit. The Kittlitz's murrelet are likely found in low densities in Statoil's and Shell's project areas. MMS determined that cumulative effects as a result of oil and gas activities in the Chukchi Sea would have no more than a minor effect on threatened and endangered species in the project area while mitigation measures are implemented (MMS 2009a).

5.2.1 Polar Bears

Shell. The USFWS determined that takes of polar bears due to harassment that would occur as a result of Shell's oil and gas exploration would be small due to the small footprint of exploration and the low numbers of polar bears using open water habitats. The USFWS also stated that routine aircraft has little to no effect on polar bears, but added that extensive or repeated over flights could disturb polar bears, noting that the behavioral reactions of non-denning bears should be limited to short-term changes in behavior and would have no effect on individual bears or the population. They also reported that vessel traffic could similarly result in short-term behavioral disturbance of polar bears (USFWS 2008). Small hydrocarbon spills, such as releases of diesel fuel from fuel transfer operations, could affect polar bears, but any effects would affect only a small percentage of the total species population for all polar bears, if any, and would be fleeting because of the limited duration of small spills. In MMS's analysis of the effects from Shell's drilling activities, it was determined that a small liquid hydrocarbon spill would have a negligible effect on polar bears when mitigation measures are implemented (MMS 2009a).

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey may have a limited and temporary effect on a small number of polar bears. Polar bears are closely tied to the presence of the sea-ice platform. The seismic survey project area will be conducted in open water and away from sea ice, thus reducing the potential of encounters with polar bears. Historical, documented effects on polar bears in Alaska by the oil and gas industry are minimal. The Chukchi Sea OCS oil and gas exploration activities in the 1980s and early 1990s did not result in any population level effects on polar bears (USFWS 2007). The MMS (2007) determined that proposed seismic operations will not be concentrated in any one area for extended periods and will occur in open water; thus, any direct effects on polar bears should be relatively short in duration and are not expected to have any effect on polar bear populations. The USFWS (2009) determined that few polar bears are likely to encounter seismic survey vessels in the project area and those bears that are in the project area may not react to the seismic survey activity. The USFWS (2009) further determined that any adverse effects that do occur are likely to be limited to temporary, minor, behavioral disturbances to a small number of polar bears and that the Incidental Take Regulations (ITR) and LOA criteria will mitigate potential effects.

5.2.2 Endangered Whales

NMFS recently evaluated in a Biological Opinion the impacts of oil and gas leasing and exploration activities in the Chukchi and Beaufort Seas, as well as the authorization of small takes under the MMPA, on threatened and endangered whales (NMFS 2008). The analysis considered the potential effects of such activities and small takes, including exploration drilling from a drillship, such as the *Discoverer*, and of marine seismic surveys on bowhead, humpback and fin whales in these waters. MMS determined that

cumulative effects as a result of oil and gas activities in the Chukchi Sea would have no more than a minor effect on endangered whales while mitigation measures are implemented (MMS 2009a).

Estimated numbers of incidental takes of whales and seals are found in the IHA submitted by Statoil to NMFS, "Request for an Incidental Harassment Authorization by Statoil to Allow Incidental Harassment of Marine Mammals during a 3D Marine Seismic Survey in the Chukchi Sea, Alaska, 2010". Likewise, Shell submitted an IHA to NMFS for its proposed 2010 Chukchi exploration drilling program.

Shell. Overall, NMFS concluded that available data indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s have not had a lasting population-level adverse effect on bowhead whales. NMFS 2008 data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea (NMFS 2008). NMFS reached the same conclusion regarding fin and humpback whales as well.

The main sources of disturbance to marine mammals associated with the drilling program will be from aircraft, the drillship, and support vessels. These types of equipment emit low-frequency sound energy that may evoke marine mammal avoidance behavior. It is often difficult to separate the effects of visual and acoustic disturbance; therefore, these are discussed as one below. Impacts from sound energy associated with well drilling, ice management, and vessel traffic could cause some temporary avoidance of the immediate area of a vessel by marine mammals, but these effects would be minor, short term, and localized. The potential impacts of program air emissions are expected to be negligible. Small hydrocarbon spills, such as releases of diesel fuel from fuel transfer operations, could affect marine mammals, but any impacts would affect only a small percentage of the total species population for all marine mammals, if any, and would be fleeting because of the limited duration of spills of this size. In MMS's analysis of the effects from Shell's drilling activities, it was determined that a small liquid hydrocarbon spill would have a negligible effect on endangered whales when mitigation measures are implemented (MMS 2009a).

Statoil. Bowhead, humpback, and fin whales are the endangered whale species present in the Chukchi Sea during the time of Statoil's proposed seismic surveys. Bowhead whales are expected to be the most common whale in the area during the seismic project activities. Humpback and fin whales are expected to be much less common in the project area. All endangered whales in the Chukchi Sea are baleen whales, and they react similarly in the presence of seismic sounds. The only expected behavioral reaction of endangered whales to Statoil's seismic survey project is short-term, temporary displacement or avoidance; and any such effect will end upon completion of the seismic survey project. The seismic project is not expected to result in any hearing impairment of endangered whales in the project area, and a temporary and minimal, if any, masking of endangered whale calls in the project area.

Historically, industrial whaling has been the primary factor depressing populations of whales. The MMS (2007) suggested that some investigators have concluded that the bowhead whale populations have largely recovered to numbers representative of their pre-industrial whaling era population. The expected behavioral effects on bowhead whales from both Statoil's seismic survey activity and Shell's exploration drilling program will be short-term, temporary displacement or avoidance. Other marine shipping activity in and around the project area may result in similar temporary avoidance disturbance effects. Baleen whales tend to avoid areas where airguns are in operation.

The NMFS IHA monitoring, avoidance, and mitigation requirements that require seismic programs to employ MMOs aboard all seismic vessels to monitor the safety radii and employ airgun ramp-up and shutdown procedures will limit effects on endangered whales to a short-term avoidance of the limited area

around the seismic operation. The potential masking effects of pulsed sounds from airguns on endangered whale calls and other natural sounds are expected to be limited. The seismic operations are not expected to result in adverse hearing effects on endangered whales. Past experience has shown that whales tend to avoid seismic vessels and their airguns before being exposed to sound levels high enough to experience TTS or PTS, i.e., hearing impairment. The NMFS IHA MMO and airgun ramp-up procedures should further reduce the chance of endangered whale TTS. MMS determined that cumulative impacts from activities in the Chukchi Sea on marine mammals are expected to be negligible (MMS 2009a).

6.0 CUMULATIVE EFFECTS ON SOCIOECONOMIC RESOURCES

MMS does not expect any significant effects on socioeconomic resources as a result of oil and gas activities, including seismic surveys and exploration drilling in the Chukchi Sea (MMS 2007a).

Shell. Shell's planned Chukchi Sea exploration drilling program will have positive effects on the NSB economy and provide employment and community development opportunities for residents from the region. Some indirect and direct community and economic development benefits will result from Shell's exploration activity. Minor and temporary influxes of people may occur in Wainwright or Barrow through the operation of the shorebased facilities. Shorebase facilities in Wainwright will be located approximately 0.8 km (0.5 mi) from the town. Staff resources at the shorebase facilities are expected to include 22–64 persons, but the camp will be largely self-contained. Therefore, any impacts are expected to be minor as concluded by MMS (2007). Positive economic benefits include jobs that are generated and the opportunities for for-profit village corporations to provide goods and services.

Most of Shell's planned exploration drilling activities will occur more than 97 km (60 statute mi) offshore, minimizing the social and cultural impact on villages. Support vessel crews are expected to remain offshore for the duration of the drilling season. Drillship crews will rotate off the vessel every 28 days and will normally leave the shorebase immediately for destinations off the North Slope. The offshore vessels will have their own medical facilities. Most supplies will be shipped in; relatively few purchases will be made in local communities due to the short duration of the program and limited local availability of necessary supplies. The influx of people into local neighboring communities will be minimal and temporary and is expected to have negligible effects on the local population or the availability of goods and services in the community.

Statoil. Socioeconomic effects from Statoil's 2010 Chukchi Marine Seismic Survey will be minor and temporary. Very few economic effects are expected for the affected Northwest Alaska Chukchi Sea coastal communities. The seismic source and support vessels will be self-contained, and Nome is the designated port for resupply and crew changes. Statoil's seismic survey may generate a few temporary jobs for residents of the North Slope Borough (NSB) and Northwest Arctic Borough (NWAB), with employment opportunities primarily as marine MMOs. Past oil and gas exploration activities in the project area have not been shown to have any lasting effects on socioeconomic resources. However, increased NSB and NWAB employment and personal income could be generated with subsequent oil and gas exploration, development, and production activities in the future.

6.1 Subsistence

The MMS (2007) concluded that short-term, local disturbance resulting from oil and gas activities could affect subsistence activities, but that long-term, permanent effects would not result, nor would harvest areas become unavailable to subsistence users. The MMS (2007) noted that local perception of subsistence effects vary. Inupiat whalers, for example, have concerns with sounds from oil and gas activities that may deflect whales farther away from their normal migration routes and drive hunters farther out to sea.

NSB residents expressed concerns that oil and gas industry activities have cumulative effects on culturally-important subsistence activities. The MMS (2007), however, concluded that the effects from exploration activities would be short-term and localized.

Shell. The effect of vessel traffic generated by Shell's planned 2010 Chukchi Sea exploration drilling program will be limited and concentrated in a short period of time during the drilling season. The project area is located far offshore, away from traditional subsistence areas and subsistence hunting activities. The degree of potential effects to subsistence users and activities due to program-related vessel traffic varies depends on the subsistence resource, when it is harvested, and where it is harvested. Shell has developed comprehensive mitigation measures, including the use of MMOs, to address the potential for effects. Shell's program will add a minimal amount of additional traffic to the existing vessel operations in the Chukchi Sea from private and industry related activities.

Because Shell's exploration drilling activities will not occur in traditional subsistence areas, the proposed drilling program is not expected to result in any significant effects on subsistence resources or subsistence hunting.

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey project will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence. The project area is located far offshore (100 mi or greater from each Chukchi Sea village), away from traditional subsistence areas and subsistence hunting activities. The seismic activity will be conducted during the open water season, after the spring traditional subsistence hunt season, and before the winter traditional subsistence hunt season. Vessel movement supporting the seismic survey between the project area and the shorebase resupply facilities in Nome will be infrequent and, thus, should have negligible effects on subsistence resources. The MMS (2008, 2009a) determined that vessel movement sounds could cause a disruption to subsistence harvest, but would not make subsistence resources unavailable to subsistence users. Statoil's seismic vessels will have MMOs onboard and will support marine mammal monitoring and mitigation activities to prevent and mitigate any potential effect to marine mammal subsistence resources.

Since the Statoil seismic survey project will not occur in traditional subsistence areas, the seismic survey activities is not expected to result in any significant effects on subsistence resources or subsistence hunting.

6.2 Sociocultural Values and Environmental Justice

The cumulative effects of seismic exploration, other oil and gas activities, and other events and activities, such as climate change and increased marine transiting, are a concern to many NSB residents (MMS 2007a). Environmental concerns are perceived to directly, indirectly, or cumulatively affect larger issues, including climate change, wildlife effects, air quality, water quality, sea ice depletion, coastal erosion, permafrost degradation, and oil spills (MMS 2007a).

The federal government acknowledged special considerations regarding minority and low-income populations through Presidential Executive Order (EO) 12898. EO 12898 directs federal agencies—including NMFS, MMS, and USFWS— to incorporate these concerns into their regulations, individual authorizations, and permits. The federal government identifies Inupiat residents on the North Slope as a minority population under EO 12898.

Oil and gas seismic and exploration activities in the Chukchi Sea OCS are subject to the provisions of EO 12898. In 2009, both Shell and Statoil held meetings in the potentially affected subsistence communities (Barrow, Wainwright, Point Lay, Point Hope, and Kotzebue) to introduce their projects and hear

community concerns. These meetings allowed Shell and Statoil to incorporate these concerns into project planning.

Shell. According to the MMS Environmental Assessment of Shell's 2010 Chukchi Exploration Plan, effects on sociocultural values as a result of Shell's proposed exploration drilling program are expected to be minimal. Most of Shell's planned exploration drilling activities will occur more than 97 km (60 statute mi) offshore. Effects on sociocultural values are expected to be limited. Support vessel crews are expected to remain offshore for the duration of the drilling season. Drillship crews will rotate off the vessel every 28 days. The influx of people into local communities will be minimal and temporary.

In 2007 and 2008, Shell contracted with a subsidiary of ASRC to develop and manage a North Slope Inupiat Subsistence Advisor Program to address the concerns of North Slope residents regarding impacts to subsistence activities.

Small hydrocarbon spills, such as releases of diesel fuel during fuel transfer operations will have no more than a negligible effect on sociocultural system. In MMS's analysis of the effects from Shell's drilling activities, it was determined that a small liquid hydrocarbon spill would have a negligible effect on subsistence resources when mitigation measures are implemented (MMS 2009a).

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey project is temporary and short-term and, thus, unlikely to have any long-lasting effect on Inupiat values. However, real or perceived effects from the seismic survey project on the environment or the elements within the environment risk affecting Inupiat sociocultural values. Western science suggests that the seismic survey studies may have temporary effects on wildlife and other aspects of the environment, but traditional and cultural knowledge may suggest otherwise. Many NSB residents may see seismic survey acquisition leading to oil and gas exploration, development, and production activities.

Effects on sociocultural resources from the Statoil 2010 Chukchi Marine Seismic Survey project are expected to be temporary and minimal, if any at all. Small hydrocarbon spills, such as releases of diesel fuel from fuel transfer operations, could affect sociocultural values, but effects would be temporary because of the limited duration of spills of this size.

6.3 Historical and Archaeological Resources

Activities associated with the Chukchi Sea exploration program could impact resources within the following areas:

- Areas where the seafloor may be disturbed by vessel mooring and mud-lined cellar (MLC) construction;
- Areas where drill cuttings and drilling fluids may be discharged; and
- Shorebase support facility locations.

Shell. Shell plans to drill a total of up to three exploration wells at five potential drill sites in 2010. Although all of these potential drill sites are located in areas the MMS has designated as having potential for containing prehistoric sites, none of the drill sites are in blocks designated by the MMS as having a high probability of historic archaeological resource presence; no shipwrecks have been reported to have sunk in Shell's lease blocks (MMS 2007a). Nonetheless, archaeological assessments have been prepared for each of the drill site areas based on shallow hazards survey data collected at the sites. Based on these assessments, it is concluded that impacts from the drillship and its mooring system to submerged cultural resources can be avoided or minimized (MMS 2009a).

Statoil. The Statoil 2010 Chukchi Marine Seismic Survey project is highly unlikely to adversely affect any submerged historical or archaeological resources within the project area. The seismic survey project will not physically disturb the seafloor, with the exception of an occasional vessel anchoring. The seismic acquisition project data will be reviewed by the MMS to identify submerged cultural resources and will bolster the baseline cultural resources information in that portion of the Chukchi Sea. Activities in the Chukchi Sea will not result in any cumulative terrestrial cultural resources effects, as the only land-based activity associated with the project will be refueling and crew supply changes.

6.4 Coastal and Marine Uses and Land Uses

Shell. It is not anticipated that the proposed drilling activities will have any effects on coastal or marine uses in the NSB and the NWAB, including military activities, marine shipping, commercial fishing, mariculture, and other mineral uses. The presence of a drillship and support vessels in the area of Shell's prospects, and the projected associated vessel and aircraft traffic between the prospects and shorebase, and between shorebase and regional hub airports, will have no effect on current or expected future levels of shipping over the time period of the planned exploration drilling program.

Statoil. Statoil anticipates that the proposed seismic activities will not have any effects on coastal or marine uses in the NSB and the NWAB, including military activities, marine shipping, commercial fishing, mariculture, and other mineral uses. The proposed seismic survey activity is expected to be at distances great enough to prevent potential conflict with other marine and coastal activities. Statoil further anticipates no effect on land use within the NSB and the NWAB, as the project area is more than 161 km (100 mi) offshore in an area where there are no land masses. Additionally, Statoil plans no shore-based activities, with the exception of resupply and crew change in Nome, during the seismic survey project. Cumulative effects to coastal and marine uses and land uses are not expected as a result of activities in the Chukchi Sea during the 2010 open water season.

7.0 CONCLUSION

The level, type, and location of both Statoil's 2010 Chukchi Marine Seismic Survey and Shell's 2010 exploration program are within the range of activities described in the Lease Sale 193 EIS. Although there may be some temporary deflection of bowhead whale during the fall migration, there will be insignificant effects on subsistence hunting activities. Monitoring and mitigation protocols for both the seismic and exploratory drilling activities will address the potential acoustic effects. The projects are sufficiently distant from each other that there are no significant cumulative effects.

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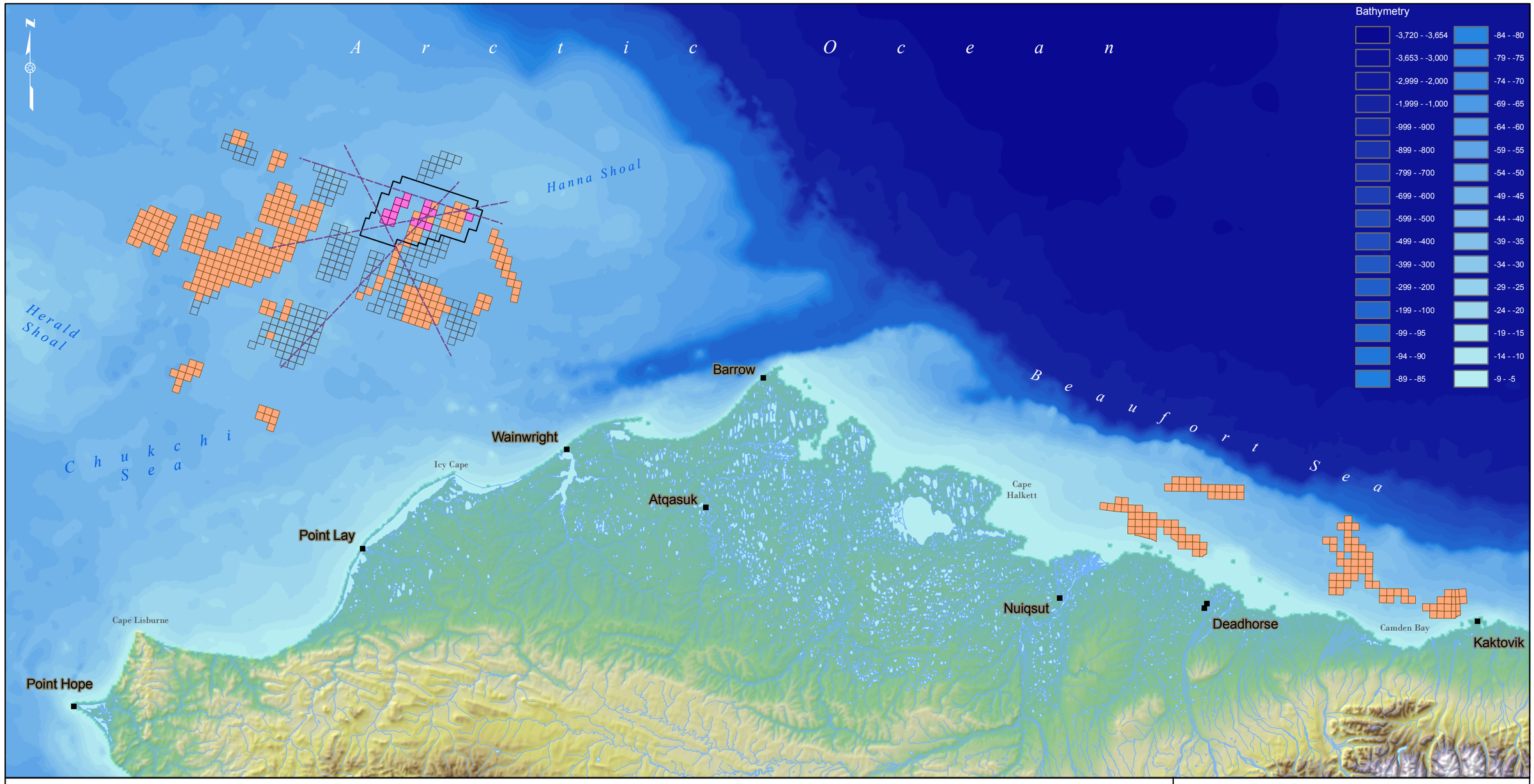

Distance to Survey Area in miles:

Barrow	158
Wainwright	114
Point Lay	138
Point Hope	246
Nome	645
Dutch Harbor	1297

Distance to approximate centroid of 3D seismic survey area.

Lease Owner

- Statoil
- Shell
- All Other

- Statoil 3D Seismic Survey Area
- 2D Seismic Lines (Potential Locations)
- Town

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Statoil

STATOIL CHUKCHI SEA 2010
MARINE SEISMIC SURVEY AREA
Cumulative Effects Analysis for 2010

SCALE: 0 20 40 80 Miles

FIGURE: 1

NAD83, Alaska Albers Equal Area

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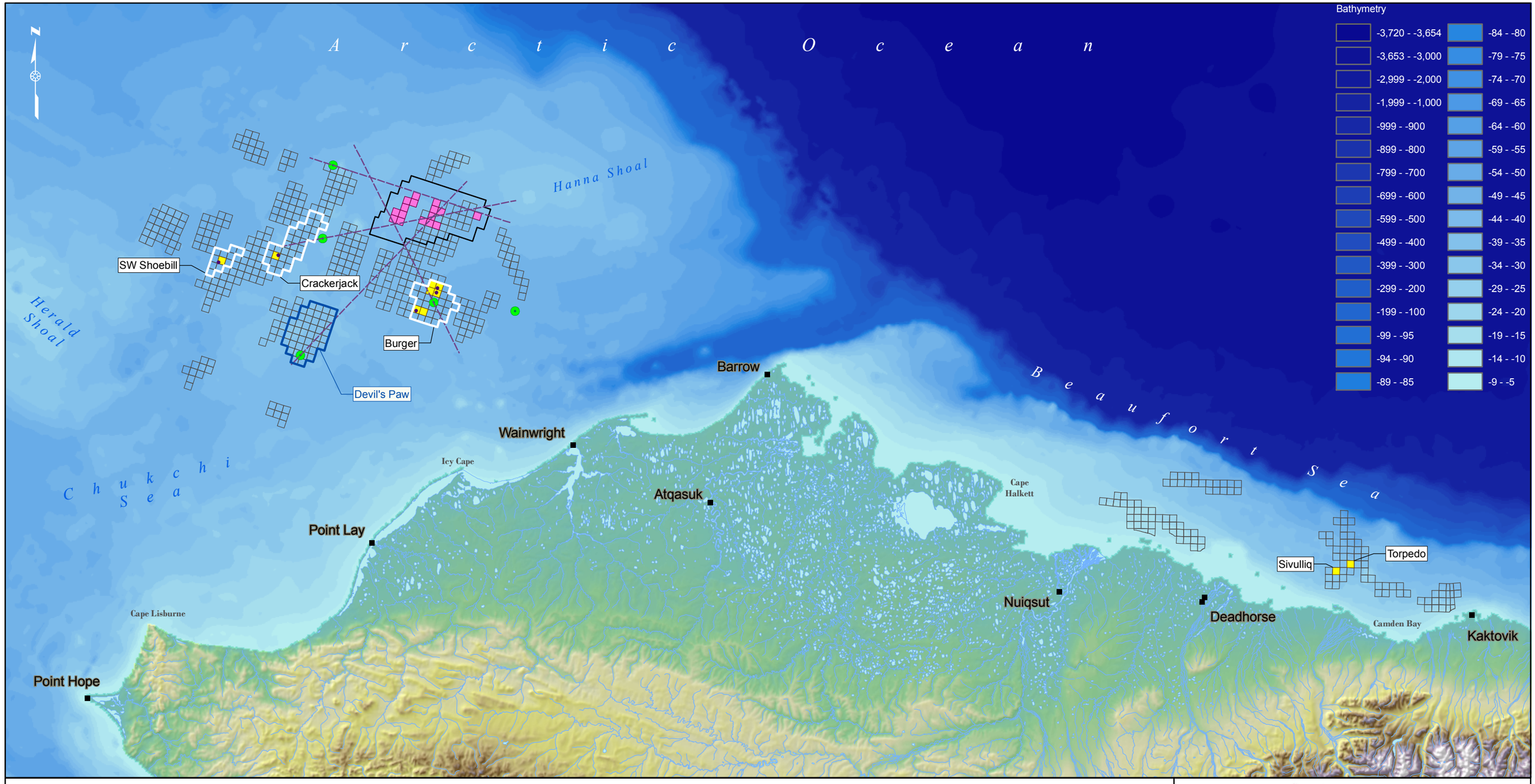

Distance to Survey Area in miles:

Barrow	158
Wainwright	114
Point Lay	138
Point Hope	246
Nome	645
Dutch Harbor	1297

Distance to approximate centroid of 3D seismic survey area.

Lease Owner
- Statoil
- All Other

- Statoil 3D Seismic Survey Area
- 2D Seismic Lines (Potential Locations)
- ConocoPhillips Prospect
- Previously Drilled Exploration Well
- Shell 2010 Exploration Plan Block
- Shell Prospect
- Shell Proposed 2010 Exploration Plan Drillsite
- Town

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CHUKCHI SEA AND CAMDEN BAY 2010 PROPOSED EXPLORATION ACTIVITIES
Cumulative Effects Analysis for 2010

SCALE: 0 20 40 80 Miles

FIGURE: 2

NAD83, Alaska Albers Equal Area

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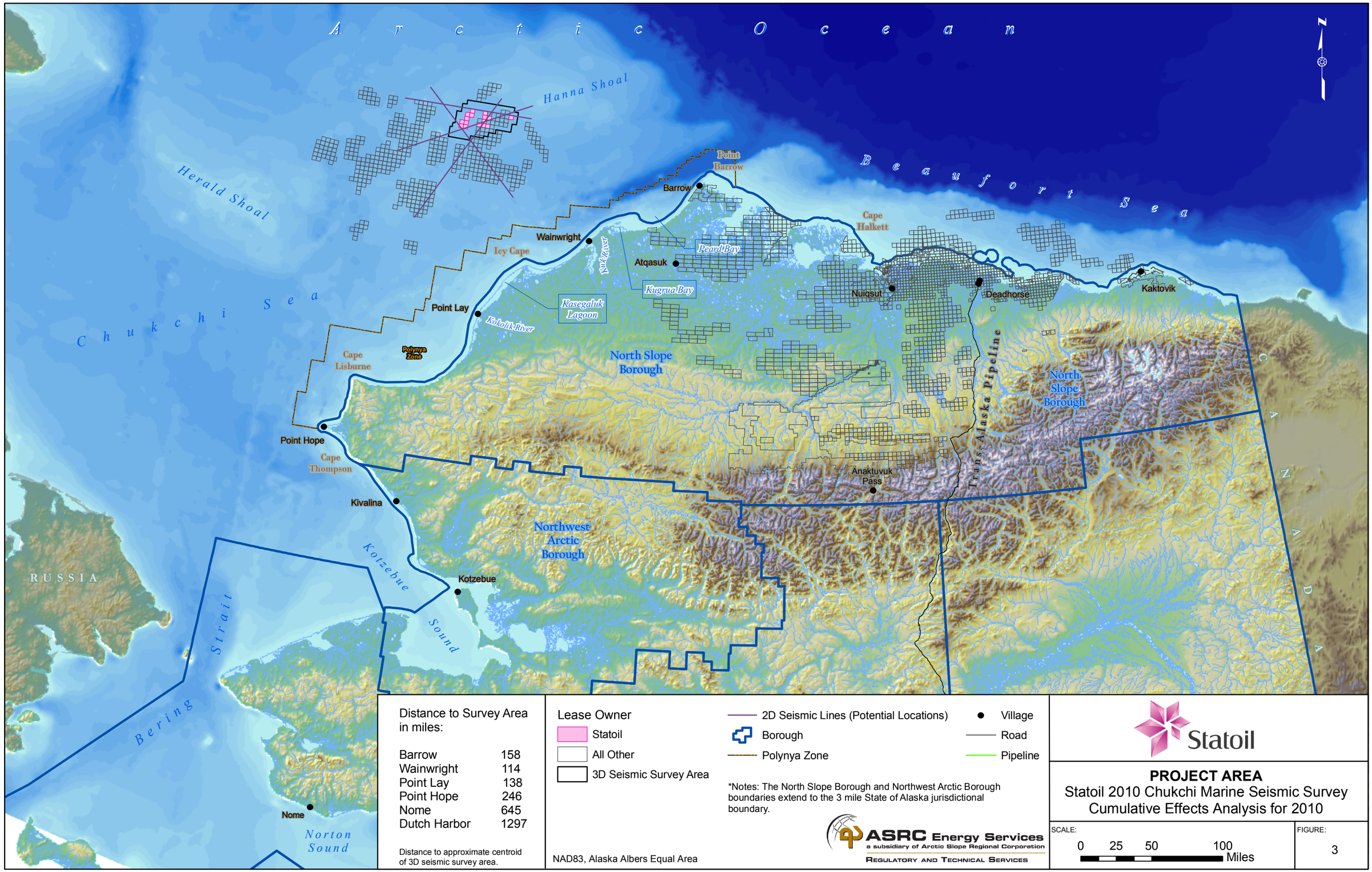

Distance to Survey Area in miles:

Barrow	158
Wainwright	114
Point Lay	138
Point Hope	246
Nome	645
Dutch Harbor	1297

Distance to approximate centroid of 3D seismic survey area.

Lease Owner
- Statoil
- All Other
- 3D Seismic Survey Area

- 2D Seismic Lines (Potential Locations)
- Borough
- Polynya Zone
- Village
- Road
- Pipeline

*Notes: The North Slope Borough and Northwest Arctic Borough boundaries extend to the 3 mile State of Alaska jurisdictional boundary.

NAD83, Alaska Albers Equal Area

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PROJECT AREA
Statoil 2010 Chukchi Marine Seismic Survey
Cumulative Effects Analysis for 2010

SCALE: 0 25 50 100 Miles

FIGURE: 3

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