Biological Opinion
for
Oil and Gas Activities Associated with Lease Sale 193

for:
Bureau of Ocean Energy Management
Bureau of Safety and Environmental Enforcement
U.S. Department of the Interior

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1 Introduction

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*., ESA), on the effects of the proposed Action, as defined later in this document, on polar bears (*Ursus maritimus*), spectacled eiders (*Somateria fischeri*), the Ledyard Bay unit of designated spectacled eider critical habitat, and Alaska-breeding Steller's eiders (*Polysticta stelleri*).

As described in this document, the proposed Action involves 1) exploration, development, production, and decommissioning of 460 leased blocks associated with the Bureau of Ocean Energy Management's (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE) Lease Sale 193 (LS 193) in the Chukchi Sea, and 2) other support activities occurring elsewhere in the Chukchi Sea and onshore across the North Slope.

BOEM and BSEE have statutory authority (under 43 USC 1331 et. seq.) to complete their respective Outer Continental Shelf (OCS) energy development actions in a tiered approach for review under the National Environmental Policy Act (NEPA) and to use an incremental step consultation process under the ESA as described in regulations at 50 CFR 402.14(k). The regulations at 50 CFR 402.14(k) state:

> When the Action is authorized by a statute that allows the agency to take incremental steps toward the completion of the action, the Service shall, if requested by the Federal agency, issue a biological opinion on the incremental step being considered, including its views on the entire action. Upon the issuance of such a biological opinion, the Federal agency may proceed with or authorize the incremental steps of the action if:
>
> 1. The biological opinion does not conclude that the incremental step would violate section 7(a)(2);
> 2. The Federal agency continues consultation with respect to the entire action and obtains biological opinions, as required, for each incremental step;
> 3. The Federal agency fulfills its continuing obligation to obtain sufficient data upon which to base the final biological opinion on the entire action;
> 4. The incremental step does not violate section 7(d) of the ESA concerning irreversible or irretrievable commitment of resources; and
> 5. There is a reasonable likelihood that the entire action will not violate section 7(a)(2) of the ESA.

At BOEM's and BSEE's request, we are conducting an incremental step consultation. Therefore, this BO examines activities in the first and future incremental steps that may result from the proposed Action. The first incremental step includes all activities associated with the exploration and delineation of the anchor field (large, initial field that is effectively a prerequisite to any future development); these activities could include development of onshore support infrastructure. Future incremental steps include all steps that would occur after the anchor field is explored and delineated. These steps include development and production of the anchor field;

exploration, development, and production of a satellite field (smaller, secondary field); decommissioning of both fields, and all associated support activities.

This BO has two components. The first component provides an analysis and conclusions as to whether the first incremental step would violate section 7(a)(2) of the ESA (i.e., whether this step would likely jeopardize listed species or destroy or adversely modify designated critical habitat) and provides incidental take exemptions for listed eider species. In addition, because the first incremental step could lead to development, production, and field decommissioning, in the second component we also analyze whether there is a reasonable likelihood that the entire proposed Action, based on an Exploration and Development Scenario (EDS) prepared by BOEM and BSEE for activities that may result from LS 193, will jeopardize listed species or destroy or adversely modify designated critical habitat.

The Service has consulted on previous versions of the incremental steps presented here for LS 193. BOEM and BSEE have since updated their EDS and refined the effects analysis to consider impacts that may result from the 460 leased blocks issued in LS 193. This section 7 consultation and BO, including the *Incidental Take Statement* (ITS) with new *Terms and Conditions,* therefore applies to activities associated with LS 193.

We prepared this BO using BOEM's and BSEE's Final Biological Assessment (BOEM 2015a), the Second Supplemental EIS (BOEM 2015b), other information received from BOEM and BSEE, published literature, agency consultation and biological survey reports, other information in our files, and personal communication with species experts in the Service.

For those activities that may result from the first incremental step, this BO considers the potential direct and indirect effects, the cumulative effects and effects of interrelated and interdependent actions added to and evaluated within the context of the status and environmental baseline to provide an aggregative analysis of impacts to listed species and designated critical habitat from activities. We also provide an incidental take statement with terms and conditions for actions that are adequately described and quantified in the first incremental step.

Based on the limited number of individuals of listed species likely to be affected, and the minor impacts to designated critical habitat, combined with the mitigation measures required and/or to be enforced by BOEM and BSEE during the first incremental step of the proposed Action, the Service concludes that activities that may occur during the first incremental step are not likely to jeopardize the continued existence of listed species or to destroy or adversely modify designated critical habitat.

We also conclude, based on the best available information at this time, the entire proposed Action, including future incremental steps, is not reasonably likely to jeopardize the continued existence of listed species or to destroy or adversely modify designated critical habitat. However, BOEM and BSEE have an on-going responsibility to ensure that future activities that may result from this action will not jeopardize the continued existence of listed species or to destroy or adversely modify designated critical habitat.

There are subsets of the Chukchi Sea and adjacent terrestrial environment that support large numbers of listed species at different times of the year. Impacts to these areas, through a very large oil spill or other large-scale impact will have a much greater impact to these species than if the impacts were to occur in other areas or at times when listed individuals are not present. It is incumbent upon BOEM to ensure that future projects are designed and located to ensure such impacts are avoided and minimized.

As BOEM proposes to authorize specific activities in future increments (e.g., development projects) these proposals will require re-initiation of section 7 consultation. At that time additional information about the nature, location, and timing of proposed oil and gas activities will be available. The Service will evaluate the proposed activities (e.g., Development and Production Plan) and at that time may determine that the proposed activities are likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of designated critical habitat, particularly if the status of a listed species declines or large changes in the environmental baseline have occurred when development is actually proposed. Also, given the lack of specificity in the BA regarding the number, size, and location of shorebases to support exploration in the first increment, we have not fully evaluated the potential effects of shorebases, nor have we enumerated or provided incidental take exemptions for spectacled and Alaska-breeding Steller's eiders related to shorebases. In the event that exploration entails construction of onshore support facilities that are likely to adversely affect spectacled or Alaska-breeding Steller's eiders through habitat impacts in the terrestrial environment, consultation should be reinitiated to ensure that impacts are appropriately evaluated, enumerated, and exempted from incidental take prohibitions.

2 The Proposed Action

This section describes the Proposed Action and includes descriptions of the Action Area, associated assumptions, and mitigation measures proposed by BOEM and BSEE for the proposed oil and gas activities.

2.1 Action Area

The Action Area is the geographic region in which direct and indirect effects of the Proposed Action may occur. Exploration and development is assumed to occur as a result of activities on the 460 leased blocks (the Leased Area). The Leased Area is in the Chukchi Sea and is a small subset of the approximately 40.2 million acre Chukchi Sea Planning Area that stretches from the from the U.S.-Russia Maritime border west of Point Hope to the edge of the Beaufort Sea Planning Area at Barrow. The Action Area is broader than the Leased Area, as structures resulting from the Proposed Action could be constructed in marine waters outside the Leased Area (e.g., platform-to-shore pipelines) and on land for shore facilities, (e.g., exploratory shore bases, pump stations, and a pipeline connecting to the Trans-Alaska Pipeline System (TAPS)). Effects of the Proposed Action could affect areas outside the Chukchi Sea Planning Area. Because the specific location of future development is unknown, the Action Area includes:

- The Chukchi Sea Planning Area (Figure 2.1);

- Marine waters between the southern boundary of the Chukchi Sea Planning Area and the Alaska coastline;
- Onshore areas for construction and operation of shore facilities, pump stations, ice roads/over-snow travel, a pipeline connecting to TAPS; and
- Any other areas where impacts of the Proposed Action may occur.

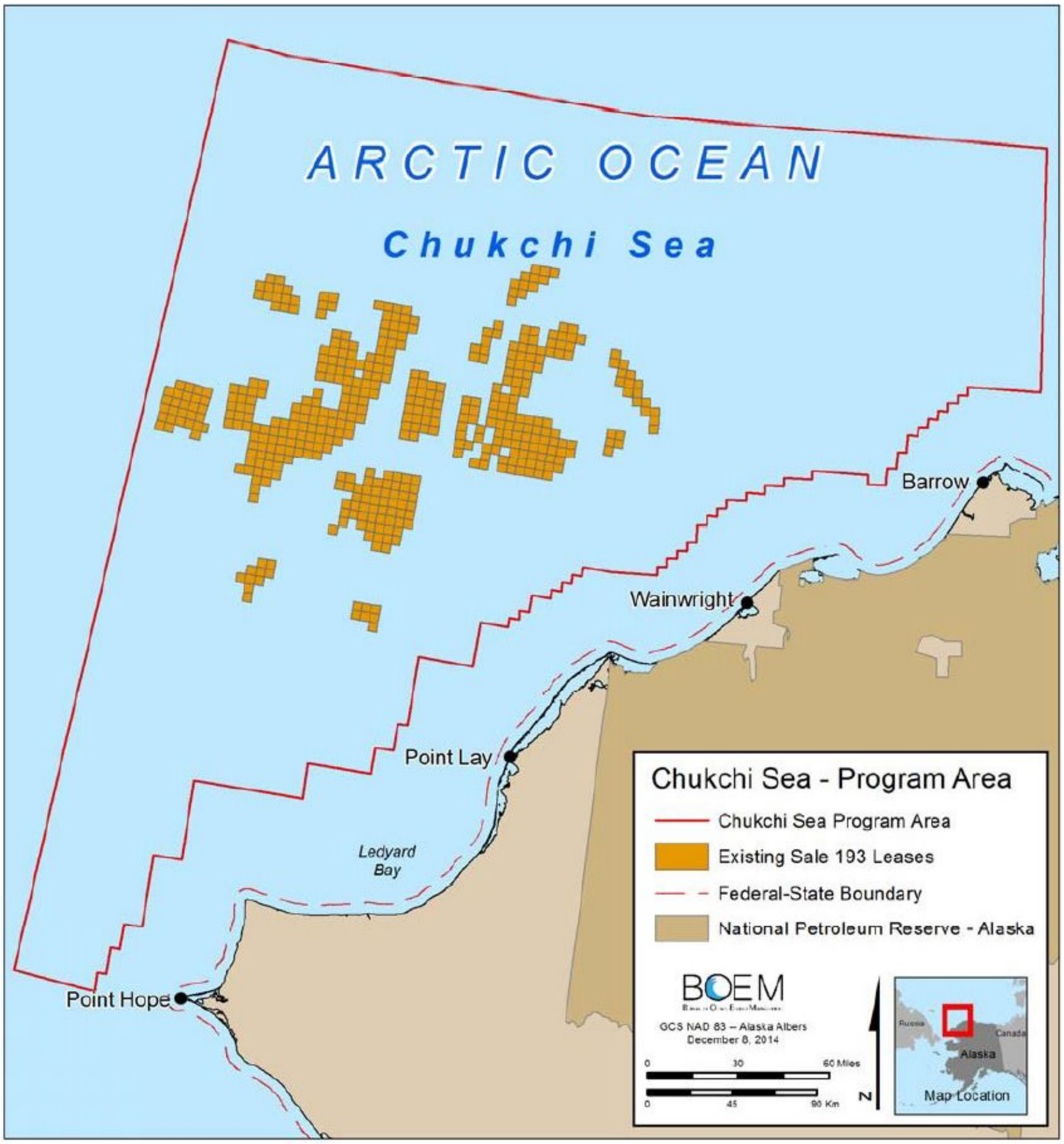


Figure 2.1. Current 460 leased blocks (Leased Area) in orange, in context of the Chukchi Sea Program Area, illustrated with red solid border and 25-mi (40 km) coastal buffer (deferred in the 2007-2012 Five-Year Program). From BOEM (2015a).

2.2 Description of the Proposed Action

The Proposed Action entails oil and gas exploration, development, production, and decommissioning in connection with the leases issued through Lease Sale 193. The activities comprising the Proposed Action are further described in the detailed hypothetical Exploration and Development Scenario (EDS) BOEM and BSEE presented in BOEM (2015a). The EDS considers both development and exploration, and while it is not specific to any existing Exploration Plan (EP), it uses the best available information from previously submitted EPs and previous development elsewhere on the U.S. OCS.

Under the Proposed Action, a large prospect, the “anchor field,” and a smaller “satellite field” would be discovered, developed, and produced from the Leased Area. Their combined potential oil and condensate are 4.3 Bbbl, which is 37% of the estimated Undiscovered Economically Recoverable Resources (UERR) in the Chukchi Sea OCS, at $110/barrel of oil (BOEM 2015a). Producing this volume of oil and associated natural gas (estimated at 2.2 Tcf) would require eight platforms of a new Arctic-class design and drilling 589 total wells (exploration, delineation, production, and service). The Proposed Action assumes that oil and gas would be transported from offshore platforms via subsea pipelines to shore where pipelines would continue over land to an existing terrestrial oil pipeline (either TAPS in its present form or a future redesigned pipeline). The Proposed Action also assumes that infrastructure for a liquid natural gas (LNG) pipeline and gas processing would be available and accessible.

For the purposes of section 7 consultation, BOEM and BSEE’s Proposed Action is divided into incremental steps. The first incremental step includes exploration and delineation of an anchor field and construction of onshore support facilities. Future incremental steps include the development and production of the anchor field, the exploration, development, and production of the satellite field, and decommissioning of both fields. Future incremental steps also include construction of subsea oil and gas pipelines and expansion and/or development of terrestrial support infrastructure. BOEM’s and BSEE’s request for incremental step consultation is appropriate because of the long-term, multistage nature of BOEM and BSEE decision making under the Outer Continental Shelf Lands Act. Incremental step consultation provides BOEM and BSEE the authority to conduct formal consultation in increments to maximize the opportunity to more accurately evaluate potential effects of the Proposed Action on listed species and designated critical habitat by considering specific details of activities closer to the time that they become viable (such as through the submission of a Development and Production Plan (DPP) to BOEM).

We note, however, that while the Proposed Action represents a reasonably foreseeable suite of exploration, development, production, and decommissioning activities that could potentially occur, considerable uncertainty exists as to what activities will actually be proposed in the future. As specific projects are proposed in this multi-stage oil and gas program, more precise information about the nature and extent of the activities – including the scale and location of the activities and a description of the particular technologies to be employed – will be considered and evaluated in additional ESA consultations and other analyses (such as NEPA) as appropriate. Through this multi-stage process, a dynamic analysis of the potential effects of oil and gas activities is ensured, and additional mitigation measures and protections may be developed and at any stage based on the specific details of the particular projects.

2.3 First Incremental Step

The first incremental step includes all activities associated with exploration and delineation of the anchor field, including construction of supporting onshore facilities (also referred to as "shorebases;" Table 2.1).

Deep penetration marine seismic surveys would be conducted to define hydrocarbon deposits in the Leased Area. Companies would conduct three-dimensional (3D) or some two-dimensional (2D) marine seismic surveys to identify limits of the prospective hydrocarbon areas. Two-dimensional seismic surveying techniques would be used to provide broad-scale information over a relatively large area, while 3D survey would produce more detailed information on smaller, specific areas of interest (identified during 2D surveys). Because the focus is on-lease exploration and development in the Chukchi Sea Leased Area, BOEM and BSEE expect most of the additional geophysical seismic surveys described under the Proposed Acton would be 3D surveys focusing on specific leasing targets to identify possible drilling locations.

The Proposed Action assumes the lessee would proceed from seismic exploration of the prospect to exploratory and delineation drilling. At least one year prior to drilling exploratory wells, the company would conduct high-resolution geophysical surveys (also called "site clearance," "shallow hazards surveys," or "geohazard surveys"). These surveys would further evaluate near surface geology, shallow hazards, depth to seafloor (bathymetry), potential shallow faults or gas zones, depth and distribution of ice gouges in the seabed, and obtain engineering data for drilling or placement of future structures (platforms and pipelines), detect archaeological resources and certain types of benthic communities. The lessee would also conduct geotechnical surveys to further increase the understanding of such site characteristics as sediment structures, ice gouges, and a variety of shallow hazard information.

Based on the evaluation of marine seismic and ancillary activity data (both geohazard and geotechnical surveys), BOEM and BSEE expect the lessee would propose to drill several test wells in the area of interest. This would involve two mobile offshore drilling units (MODUs) to drill exploration wells (with a maximum of four wells drilled per open-water season). If a discovery were to take place during exploration well drilling, MODUs would drill delineation wells to determine the areal extent of economic production. A component of exploratory drilling involving vertical seismic profiling (VSP) surveys would be conducted in the wellbores.

In conjunction with the beginning of the first incremental step, onshore facilities would be constructed near Barrow or Wainwright. These shorebases would provide air support, search and rescue capabilities, and personnel housing/equipment storage.

Table 2.1. Summary of activities anticipated during the first incremental step

Activity	Maximum number during first incremental step	Activity period
Open-water season 2D/3D marine seismic survey	1	July-November
In-ice 2D marine seismic survey	1	October-December
Geohazard survey	5	July-November
Geotechnical survey	5	July-November
Exploratory and delineation drilling	28 wells	June-November
Vertical seismic profile survey	28	June-November
Shorebase construction	Up to 3 bases, 2 years of construction	January-December

2.3.1 Deep Penetration Marine Seismic Surveys

During the exploration phase, lessees would conduct deep penetration marine seismic surveys to search for and define the prospective areas on lease that could contain hydrocarbon deposits. Two-dimensional deep penetration seismic surveying techniques would provide broad-scale information over a relatively large area and are intended for pre-lease exploration, or to provide area-wide geologic information. Three-dimensional deep penetration seismic surveys would be conducted on a closely spaced grid pattern to provide a more detailed image of the prospect that would then be used to select proposed drilling locations.

During the first incremental step, two marine seismic surveys would be conducted, with no more than one survey in any given year. One of these two surveys would be an in-ice survey; the other would be a typical 2D/3D marine seismic survey (Table 2.1).

Marine seismic surveys would typically be conducted during the open-water season from July 1st into November. However, during the open-water season, there would likely be periodic incursions of sea ice, and there is no guarantee that a given location would be ice-free throughout the entire survey. The in-ice survey would be conducted between October and late December, and exact timing would be dependent in part on ice conditions and the class of icebreaker available for escort.

2.3.1.1 2D/3D Open-water Seismic Surveys

Airguns would be the typical acoustic source for marine seismic surveys. To create outgoing sound signals, a high-pressure air pulse from the airguns is released into the water to produce an air-filled cavity (a bubble) that expands and contracts. The size of individual airguns could range from tens to several hundred cubic inches (in^3). Airguns are usually deployed in an array to produce a more downward-focused sound signal, and airgun array volumes for marine seismic surveys are expected to range from 1,800–4,500 in^3, but may range up to 6,000 in^3 (0.1 m^3). Airguns would be fired at short, regular intervals to emit pulsed rather than continuous sound. While most energy is focused downward, and the short duration of each pulse limits the total energy into the water column, the sound can propagate horizontally for several kilometers (Greene and Richardson 1988, Hall et al. 1994).

Marine 3D seismic surveys differ from typical 2D seismic surveys in that survey lines are more closely spaced and concentrated in a particular area. Specifications of a 3D survey depend on client needs, subsurface geology, water depth, and geological targets. A 3D and 2D source array typically consists of two to three subarrays of six to nine airguns each. Source-array size may vary during seismic surveys to optimize resolution of the geophysical data collected at any particular site. Energy output of the array is determined more by the number of guns than by total array volume (Fontana 2003, pers. communication, as cited in MMS 2007). Vessels would usually tow up to three source arrays, depending on survey design specifications. Most operations would use a single source vessel; however in a few instances, more than one source vessel would be used. Vessels conducting seismic surveys would generally be 230-295 ft (70–90 m) long.

The sound-source level (zero-to-peak) associated with typical 3D seismic surveys ranges between 233 and 240 dB re 1 µPa at 1 m (rms). Marine seismic surveys would take place at vessel speeds of 4.5 knots (kn) (8.3 km/hr), and a source array would be activated at approximately 10–15 sec intervals, depending on vessel speed. The timing between outgoing source signals may vary for different surveys in order to achieve a desired "shot point" spacing to meet geological objectives; typical spacing is either 82 or 123 ft (25 or 37.5 m).

Sound receivers for a 3D survey would include multiple, 4–16 streamer-receiver cables, towed behind the source array. Streamer cables contain numerous hydrophone elements at fixed distances within the cable. Each streamer would be 1.9-5 mi (3–8 km) long, with an overall array width of up to 4,921 ft (1.5 km) between the outermost streamer cables. Biodegradable liquid paraffin would fill the streamer to provide buoyancy. Solid/gel streamer cables would also be used. The wide path needed to tow this equipment affects both turning speed, and the area covered by a single pass over a geologic target. Therefore, it is common practice to acquire data using an offset racetrack pattern, whereby each acquisition line is several kilometers away from, and traversed in the opposite direction, of the previously completed track. Acquiring a single track line may take several hours, depending on the size of the survey area. The vessel would then require 2–3 hrs to turn at the end of a track line, and start acquiring data along the next track. Adjacent track lines for a modern 3D seismic survey are generally parallel and spaced several hundred meters apart across the survey area. Vessel transit speeds would typically range from 8–12 kn (12.9–19.3 km/hr) depending on a number of factors including, but not limited to, the vessel itself, sea state, and ice conditions.

Seismic surveys would be conducted day and night during favorable ocean conditions, and a single survey effort may continue for weeks or months, depending on the size of the survey. Data-acquisition would be affected by the number of streamer cables towed and by weather/ice conditions. Typically, data are successfully collected between 25% and 30% of the time (approximately 6–8 hrs a day) due to equipment or weather constraints. In addition to downtime due to weather, sea conditions, turning between lines, and equipment maintenance, seismic surveys could be suspended due to proximity of protected species. Therefore, individual seismic surveys could require 60–90 days to cover a 200 mi^2 (518 km^2) area.

Marine 2D seismic surveys would use similar geophysical-survey techniques to those of 3D seismic surveys; however both the mode of operation and vessel type would be different. Two-dimensional seismic surveys provide a less-detailed subsurface image because survey lines are spaced farther apart. Large prospects would be easily identified with 2D seismic data, however detailed images of the prospective areas, can only be achieved with 3D data. Two-dimensional seismic vessels are generally smaller than 3D-seismic survey vessels. The 2D seismic source array would consist of three or more arrays of six to eight airguns each (equivalent to arrays used for 3D surveys). Sound-source levels (zero-to-peak) associated with 2D marine seismic surveys are the same as 3D marine seismic surveys (233–240 dB re 1 μPa at 1 m (rms)). Typically, a single hydrophone streamer cable, approximately 5-7.5 mi (8–12 km) long, is towed behind the survey vessel. Two-dimensional seismic surveys would acquire data along single track lines that are spread more widely (usually several km) than lines for 3D seismic surveys (usually several hundred meters).

Marine seismic vessels may operate for weeks without refueling or resupply. A support vessel would accompany the seismic vessel for safety, general support, maintenance, and resupply, although it would not be directly involved with seismic data collection. With the exception of in-ice surveys, the majority of marine seismic surveys require mostly ice-free conditions in order to conduct effective operation and maneuvering of airgun arrays and streamers.

2.3.1.2 In-Ice Towed-Streamer 2D Surveys

Technological advances have allowed geophysical (seismic reflection and refraction) surveys to be conducted in thicker sea ice concentrations; defined in terms of percent coverage in tenths. For example, an area with 1/10 sea ice coverage means the area contains sporadic ice floes that allow easy vessel navigation; whereas 10/10 ice coverage means there is no open water in the area. This new technology employs an icebreaker and a 2D seismic source vessel with a specialized fitting to allow streamers to be towed below the ice. The icebreaker would generally operate 0.3–0.62 mi (0.5–1 km) in advance of the seismic vessel, which would follow at speeds ranging from 4 to 5 kn (7.4 to 9.3 km/hr). As with open-water surveys, in-ice seismic surveys would operate 24 hrs a day, or as conditions permit.

Airgun arrays and streamers used in in-ice surveys would be similar to those used in open-water surveys. A single hydrophone streamer, which would use a solid fill material to produce constant and consistent streamer buoyancy, would be towed behind the vessel. The streamer would receive reflected signals from the subsurface and transfer data to an on-board processing system. The survey vessel would have limited maneuverability while towing the streamer and therefore would require a 6.2 mi (10 km) run-in for the start of a seismic line, and a 2.5-3.1 mi (4–5 km) run-out at the end of the line. In-ice surveys would occur until late December, or when ice thickness becomes an issue.

2.3.2 Geohazard surveys

Prior to submitting an exploration or development plan, oil and gas industry operators are required to evaluate any potential geological hazards or cultural resources, and document the type of benthic community present pursuant to 30 CFR 550. The BOEM, Alaska OCS Region, has provided guidelines (Notices to Lessees 05–A01, 05–A02, and 05–A03) that require high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate there is enough previously collected data of good quality to evaluate the site. These data are vital not only when planning for the design and construction of a facility, but also to ensure that all associated activities are completed safely.

Under the Proposed Action, five ancillary geohazard surveys would be conducted during the first incremental step, with no more than one survey in any given year (Table 2–1). These surveys would utilize airgun arrays or other sound generating equipment smaller in size and lower in sound level output than those described for 2D and 3D seismic surveys. Ancillary geohazard surveys would be used to:

- Locate shallow hazards (<2,000 m water depth);
- Obtain engineering data for placement of structures (e.g., proposed platform locations and pipeline routes); and
- Detect geohazards, archaeological resources, and certain types of benthic communities.

Geohazard surveys would employ various geophysical methods (e.g., seafloor imaging, water-depth measurements, and high-resolution seismic reflection profiling) designed to identify and map hazards (e.g., shallow faults or ice gouges), and potentially collect oceanographic data. Basic components of a geophysical system include 1) a sound source, to emit acoustic impulses or pressure waves; 2) a hydrophone or receiver, to receive and interpret the acoustic signal; and 3) a recorder/processor to document the data. All geohazard surveys would occur on-lease between July and November.

The suite of equipment used during a typical shallow hazards survey consists of:

- *Seismic Systems*
  Seismic systems produce sound waves which penetrate the seafloor. The waves then reflect at the boundary between two layers with different acoustic impedances, producing a cross sectional image. These data are interpreted to infer geologic structure of the area. Seismic energy can be produced by several different types of sources; they will be discussed briefly below.
- *Single channel high-resolution seismic reflection profilers*. High-resolution seismic reflection profilers, including sub-bottom profilers, boomers, and bubble pulsers, consist of an electromechanical transducer that sends a sound pulse down to the seafloor. Sparkers discharge an electrical pulse in seawater to generate an acoustic pulse. The energy reflects back from the shallow geological layers to a receiver on the sub-bottom profiler or a small single channel streamer. Sub-bottom profilers are usually hull mounted or pole-mounted; the other systems are towed behind the survey vessel. These systems range in frequency from 0.2 to 200 kHz, Laban et al. 2009; Greene and Moore 1995).
- *Multichannel high-resolution seismic reflection systems*. The multichannel seismic system consists of an acoustic source which may be a single small gun (air, water, Generator-Injector, etc.) 10 to 65 in^3, or an array of small guns (usually two or four 10 in^3 guns). The source array is towed about 3 m behind the vessel with a firing interval of

approximately 12.5 m (7–8 sec). A single 300–600 m, 12–48 channel streamer with a 12.5 m hydrophone spacing and tail buoy is the passive receiver for reflected seismic waves. A 40 in^3 airgun array is commonly used in the Arctic as the source for these multichannel seismic surveys. This array will typically have a frequency between 0 and 200 Hz, and a source level between 196 and 217 dB re 1 μPa at 1 m (rms) (NMFS 2008, 2009, 2010; Greene and Moore 1995).

Seismic survey ships are designed to minimize vessel noise because the higher frequencies used in higher resolution work are easily masked by vessel noise. Seismic surveys are site specific, and may cover less than one lease block. Survey extent is determined by the number of potential drill sites in an area. Typical survey vessels travel at 3–4.5 kn (5.6–8.3 km/hr). A single vertical well site survey would collect about 70 line-miles of data per site and require approximately 24 hrs to complete. BOEM and BSEE regulations require data to be gathered on a 150– by 300–m grid within 600 m of the drill site, a 300 by 600 m grid out to 1,200 m from the drill site, and a 1,200 by 1,200 m grid out to 2,400 m from the well site. If there is a high probability of encountering archeological resources, the 150– by 300–m grid must extend to 1,200 m from the drill site.

- *Echosounder*. Echosounders measure the time it takes for sound to travel from a transducer, to the seafloor, and back to a receiver. Travel time is converted to a depth value by multiplying it by the sound velocity of the water column. Single beam echosounders measure the distance of a vertical beam below the transducer. The frequency of individual single beam echosounders can range from 3.5 to 1000 kHz with source levels between 192 to 205 dB re 1μPa at 1 m (rms) (Koomans 2009). Multibeam echosounders emit a swath of sound to both sides of the transducer with frequencies between 180 and 500 kHz and source levels between 216 and 242 dB re 1 μPa at 1 m (rms) (Hammerstad 2005; HydroSurveys 2010).
- *Side scan sonar*. Side scan sonar is a sideward-looking, narrow-beam instrument that emits a sound pulse and "listens" for its return. Side scan sonar can be a two or multichannel system with single frequency monotonic or multiple frequency Compressed High Intensity Radar Pulse (CHIRP) sonar acoustic signals. The frequency of individual side scan sonars can range from 100 to 1600 kHz with source levels between 194 and 249 dB re 1 μPa at 1 m (rms). Pulse lengths will vary according to the specific system; monotonic systems range between 0.125 and 200 milliseconds (ms) and CHIRP systems range between 400 and 20,000 ms. (HydroSurveys 2008a, b; Dorst 2010).

A typical geohazard survey would consist of a vessel towing an airgun about 82 ft (25 m) behind the vessel and a 1,969 ft (600 m) streamer cable with a tail buoy. The source array is usually a single array composed of one or more airguns. Two-dimensional geohazard surveys would usually employ a single airgun, while 3D ancillary surveys would tow an array of airguns (typically smaller in volume than arrays used in marine seismic exploration). Vessels would travel at 3–3.5 kn (5.6–6.5 km/hr), and the source would be activated every 7–8 sec (or about every 12.5 m (41 ft)). Vessels used for geohazard surveys are designed to be ultra-quiet, as the higher frequencies used in geohazard work may be easily masked by vessel noise.

A typical seismic survey would cover one proposed drilling location at a time. Federal regulations require information be gathered on a 984 x 2,953 ft (300 x 900 m) grid, which amounts to about 80 mi (129 line-kilometers) of data per lease block (NTL No. 05-A01). If there is a high probability of encountering archeological resources, north-south lines would be adjusted to 164 ft (50 m) apart while the 2,953 ft (900 m) spacing would remain the same. Including turns, the time required to survey a single lease block would be approximately 36 hrs. Airgun volumes for ancillary geohazard surveys are typically 40–450 in^3 (1.5–2.5 L), and output of a 90–in^3 (1.5 L) airgun would range from 229–233 dB high-resolution re 1μPa at 1 m (rms). Airgun pressure would typically be 2,000 pounds per square inch (psi), although they may be used at 3,000 psi for higher signal strength to collect deeper subsurface data.

2.3.3 Geotechnical Surveys

In addition to geohazard surveys, other ancillary activities may provide more detailed information about a prospective site. These are important for understanding such site characteristics as sediment structures, strudel scouring, ice gouges, and a variety of shallow hazard information.

- *Geological/geochemical surveys* involve collecting bottom samples to obtain physical and chemical data on surface sediments. Sediment samples are typically collected using a gravity/piston corer, grab sampler, or dredge sampler. Shallow coring, using conventional rotary drilling from a boat or drilling barge, may also be used to collect physical and chemical data on near-surface sediments.

Under the Proposed Action, five ancillary geotechnical surveys would be conducted during the first incremental step, with no more than one survey in any given year (Table 2.1). All geotechnical surveys would be conducted between July and November.

2.3.4 Exploratory and Delineation Drilling

During the first incremental step, BOEM and BSEE anticipate exploration drilling operations would employ two Mobile Offshore Drilling Units (MODUs) with icebreakers and other support vessels. Examples of MODUs include drillships, semisubmersibles, and jackup rigs.

2.3.4.1 Drillships

Drillships are maritime vessels that are equipped with a drilling apparatus. Most are built to the design specification of the company, but some are modified tanker hulls that have been equipped with a dynamic positioning system. One example of a drillship that has been used in drilling on the Alaska OCS is the *M/V Discoverer* (also known as the *Noble Discoverer*). Shell Oil has proposed, in prior applications, to use the *Discoverer* for drilling in both the Chukchi and Beaufort seas and used the vessel in their 2012 exploratory drilling in the Leased Area (Shell Offshore Inc. 2010; Bisson et al. 2013). The *Discoverer* is a drillship, built in 1976, that has been retrofitted for operating in Arctic waters. It is a 512 ft (156 m) conventionally-moored drillship with drilling equipment on a turret. It mobilizes under its own power, and can therefore be moved off the drill site with help from an anchor handler.

Depending on the circumstances, the procedure and time required to move off a drill site can change. In extreme emergencies, this process can be completed in less than one hour, although the process could take 4 to 12 hours in other situations (e.g., operations are temporarily curtailed in response to a hazard such as sea ice). Typical transit speed of the *M/V Discoverer* is 8 kn (14.8 km/hr). Sounds produced by the *Discoverer* were measured in the Chukchi Sea during 2012 activities, and the broadband source level of the *Discoverer* while drilling was 182 dB re 1 μPa (rms) (Bisson et al. 2013).

Support vessels would be used to assist the drillship with icebreaking and ice management, anchor handling, oil spill response, refueling, resupply, and servicing. Resupplies would also potentially occur via a support helicopter from the shore to the drill site. The total number of support vessels and aircraft depends on the local conditions and the design of the exploration program.

2.3.4.2 Jackup Rigs

Jackup rigs are offshore structures composed of a hull, support legs, and a lifting system that allow them to be towed to a site, lower the legs into the seabed while elevating the hull to provide a stable work deck. Because jackup rigs are supported by the seabed, they are preloaded when they arrive onsite to simulate maximum expected support leg load and ensure that, after being jacked to full airgap (maximum height above the water), and experiencing operating loads, the supporting soil would provide a reliable foundation. Actual dimensions of a jackup rig would depend on the environment in which the unit would operate and the maximum operating water depth. A typical jack up rig with a maximum operating depth of 164 ft (50 m) is approximately 164 ft (50 m) in length, 144 ft (44 m) in beam, and 23 ft (7 m) in depth. Noise levels from jackup rigs have not been measured in the Arctic or elsewhere (Wyatt 2008). However, because jackup rigs use the same general drilling machinery as drillships, they are expected to produce noise levels similar to those produced by drillships (discussed above). Furthermore, noise levels transmitted into the water from bottom-founded structures are expected to be less than levels produced by drillships because a jackup rig's vibrating machinery is not in direct contact with the water. As with drillships, support vessels would be used to assist with ice breaking and ice management, oil spill response, refueling, resupply, and servicing. There is also the potential for re-supply to occur via support helicopters from the shore. The total number of support vessels would depend on local conditions and the design of the exploration plan, however BOEM and BSEE estimate up to 25 support vessels could be used for exploratory drilling and delineation during the first incremental step.

2.3.4.3 Semisubmersibles

A semisubmersible is an MODU designed with a platform-type deck that contains drilling equipment and other machinery supported by pontoon-type columns that are submerged into the water. Semisubmersibles may be self-propelled or towed into place, and maintain position either by mooring or dynamic positioning (i.e., the vessel uses its propulsion system to maintain position). Once in place, they are partially submerged using the pontoon system. This reduces rolling and pitching when compared to other types of MODUs. Semisubmersibles and their engines are generally smaller than those of drillships. Therefore semisubmersible noise levels are expected to be comparable or slightly less than those produced by drillships. If the vessel were moored rather than dynamically positioned, some subsea footprint would result. Support vessels required for semisubmersible operation would be the same as those used with drillships. To date, semisubmersibles have not been used in the U.S. Arctic, however, at least one company has proposed to use a semisubmersible drilling unit in future exploratory drilling in the Leased Area.

2.3.5 Exploratory Drilling Operations

Drilling operation would be conducted from June through November, and each operation is expected to range between 30 and 90 depending on the well site, depth of the well, drilling delays, and time required for well logging and testing operations. Considering the relatively short open-water season in the Chukchi Sea, BOEM and BSEE estimate two wells per rig could be drilled, tested, and abandoned during a single open-water season, assuming two MODUs were operating simultaneously. If a discovery were made during exploratory drilling, MODUs would drill delineation wells to determine the areal extent of economic production, and operators would verify that sufficient volumes would be present to justify the expense of installing a platform and pipelines.

During the first incremental step, BOEM and BSEE anticipate a maximum of 28 exploratory and delineation wells would be drilled, including dry wells. No more than four wells would be drilled annually (Table 2.1). All wells, including successful exploration and delineation wells would likely be plugged and abandoned within the same season, rather than being converted to production wells because several years would be required before platforms and pipelines could be installed to produce oil.

Exploratory drilling would result in some disturbance to an area of the seafloor. The area of disturbance would vary based on the type of rig used, ocean currents, and other environmental factors, although in general, sea floor disturbance would include the mud cellar, anchoring system for the MODU (e.g., legs of the jackup rig or footprint of the drillship anchors), displacement of sediments, and discharges from the drill hole. For example, a previous drilling operation on the Burger prospect (within the Leased Area) was estimated to have disturbed 1,018 ft^2 (95 m^2) of seafloor per well, and each well cellar excavated 619 yd^3 (473 m^3) of sediment (BOEM 2015a). Cuttings from the well cellar excavation were deposited on the seafloor below the temperature and salinity stratification layer. BOEM and BSEE estimate the maximum thickness of the sediment deposition onto the seafloor would be 10.4 ft (3.2 m) and deposition would expand to a horizontal distance of 449 ft (137 m) from the excavation site, where it would be 0.4 in (1 cm) thick. Displaced sediments would be expected to cover an additional 1,600 ft^2 (or 148.6 m^2). Finally, the anchoring system of a drill ship with 12 anchors (drill ships employ 8–12 anchors) would be expected to disturb an estimated 78,000 ft^2 (7,500 m^2) of the sea floor.

2.3.5.1 Vertical Seismic Profiling

Vertical seismic profiling (VSP) is conducted in the wellbore as part of the drilling program. This activity uses hydrophones suspended at intervals within the well to receive signals from external sound sources (e.g., airguns suspended from the rig or a nearby vessel). Data are then used to help determine the structure of a petroleum-bearing zone. VSPs would vary by well configuration, the number and location of sources and geophones, and how geophones are deployed. Most VSPs would use a surface seismic source (e.g., a vibrator on land or an airgun in offshore environments). Types of VSP include zero-offset VSP, offset VSP, walk away VSP, walk-above VSP, salt proximity VSP, shear-wave VSP, and drill-noise or seismic-while-drilling VSP. Airgun volumes for VSPs are typically 450–750 in^3 (7.4 –12.3 L). For example, a 500 in^3 airgun array was used in offshore Greenland for a VSP survey, and the acoustic properties were modeled for an environmental impact assessment to predict the possible exposure levels to marine mammals (Kyhn et al. 2011). Acoustic output of the 500–in^3 airgun array was 222 dB re 1μPa at 1 m (rms). It is unlikely that VSPs would be conducted at every exploratory and delineation well; however, for the purposes of this BA, BOEM and BSEE conservatively assumes that VSP would be conducted in association with each wellbore, resulting in a maximum of 28 VSPs during the first incremental step (Table 2.1).

2.3.5.2 Authorized Discharges

During the first incremental step, synthetic drilling mud would be reconditioned and reused with 80% efficiency. All rock cuttings would be discharged at the exploration site. Discharges from exploratory operations in the Chukchi Sea would be permitted under a National Pollutant Discharge Elimination System (NPDES) General Permit issued by EPA with a term of five years. Discharges under a General Permit for exploration would include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. Detailed information on the various types and properties of discharges from routine oil and gas activities is contained in the 2007 FEIS (MMS 2007). BOEM and BSEE estimates drill cuttings from one exploration well would be 5,800 bbl, with 3,200 bbl of drilling fluids. The current NPDES General Permit for exploration discharges in the action area is the 2012–2017 NPDES General Permit for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea (AK 28-8100) (EPA 2012). The terms of this permit are indicative of expected terms of future General Permits and the types of discharges in the current 2012–2017 General Permit are presented in Table 4–6 of the second SEIS (BOEM 2015b).

2.3.5.2.1 Unauthorized Discharges

Small Spills

During the first incremental step, small numbers of low volume refined oil spills (<1,000 bbl) would be likely to occur. These small spills would be limited to refined oils because crude and condensate oils would not be produced during the first incremental step. Refined oils are used in exploratory drilling activity for refueling and equipment operations. Small refined oil spills during seismic, geophysical and geotechnical (G&G) surveys, and exploratory drilling would occur during the first incremental step from June through early November.

Total volumes and numbers of small refined oil spills estimated annually during the first incremental step are presented in Table 2–2. BOEM and BSEE estimate that approximately 20 spills ranging in size from <1 bbl to 55 bbl per spill would occur during the first incremental step (spill ranges sourced from BOEM 2015b). BOEM and BSEE anticipate that most spills from seismic and G&G survey activities during the first incremental step would be <1 bbl, while one would be up to13 bbl (spill ranges sourced from BOEM 2015b). BOEM and BSEE anticipate that most spills originating from exploration and delineation drilling activities would be up to 5 bbl, while some would be up to 55 bbl. For the purpose of analysis, BOEM and BSEE assume that the 13 bbl spill and one 55 bbl spill would occur during the first incremental step.

Table 2.2. Total annual potential small refined oil spills estimated from activities associated with the first incremental step.

Activity phase	Total number	Total volume (bbl)
Exploration geological and geophysical activities	0-6	0-<18
Exploration and delineation drilling	0-14	0-<115

2.3.5.2.2 Large Spills

BOEM and BSEE estimate that large spills, >1,000–150,000 bbl, would not occur during the first incremental step based on historical oil spill data. In the course of drilling over 15,000 exploration wells on the OCS from 1971–2010, no crude oil spills ≥1,000 bbl have occurred during exploration, with the exception of the Deepwater Horizon (DWH) incident. Furthermore, no large spills are expected to occur during the first incremental step because a very small fraction of spills are estimated during the relatively short exploration and delineation phase compared to the total spill frequency for future incremental steps (which include development and production). Despite this assumption, oil spill response equipment and cleanup vessels would be included in the first incremental step and may be staged near the drilling area, or in more protected nearshore areas, such as Goodhope Bay in Kotzebue Sound.

2.3.5.2.3 Very Large Oil Spill

During the first incremental step, BOEM and BSEE anticipate it would be highly unlikely (but the risk cannot be wholly eliminated) that a VLOS (defined by spills > 150,000 bbl) could occur from a loss of well control followed by a long duration flow. A VLOS is extremely unlikely because the frequency of such spills from loss of well control is extremely low. Therefore, while the potential impacts of a VLOS would be substantial if one were to occur, and such effects were analyzed in the Second SEIS for the purpose of evaluating a low-probability, high impact event, the effects of a VLOS are not considered reasonably certain to occur. Therefore, a VLOS is not considered a direct or indirect effect of the first incremental step and is beyond the scope of analysis here. Details of the assumptions of the VLOS scenario and analytical methods are presented in Section 4.4.2 and Appendix A of the second SEIS (BOEM 2015a).

2.3.6 Onshore Facilities Construction

During the first incremental step, up to three exploration-support facilities would be constructed onshore to provide housing, equipment storage, air support, and search and rescue. These coastal facilities would be situated near Wainwright or Barrow, with efforts made to use existing infrastructure and co-locate bases, although uncertainty remains regarding the specific location of these exploration-support facilities. Impacts to wetland habitat identified in the BA include:

- Up to approximately 15 acres of tundra would likely be filled for an exploration camp. The exploration camp would include stationary equipment consisting of generators, pumps, compressors, and jackhammers, and the camp would also include housing facilities, mess hall(s), and recreation, as well as vehicle parking;
- If the support base were to be located near Wainwright, up to approximately 5 acres of tundra would be filled to expand the existing Wainwright airport in order to support cargo (C-130 Hercules) and commercial airlines (Boeing 737); and

- Up to approximately 7 acres of tundra could be filled to construct a search and rescue (SAR) base with a helipad and a road connection to the village of Wainwright or Barrow (Table 2.3). Additionally, at least one mile of road may be built (BOEM 2015a).

Construction for these shore-based exploration facilities would require gravel which would be obtained from an approximately 240-acre material site. BOEM and BSEE anticipate the material site would be located near Wainwright or Barrow. Approximately 70 additional acres of tundra at the edge of the gravel fill could be exposed to gravel/dust spray and dust shadow as a result of onshore facilities construction during the first incremental step. BOEM and BSEE assume dust and gravel spray would occur within 30–35 ft (approximately 10 m) of adjacent fill material and that the dust shadow would extend beyond 30–35 ft by less than 165 ft (approximately 50 m) from adjacent fill material (Table 2.3). These impacts would persist throughout the life of the Proposed Action as vehicle use continues and maintenance is accomplished on the fill.

Overall, BOEM and BSEE anticipate approximately 337 acres of tundra would be impacted by onshore facilities construction associated with the first incremental step. However, before any onshore construction were to occur, plans and detailed information, including location(s) and size(s) of facilities and borrow sources, would be subject to a multi-tiered decision making and review process. First, Outer Continental Shelf Lands Act (OCSLA) staged decision making would provide for review of the Exploration Plan(s). Compliance with conditions of the Biological Opinion that results from the current ESA consultation will be required.

Other mitigation may be required as well, including but not limited to site characterization or alternative siting. The lessee would also be obligated to coordinate with the land owner(s) in order to obtain necessary authorizations and permits for all onshore activities, including construction and gravel mining. Construction activities that impact wetlands will also be reviewed by the Corps of Engineers, and permit(s) required under section 404 of the Clean Water Act would include measures to avoid, minimize, and otherwise mitigate habitat loss. This coordination would require additional ESA consultation(s) to ensure listed species are protected and could entail additional mitigation measures to reduce construction and operation impacts to natural resources.

Table 2.3. Estimated maximum disturbance areas from onshore activities associated with the first incremental step of the proposed action.

Step	Construction Component	Short-term Maximum Impact Area (acres)[2]	Long-term Maximum Impact Area (acres)
First Incremental Step	Exploration Camp	0	15
	Search and Rescue Base[3]	0	7
	Air Support Base[4]	0	5
	Dust/Gravel Spray and Shadow[5]	0	70
	Gravel Material Site[6]	0	240

[2]Assumes that restoration would occur at all sites after use is complete.
[3]Assumes ~1 mile of 50-ft wide road extension from Wainwright.
[4]Assumes a 2,000-ft long, 150-ft wide extension to the Wainwright Airstrip.
[5]Assumes dust and gravel spray within 30-35 ft (approximately 10 m) of adjacent fill material and that dust shadow extends beyond 30-35 ft (approximately 50 m) from adjacent fill material.
[6]For the purposes of this BA, habitat alteration/loss from gravel material sites are assumed to be a long-term impact because USFWS has found that rehabilitation of mine sites to provide habitat comparable in quality to pre-construction has been largely unsuccessful to date (Louise Smith, USFWS, per. commun., 2014).

2.3.7 Transportation

During the first incremental step, operations at remote locations in the Leased Area would require transportation of supplies and personnel by different means, depending on seasonal constraints and phase of the operations. Marine vessels would be the primary form of transport during the first incremental step, although aircraft would be used to support exploratory drilling and onshore activities, as well as to conduct any search and rescue efforts. Onshore transportation would be limited to vehicles associated with shorebase operation.

During exploration surveys, seismic vessels would be largely self-contained and helicopters would not be used for routine support of operations. During open-water seasons under the first incremental step, smaller support vessels would make occasional trips (one to three round-trips per survey, depending on survey duration) between shore-bases (likely Barrow and/or Wainwright). Additionally, if directed by NMFS or USFWS, a mitigation vessel may accompany the seismic survey vessel. No support vessels would be associated with the in-ice seismic survey; however, an icebreaker would be present during the survey for ice management (Table 2.4).

During exploration drilling, operations would be supported by both helicopters and supply vessels (Table 2.4). An anchor handler would move MODUs to the various drill sites. Helicopters would fly from Barrow and/or Wainwright at a frequency of one to six flights per day. Support-vessel traffic would be one to three round-trips per week, also out of Barrow and/or Wainwright. After completion of the shore-bases, air and vessel traffic might alternatively originate from the onshore air support facility.

During the first incremental step, a tug and a refueling barge may be moored in Kotzebue Sound for oil spill recovery. It is anticipated that these vessels would be moored in the Goodhope Bay area of Kotzebue Sound. These vessels would be used for nearshore oil spill recovery. An additional tanker would serve as spill storage. Ice-breaking and ice-management would likely occur during some of the activities described in the previous subsections. BOEM and BSEE define ice breaking and ice management as separate activities. Ice-breaking is defined as opening a pathway or lead through pack ice, ice floes or landfast ice for the purpose of moving vessels through sea ice. Ice-breaking occurs in waters with ice. BOEM and BSEE define ice management as using an ice-hardened vessel or icebreaker to move floes away from a stationary vessel, such as a drill rig, by pushing, towing or passing back and forth upstream of the stationary vessel or drill rig. Ice management activities take place in an environment that is primarily open water.

During shorebase construction heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Under the Proposed Action, one to two barge trips (possibly from either West Dock or Nome) would occur in each of two consecutive open-water seasons. There could be as many as five transport aircraft (C-130 Hercules or larger) trips per day during peak periods of base construction (Table 2.4).

Utilization of winter ice roads would depend on the location of the shorebases in proximity to Wainwright or Barrow, the presence of any existing ice roads, and the exploration plan (EP) submitted to BOEM by the lessee. Submission of an EP would require project-specific NEPA analysis and, if needed, additional ESA consultation to assess impacts of any proposed ice roads or additional infrastructure associated with the shorebases on threatened or endangered species and critical habitat. The overall frequency of transportation in and out of the shore-base would decrease substantially after construction is completed. In construction of the shorebase it is anticipated that mobile ground equipment such as dozers, graders, crew vehicles would be used (Table 2.4).

Table 2.4. Transportation activities associated with the first incremental step[1].

Activity type	Activity period	Transportation Type		
		Marine vessel	Aircraft	Terrestrial vehicle
Open-water season 2D/3D marine seismic survey	July-November	1 source/receiver vessel, 1 support vessel (1-3 trips to shore/survey), ± 1 mitigation vessel	None	None
In-ice 2D marine seismic survey	October-December	1 seismic survey vessel, 1 icebreaker	None	None
Geohazard survey	July-November	1 vessel[2]	None	None
Geotechnical survey	July-November	1 vessel[2]	None	None
Exploratory drilling	June-November	Drilling support: 2 MODUs, 2 icebreakers, 3 anchor handlers, 2 supply tug-and-barges,	1+ helicopter (1-6 flights/day)	None

		3 offshore supply vessels, 2 support tugs, 2 science vessels, 2 shallow water vessels, ± 1 MLC ROV system vessel Oil spill response: 1 OSR vessel, 1 OSR tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 nearshore OSR tug and barge		
Shorebase construction[3]	Year-round	1-2 barge trips during the first two open-water seasons of shorebase construction	1+ C-130 Hercules or similar, 1+ Boeing 737 or similar (up to 5 flights/day)	Crew vehicles, dozers, graders, dump trucks, other mobile construction equipment as determined by EP

[1]The quantitave information contained in Table 2.4 represents BOEM and BSEE's best estimate for transportation activities associated with the first incremental step based on previous and present-day Eps as well as NEPA documents specific to the OCS.
[2]In lieu of additional support vessels, companies that conduct geohazard and geotechnical surveys in the Arctic typically coordinate to ensure that 2 survey vessels are present in the vicinity of one another to provide support in the event of an emergency.
[3]Shorebase construction is not analyzed here; reinitiation of consultation will be required for proposals that are likelyl to adversely affect spectacled or Alaska-breeding Steller's eiders.

2.4 Future Incremental Steps

Future incremental steps include all activities that would occur after anchor field exploration and delineation (Table 2.5). While there is considerable uncertainty about the type and location of activities that may occur as a result of Lease Sale 193, BOEM and BSEE describe a development scenario. This scenario forms the basis of our analysis for future incremental steps and a summary is provided below.

BOEM and BSEE anticipate that additional exploratory surveys and drilling conducted during development of the anchor field could reveal a smaller discovery in a satellite field approximately 20 mi from the anchor field hub platform. The EDS assumes three platforms would be installed at the satellite field. Under the Proposed Action, oil would be produced before gas, as oil can be shipped to market via TAPS, while the gas would initially be re-injected to aid oil recovery. Gas production would occur only after construction of a gas transportation system (i.e., pipelines). The Proposed Action assumes a pipeline to transport gas across Alaska will be available in later years of offshore production.

Development of the anchor field would begin in the 5th year after exploration starts, and BOEM and BSEE assume that most development activities would occur over the next 20 years (installation of supplemental offshore gas pipeline could continue into the later years of the Proposed Action). BOEM and BSEE anticipate that production activities would begin in approximately the 10th year and continue for roughly 50 years. Decommissioning would commence after oil and gas reserves are depleted and income from production no longer pays operating expenses. Decommissioning is assumed to begin after approximately 30 years of production. BOEM (2015a) states that the schedule of activities is compressed and ambitious, assumes no delays of any kind, and assumes immediate commitment from operator(s) after a successful exploration program.

2.4.1 Concurrent Activities

The phases of offshore oil and gas development during future incremental steps – exploration of the satellite field, development of both fields, and decommissioning of both fields – would occur simultaneously (Table 2.5). Activity level during future incremental steps would vary among and within these phases. The highest level of activity could occur during initial phases of satellite development and initial phases of decommissioning.

During initial years of satellite field development, simultaneous operation could occur for up to 4 geohazard and geotechnical surveys, 4 drilling MODU actions, and installation of flowlines (4 survey vessels and their 9 support, mitigation, and supply vessels; plus 4 MODUs and their 38 support vessels; plus 4 platforms and their 16 supply or maintenance vessels = 75 vessels or platforms operating simultaneously). In addition, each MODU and platform would receive 1-3 helicopter flights ((4 MODUs and 4 platforms) x 3 flights = 24 flights) daily. During this period, all onshore support infrastructure, except perhaps the gas pipeline, would be in place and in operation.

A high level of activity could also occur during initial years of decommissioning when up to 8 platforms and up to 3 MODUs (MODUs decommission subsea wells) may be present (3 MODUs and their 29 support vessels; plus 8 platforms and their 36 supply or maintenance vessels = 76 vessels or platforms operating simultaneously). As during development each MODU and platform would receive 1-3 helicopter flights ((3 MODUs and 8 platforms) x 3 flights = 33 flights) daily. All onshore support infrastructure would remain in operation.

Table 2.5. Activities anticipated during future incremental steps of the Proposed Action.[1] From BOEM (2015a).

Activity	Activity Period	Estimated Operations	Associated Transportation
Exploration (Satellite Field)			
Marine seismic surveys (including potential in-ice surveys)	July–November (October–December for in-ice)	6 surveys over ~20 years; no more than one survey per year	1 source/receiver vessel, 1 support vessel (1–3 trips to shore per survey), +/- 1 mitigation vessel +/- 1 icebreaker (in-ice surveys only)

Activity	Activity Period	Estimated Operations	Associated Transportation
Geohazard survey	July–November	8 surveys over ~20 years; no more than two surveys per year, generally a maximum of 1 survey per year	1 vessel[1]
Geotechnical survey	July–November	8 surveys over ~20 years; no more than two surveys per year	1 vessel per survey[1]
Exploratory and delineation drilling	June–November	12 wells drilled in satellite field; maximum of 4 wells drilled per open-water season; maximum of 4 MODUs per open-water season (includes MODUs for production drilling)	Drilling Support: 2–4 MODUs, 2–4 ice breakers, 3–6 anchor handlers, 2–4 supply tug-and-barges, 3–6 offshore supply vessels, 2–4 support tugs, 2–4 science vessels, 2–4 shallow water vessels, +/- 1 MLC ROV system vessel Oil Spill Response: 1 oil spill response vessel, 1 oil spill response tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 oil spill response tug and barge for nearshore response
Development			
Offshore			
Subsea oil pipeline installation	July–November	160 mi of buried oil pipe from hub platform to shore; installed at the onset of development over the course of several open-water seasons	1 lay vessel, 1 trenching vessel, +/- 1 mitigation vessel
Subsea gas pipeline installation	July–November	160 mi of buried oil pipe from hub platform to shore; installed towards the end of development over the course of several open-water seasons	1 lay vessel, 1 trenching vessel, +/- 1 mitigation vessel
Platform Installation	July–November	8 platforms installed over ~20 years (5 in anchor field, 3 in satellite field)	multiple tugs, barges
Flowline Installation	July–November	30 mi of flowline connecting subsea templates to host platforms (2 mi per template)	1 reel vessel, 1 trenching vessel, +/- 1 mitigation vessel
Template Installation	July–November	15 subsea templates	1+ installation vessel, 1 ROV, +/- 1 mitigation vessel
On-platform drilling	Year-Round	16 wells per platform per year (including both production and service wells)	None

Activity	Activity Period	Estimated Operations	Associated Transportation
Subsea well drilling	July–November	90 production wells (6 per template); maximum of 4 MODUs during open-water season (includes MODUs for exploratory drilling); BOEM assumes that a single MODU could drill up to 3 subsea wells in a single season	Drilling Support: 2–4 MODUs (includes MODUs associated with exploratory drilling that could occur simultaneous to subsea well drilling), 2–4 ice breakers, 3–6 anchor handlers, 2–4 supply tug-and-barges, 3–6 offshore supply vessels, 2–4 support tugs, 2–4 science vessels, 2–4 shallow water vessels,
			+/- 1 MLC ROV system vessel Oil Spill Response: 1 oil spill response vessel, 1 oil spill response tug and barge, 2 oil spill tankers, 1 oil spill containment system tug and barge, 1 oil spill response tug and barge for nearshore response
Personnel and supply transport	Year-Round	Includes crew changes, supply delivery, and waste transport	1–3 vessel trips per platform per week, 1–3 helicopter trips per platform per day, 1–2 barge trips per open-water season (for waste disposal)
Spill response	July–November	Vessels will likely be stationed at Wainwright or Barrow	1 barge (for spill response), 1 tug (for spill response), 1 tank vessel (for spill storage)
Onshore			
Production base construction	Year-Round	Construction to occur over 2 years. Would include landfall valve pad, protective ice berm, valve enclosure control building, pipeline riser well, onshore pipeline trench and backfill, a pump station, pipeline pigging facilities, and a land-farm for barged drilling waste treatment	Dump trucks, graders, crew transport vehicles Flights Barges
Boat terminal construction	Year-Round	Construction to occur over 2 years. Boat terminal would include a barge dock with lay-down area and material storage, fuel tank farm, and vehicle parking	Dredge, dozers, dump trucks, graders, crew transport vehicles Flights Barges
Oil pipeline installation	Year-round	300–320 mi of oil pipeline tying into TAPS; installed at the onset of development over the course of several winters. Includes VSMs and pump station installation.	Crew transport vehicles, helicopters, graders, backhoes, dump trucks, other large construction vehicles as needed

Activity	Activity Period	Estimated Operations	Associated Transportation
Gas pipeline installation	Year-round	300–320 mi of gas pipeline tying into future existing gas transport system; installed towards the end of development over several winters	Crew transport vehicles, helicopters, graders, backhoes, dump trucks, other large construction vehicles as needed
Personnel and supply transport	Year-Round	Includes crew changes and supply delivery	1–2 barge trips each summer for two summers during production base construction, Up to 5 C-130 or larger aircraft flights per day, road traffic
Production			
Offshore maintenance and support	Year-Round	Pigging, pipeline repairs, equipment and facilities maintenance and upgrades, well servicing, crew changes	1 support vessel trip per platform every 1–2 weeks, 1–3 flights per platform per day
Onshore maintenance and support	Year-Round	Pigging, pipeline repairs, equipment and facilities maintenance and upgrades, crew changes	2 flights per day, road traffic
Decommission			
Offshore decommission	Year-Round	Drilling and plugging wells, plugging pipelines and flowlines, removal of templates, manifolds, platforms	2–3 MODUs

[1] The quantitative information contained in this table is BOEM and BSEE's best estimates for transportation activities. Previous and present-day EPs as well as government NEPA documents specific to the Alaska OCS were consulted in the development of these estimates.

2.4.2 Infrastructure Development

Off- and onshore development would commence simultaneously. Development would begin with 1) installation of oil pipelines (on- and off-shore), which would take several years; and 2) construction of a production base and first pump station.

2.4.2.1 Onshore Development

A main 142-acre production shorebase would be developed at a new location, or alternatively, by expanding an existing exploration shorebase to accommodate production needs (Table 2.5, Table 2.6). Any location near Wainwright or Barrow, or otherwise on the coast between Icy Cape and Point Belcher may serve as the production base. The production shorebase would support offshore operations and would be comprised of the landfall valve pad, protective ice berm, valve enclosure control building, pipeline riser well, the first pump station, a pipeline trench with backfill, pipeline pigging facilities, and a landfarm for barged drilling waste treatment. Construction of a 10-acre supply boat terminal would occur near the production shorebase. The boat terminal would include the barge dock with lay-down area and material storage, fuel tank farm, and vehicle parking (Table 2.6).

A 300–320 mi pipeline with associated communication cables suspended on vertical support members (VSMs) would originate from the production shorebase and connect to existing North Slope oilfield infrastructure. Onshore pipeline construction would occur during winter months and require gravel mining from one or more new or existing sources, and supply and personnel transport along a seasonal ice road. The EDS states two 240-acre gravel material sites (Table 2.6) (in addition to the site developed for construction during the first incremental step) would likely be located at the midpoint and eastern end of the onshore pipeline corridor. The pipeline corridor would be approximately 300 ft (91 m) wide with a 100–ft (30.5 m) right-of-way. The total estimated pipeline corridor footprint would include an estimated 10 river crossings, a gravel pad for storage of spill prevention equipment, three pump stations (excluding Pump Station 1, which would be located at the production shorebase), and 20 valve pads and numerous VSMs (Table 2.6). Pump stations would be constructed along at necessary intervals and likely co-located within existing oil fields (e.g., Alpine).

BOEM and BSEE assume that a 300-320 mi onshore gas transport pipeline (similar to TAPS) will be buried in the oil pipeline corridor approximately 20 years later, with a gravel road for the pipeline's length the in the same corridor. (BOEM 2015a).

Table 2.6. Maximum estimated impacts from onshore activities associated with future incremental steps. From BOEM (2015a).

Infrastructure	Temporary Impacts (ac)	Permanent Impacts (ac)
Production Base – Total Area	**0**	**142**
Primary Production Pad[1]	*0*	*25*
Pump Station 1	*0*	*27*
Supply Boat Terminal and Barge Dock	*0*	*10*
Landfall Control Pad	*0*	*10*
Dust/Gravel Spray and Shadow[2]	*0*	*70*
Pipeline Corridor – Total Area	**3,600**	**339**
Ice Road	*3,600*[4]	*0*
Pump Stations	*0*	*150*[5]
VSMs	*0*	*9*[6]
Valve Pads	*0*	*4*[7]
River Crossings	*0*	25[8]
Dust/Gravel Spray and Shadow[2]	*0*	*151*
Gas Pipeline Corridor – Total Area	**436**	**13,202**
All Season Road	*0*	*1,275*[9]
Gas Pipeline Trench	*436*[10]	*0*
Dust/Gravel Spray and Shadow[2]	*0*	*11,927*
Gravel Material Sites[3]	0	480[11]
Total excavation and fill:[12]		**1,756**

[1]Assumes inclusion of the landfarm and protective ice berm.
[2]Assumes dust and gravel spray within 30–35 ft (approximately 10 m) of adjacent fill material and that dust shadow extends beyond 30–35 ft by less than 165 ft (approximately 50 m) from adjacent fill material.
[3]For the purposes of this BO, habitat alteration/loss from gravel material sites are assumed to be a long-term impact because USFWS has found that rehabilitation of mine sites to habitat comparable in quality to that which was present prior to mine construction has been largely unsuccessful to date (Louise Smith, USFWS, per. commun., 2014).
[4]Assumes a 25–35 ft wide ice road.
[5]Assumes three pump stations (excluding the production shorebase, which would serve as the first pump station), each with 50-acre footprints.
[6]Assumes 0.3 acres required per VSM per mile.
[7]Assumes 20 valve pads at 0.2 acres each.
[8]Assumes ten river crossings required 2.5 acres each.
[9]Assumes a 35-ft wide all-season road.
[10]Assumes a 12-ft wide trench for a pipe 38–50 in diameter.
[11]Two gravel material sites at 240 acres each.
[12]Excludes dust shadow.

2.4.2.2 Offshore Development

Offshore pipeline installation would occur during the open water season. All pipelines would be trenched in the seafloor. BOEM and BSEE anticipate that the depth and width of subsea pipeline trenches would be similar to those dug for Northstar (7–11 ft deep and 8–52 ft wide), with pipelines at greater depths requiring deeper and wider trenches. Approximately 6–9 ft of backfill would cover trenched pipelines. An estimated 160 mi of trunk oil pipelines would connect the anchor field hub platform (1st installed platform) to the onshore processing facility. An additional estimated 20 mi of oil pipeline would connect the satellite field and anchor field hubs. Installation of subsea gas pipelines would occur along the same routes as oil pipelines approximately 20 years later.

Installation of production platforms would occur after pipeline installation, during several open-water seasons. BOEM and BSEE anticipate industry would use large, bottom-founded platforms that would be pinned to the seafloor and stabilized by their wide bases, anchoring systems, and ballast systems. Vessels would transport platform sections for offshore, onsite construction.

Each platform would have two drilling rigs capable of drilling year-round, and would support processing equipment, fuel and production storage infrastructure, and quarters for personnel. Oil would be piped to shore after processing. There would be some storage capacity on the platforms to accommodate periods of processing equipment downtimes, although information about the storage capacity range on platforms is currently unavailable. The first platform would serve as the hub. Additional anchor field platforms would be located approximately 5 mi from the hub platform, with buried subsea flowlines connecting each platform to the hub. One of the three satellite field platforms would act as a secondary hub, delivering oil and gas to the anchor field hub via 20 mi of subsea flowline. The two remaining satellite field platforms would connect to the secondary hub via 5 mi of subsea flowline. A total of 15 subsea templates would be installed during open-water seasons. Templates would be located within 2 mi of the host platform and connected via subsea flowline.

BOEM and BSEE listed a 160-mi subsea pipeline as an activity to take place during future incremental steps and stated it would be installed towards the end of development (Table 2-4 in BOEM 2015a, Table 2.5).

2.4.3 Production Drilling

Production and service well drilling would take place from production platforms and drillships. Up to eight wells could be drilled annually by each production platform rig (e.g., 2 rigs on each platform drilling 16 wells per platform per year). A total of 459 production and service wells would be drilled from production platforms over the life of the Proposed Action. Subsea wells would be drilled by drillships. With efficiencies gained by repeated operations, BOEM and BSEE assume that a single drillship could drill up to three subsea wells in a single season. BOEM and BSEE estimate in the Proposed Action that 6 to 9 subsea wells would be drilled per open-water season, requiring two to three drillships each summer over approximately 12 years. A total of 90 subsea production wells would be drilled over the life of the Proposed Action. Treated well cuttings and mud wastes from platform and subsea wells could be reinjected in disposal wells or barged to an onshore treatment and disposal facility located at the shorebase (e.g., treated at a landfarm; see *Transportation* section below). Production well drilling produces less drilling mud and fewer cuttings than exploration and delineation well drilling.

2.4.3.1 Production

Production operations would largely involve resupply of materials and personnel, inspection of various systems, and maintenance and repair. Well workovers would likely occur at 5 to10 year intervals to restore production flow rates. Pipelines will be inspected and cleaned regularly using internal devices ("pigs").

2.4.3.2 Transportation

Table 2.5 presents transportation types and trip frequencies estimated to occur during future incremental steps by activity type. BOEM and BSEE estimate up to 3 helicopter flights per day and 3 support vessel trips per week would be made to the central platform site, either from the production shorebase or Barrow. Heavy equipment and other materials for construction would likely be transported to the shorebase site via barges (estimated at two barge trips per year) and aircraft (five C-130 flights per week).

In the production phase, the number of helicopter trips to production platforms would likely remain the same as during development (Table 2.5 states 1-3 helicopter flights per platform daily), while vessel traffic would decrease to one trip every one to two weeks. Two barge trips per year for six years may also be required to remove cuttings and spent mud from the subsea templates and central platform. Two to three daily aircraft flights are expected at the shorebase, and ice roads may be constructed as needed.

2.4.4 Decommissioning

Decommissioning would commence after oil and gas resources are depleted and income from production no longer pays operating expenses. MODUs (two to three per open-water season over an estimated 12 years) would be used to permanently plug wells with cement. Wellhead equipment would be removed, and processing modules would be moved off platforms. Subsea pipelines and flowlines would be decommissioned by cleaning the line, plugging both ends, and leaving it in place buried in the seabed. The overland oil and gas pipelines are likely to be used by other fields in the NPR-A and would remain in operation. Lastly, the platforms would be disassembled and removed using vessels, and the seafloor site would be cleared of all obstructions. Post-decommissioning surveys would be required to confirm that no debris remains.

2.4.5 Discharges

2.4.5.1 Authorized Discharges

Discharges from development and production operations in the Chukchi Sea are permitted under a National Pollutant Discharge Elimination System (NPDES) General Permit issued by the EPA and have a term of five years. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. The production fluids (oil, gas, and water) would be gathered on the platforms where gas and produced water would be separated and gas and water reinjected into the reservoir using service wells. During the later gas sales phase, water would continue to be reinjected. Disposal wells would handle wastewater from the crew quarters on the platforms.

2.4.5.2 Unauthorized Discharges

2.4.5.3 Small Spills

Small spills (<1,000 barrels) of refined oils and crude and condensate oils could occur onshore and offshore during future incremental steps. BOEM and BSEE estimate approximately 535 spills of refined oil and 222 spills of crude or condensate oil or liquid nature gas could occur during future incremental steps. BOEM and BSEE anticipate that these spills would be <1–5 barrels each but also assume that one of onshore spills of roughly 700-barrels would originate from the pipeline.

2.4.5.4 Large Spills

Large spills (≤1,000 barrels) could occur during future incremental steps. We provide an overview of BOEM and BSEE's oil spill scenario (BOEM 2015b) in a later section of this BO.

2.5 Mitigation Measures during First and Future Incremental Steps

Mitigation measures are specific to the type and phase of oil and gas development. A variety of typical design features and operational procedures are used to mitigate potential impacts of petroleum these activities. Our analysis of effects of the Action assumes all mitigation measures identified in the BA (BOEM 2015a) will be implemented and compliance will be ensured. Mitigation measures and typical monitoring protocols for exploratory seismic operations and exploratory and delineation drilling are presented in Appendix A. Mitigation measures for vessel, aircraft, and terrestrial vehicle operations and onshore development activities are also presented.

Offshore mitigation measures result from compliance with permits issued by various agencies, including:

- BOEM's Lease Sale 193 Stipulations (Stipulations 4, 5, and 7 especially mitigate impacts to listed species and designated critical habitat);
    - ITLs (Information to Lessees) and NTLs (Notices to Lessees) associated with these stipulations;
- Mitigation measures imposed by multiple agencies to reduce oil spill risk;
- Conditions of take authorizations issued under the MMPA by National Marine Fisheries Service and the Service, especially those issued by the Service for polar bears; and
- Conditions of permits issued by the EPA for discharges.

Onshore activities associated with the Proposed Action would be subject to permits, authorizations, conditions, stipulations, and best management practices (BMPs) as recommended or required by the appropriate land-based resource and management agencies such as the USACE and BLM. For example, the BLM's 2013 Record of Decision (ROD) for the National Petroleum Reserve – Alaska Integrated Activities Plan (BLM 2013) presents stipulations and BMPs that are typical of the types of mitigation BOEM anticipates for onshore oil and gas activities described in the Proposed Action if located within NPR-A. These mitigation measures provide operators with guidance in minimizing impacts to wildlife, vegetation, and subsistence resources, including requirements for water and mineral withdrawals, waste disposal, construction footprints, and contaminant and spill handling. Of particular applicability are those that minimize impacts to ESA-listed species (BLM 2013). Additional consultation would take place when BOEM receives a development proposal from an operator containing project-specific details that would enable BOEM, BSEE, and the Service to evaluate impacts on listed species and designated critical habitat at a more detailed level and to identify potential mitigations of potential impacts.

3 Status of the Species

This section presents biological and ecological information relevant to the BO. Appropriate information on species' life history, habitat and distribution, and other factors necessary for their survival is included for analysis in later sections.

3.1 Spectacled eider

Spectacled eiders (Figure 3.1A) were listed as threatened throughout their range on May 10, 1993 (USFWS 1993) based on indications of steep declines in the two Alaska-breeding populations. There are three primary spectacled eider populations, corresponding to breeding grounds on Alaska's North Slope, the Yukon–Kuskokwim Delta (YK-delta), and northern Russia. The YK-delta population declined 96% between the early 1970s and 1992 (Stehn et al. 1994). Data from the Prudhoe Bay oil fields (Warnock and Troy 1992) and information from Native elders at Wainwright, Alaska (R. Suydam, pers. comm. in USFWS 1996) suggested concurrent localized declines on the North Slope, although data for the entire North Slope breeding population were not available. Spectacled eiders molt in several discrete areas (Figure 3.1B) during late summer and fall, with birds from different populations and genders apparently favoring different molting areas (Petersen et al. 1999). All three spectacled eider populations overwinter in openings in pack ice of the central Bering Sea, south of St. Lawrence Island (Petersen et al. 1999; Figure 3.1B), where they remain until March–April (Lovvorn et al. 2003).

3.1.1 Life History

Breeding – In Alaska, spectacled eiders breed primarily on the Arctic Coastal Plain (ACP) of the North Slope and the YK-delta. On the ACP, spectacled eiders breed north of a line connecting the mouth of the Utukok River to a point on the Shaviovik River about 24 km (15 mi) inland from its mouth, with breeding density varying across the ACP (Figure 3.2). Although spectacled eiders historically occurred throughout the coastal zone of the YK-delta, they currently breed primarily in the central coast zone within about 15 km (9 mi) of the coast from Kigigak Island north to Kokechik Bay (USFWS 1996). However, sightings on the YK-delta have also occurred both north and south of this area during the breeding season (R. Platte, USFWS, pers. comm. 1997).

Spectacled eiders arrive on the ACP breeding grounds in late May to early June. Numbers of breeding pairs peak in mid-June and decline 4–5 days later when males begin to depart from the breeding grounds (Smith et al. 1994, Anderson and Cooper 1994, Anderson et al. 1995, Bart and Earnst 2005). Mean clutch size reported from studies on the Colville River Delta was 4.3 (Bart and Earnst 2005). Spectacled eider clutch size near Barrow has averaged 3.2–4.1, with clutches of up to eight eggs reported (Quakenbush et al. 1995, Safine 2011). Incubation lasts 20–25 days (Kondratev and Zadorina 1992, Harwood and Moran 1993, Moran and Harwood 1994, Moran 1995), and hatching occurs from mid- to late July (Warnock and Troy 1992).

Nest initiation on Kigigak Island on the YK-delta occurs from mid-May to mid-June (Lake 2007). Incubation lasts approximately 24 days (Dau 1974). Mean spectacled eider clutch size is higher on the YK-delta compared to the ACP. Mean annual clutch size ranged from 3.8–5.4 in coastal areas of the YK-delta (1985–2011; Fischer at al. 2011), and 4.0–5.5 on Kigigak Island (1992–2011; Gabrielson and Graff 2011), with clutches of up to eight eggs reported (Lake 2007).

On the breeding grounds, spectacled eiders feed on mollusks, insect larvae (craneflies, caddisflies, and midges), small freshwater crustaceans, and plants and seeds (Kondratev and Zadorina 1992) in shallow freshwater or brackish ponds, or on flooded tundra. Ducklings fledge approximately 50 days after hatch, when females with broods move from freshwater to marine habitat prior to fall migration.

Survivorship – Nest success is highly variable and thought to be primarily influenced by predators, including gulls (*Larus* spp.), jaegers (*Stercorarius* spp.), and red (*Vulpes vulpes*) and arctic foxes (*Alopex lagopus*). In arctic Russia, apparent nest success was estimated to be < 2% in 1994 and 27% in 1995; low nest success was attributed to predation (Pearce et al. 1998). Apparent nest success in 1991 and 1993–1995 in the Kuparuk and Prudhoe Bay oil fields on the ACP was also low, varying from 25–40% (Warnock and Troy 1992, Anderson et al. 1998). On Kigigak Island in the YK-delta, nest survival probability ranged from 6–92% from 1992–2007 (Lake 2007); nest success tended to be higher in years with low fox numbers or activity (i.e., no denning) or when foxes were eliminated from the island prior to the nesting season. Bowman et al. (2002) also reported high variation in nest success (20–95%) of spectacled eiders on the YK-delta, depending on year and location.

(A)

(B)

Figure 3.1. (A) Male and female spectacled eiders in breeding plumage. (B) Distribution of spectacled eiders. Molting areas (green) are used July –October. Wintering areas (yellow) are used October –April. The full extent of molting and wintering areas is not yet known and may extend beyond the boundaries shown.

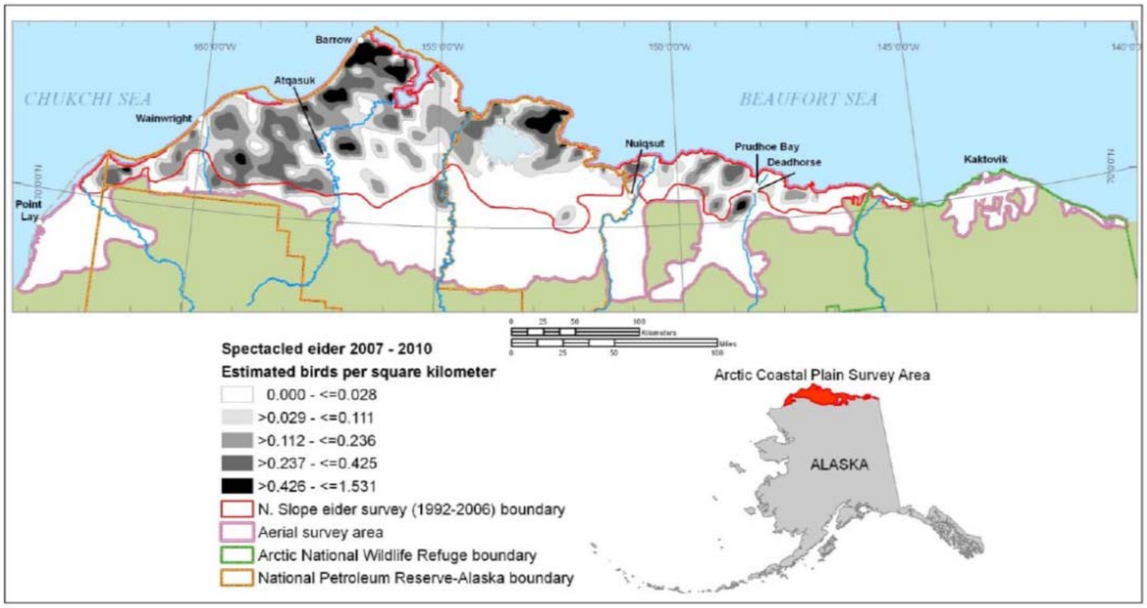


Figure 3.2. Density distribution of spectacled eiders observed on aerial transects sampling 57,336 km^2 of wetland tundra on the North Slope of Alaska during early to mid-June, 2007–2010 (Larned et al. 2011).

Available data indicate egg hatchability is high for spectacled eiders nesting on the ACP, in arctic Russia, and at inland sites on the YK-delta, but considerably lower in the coastal region of the YK-delta. Spectacled eider eggs that are addled or that do not hatch are very rare in the Prudhoe Bay area (Declan Troy, TERA, pers. comm. 1997), and Esler et al. (1995) found very few addled eggs on the Indigirka River Delta in Arctic Russia. Additionally, from 1969 to 1973 at an inland site on the Yukon Delta National Wildlife Refuge, only 0.8% of spectacled eider eggs were addled or infertile (Dau 1974). In contrast, 24% of all nests monitored in a coastal region of the YK-delta during the early to mid-1990s contained inviable eggs and ~10% of eggs in successful nests did not hatch due to either embryonic mortality or infertility (Grand and Flint 1997). This relatively high occurrence of inviable eggs near the coast of the YK-delta may have been related to exposure to contaminants (Grand and Flint 1997). It is unknown whether hatchability of eggs in this region has improved with decreased use of lead shot in the region and gradual settling of existing lead pellets (Flint and Schamber 2010) in coastal YK-delta wetlands.

Recruitment rate (the percentage of young eiders that hatch, fledge, and survive to sexual maturity) of spectacled eiders is poorly known (USFWS 1999) because there is limited data on juvenile survival. In a coastal region of the YK-delta, duckling survival to 30 days averaged 34%, with 74% of this mortality occurring in the first 10 days, while survival of adult females during the first 30 days post hatch was 93% (Flint and Grand 1997).

Fall migration and molting – As with many other sea ducks, spectacled eiders spend the 8–10 month non-breeding season at sea. Satellite telemetry and aerial surveys led to the identification of spectacled eider migrating, molting, and wintering areas. These studies are summarized in Petersen et al. (1995 and 1999) and Larned et al. (1995). Results of more recent satellite telemetry research (2008–2011) are consistent with earlier studies (Sexson et al. 2014). Phenology, spring migration and breeding, including arrival, nest initiation, hatch, and fledging, is 3–4 weeks earlier in western Alaska (YK-delta) than northern Alaska (ACP); however, phenology of fall migration is similar between areas. Individuals depart breeding areas July–September, depending on breeding status and success, and molt in September–October (Matt Sexson, USGS, pers. comm.).

Males generally depart breeding areas on the ACP when females begin incubation in late June (Anderson and Cooper 1994, Bart and Earnst 2005). Use of the Beaufort Sea by departing males is variable. Some appear to move directly to the Chukchi Sea over land, while the majority move rapidly (average travel of 1.75 days), over nearshore waters from breeding grounds to the Chukchi Sea (TERA 2002). Of 14 males implanted with satellite transmitters, only four spent an extended period of time (11–30 days) in the Beaufort Sea (TERA 2002). Males appeared to prefer areas near large river deltas such as the Colville River where open water is more prevalent in early summer when much of the Beaufort Sea is still frozen. Most adult males marked with satellite transmitters in northern and western Alaska in a recent satellite telemetry study migrated to northern Russia to molt (USGS, unpublished data). Results from this study also suggest that male eiders likely follow coast lines but also migrate straight across the northern Bering and Chukchi seas en route to northern Russia (Matt Sexson, USGS, pers. comm.).

Females generally depart the breeding grounds later, when more of the Beaufort Sea is ice-free, allowing more extensive use of the area. Females spent an average of two weeks in the Beaufort Sea (range 6-30 days) with the western Beaufort Sea the most heavily used (TERA 2002). Females also appeared to migrate through the Beaufort Sea an average of 10 km further offshore than males (Petersen et al. 1999). The greater use of the Beaufort Sea and offshore areas by females was attributed to the greater availability of open water when females depart the area (Petersen et al. 1999, TERA 2002). Recent telemetry data indicate that molt migration of failed/non-breeding females from the Colville River Delta through the Beaufort Sea is relatively rapid, 2 weeks, compared to 2–3 months spent in the Chukchi Sea (Matt Sexson, USGS, pers. comm.).

Spectacled eiders use specific molting areas from July to late October/early November. Larned et al. (1995) and Petersen et al. (1999) found spectacled eiders show strong preference for specific molting locations, and concluded that spectacled eiders molt in four discrete areas (Table 3.1). Females generally used molting areas nearest their breeding grounds. All marked females from the YK-delta molted in nearby Norton Sound, while females from the North Slope molted in Ledyard Bay, along the Russian coast, and near St. Lawrence Island. Males did not show strong molting site fidelity; males from all three breeding areas molted in Ledyard Bay, Mechigmenskiy Bay, and the Indigirka/Kolyma River Delta. Males reached molting areas first, beginning in late June, and remained through mid-October. Non-breeding females, and those that nested but failed, arrived at molting areas in late July, while successfully-breeding females and young of the year reached molting areas in late August through late September and remained through October. Fledged juveniles marked on the Colville River Delta usually staged in the Beaufort Sea near the delta for 2–3 weeks before migrating to the Chukchi Sea.

Table 3.1. Important staging and molting areas for female and male spectacled eiders from each breeding population.

Population and Sex	Known Major Staging/Molting Areas
Arctic Russia Males	Northwest of Medvezhni (Bear) Island group
	Mechigmenskiy Bay
	Ledyard Bay
Arctic Russia Females	unknown
North Slope Males	Ledyard Bay
	Northwest of Medvezhni (Bear) Island group
	Mechigmenskiy Bay
North Slope Females	Ledyard Bay
	Mechigmenskiy Bay
	West of St. Lawrence Island
YK-delta Males	Mechigmenskiy Bay Northeastern Norton Sound
YK-delta Females	Northeastern Norton Sound

Avian molt is energetically demanding, especially for species such as spectacled eiders that complete molt in a few weeks. Molting birds require adequate food resources, and apparently benthic community of Ledyard Bay (Feder et al. 1989, 1994a, 1994b) provides this for spectacled eiders. Large concentrations of spectacled eiders molt in Ledyard Bay using this food resource; aerial surveys on 4 days in different years counted 200 to 33,192 molting spectacled eiders in Ledyard Bay (Petersen et al. 1999; Larned et al. 1995).

Wintering – Spectacled eiders generally depart molting areas in late October/early November (Sexson et al. 2014, Sexson 2015), migrating offshore in the Chukchi and Bering seas to a single wintering area in pack-ice lead complexes south/southwest of St. Lawrence Island (Figure 3.1B). In this relatively shallow area, > 300,000 spectacled eiders (Petersen et al. 1999) rest and feed, diving up to 230 ft (70 m) to eat bivalves, other mollusks, and crustaceans (Cottam 1939, Petersen et al. 1998, Lovvorn et al. 2003, Petersen and Douglas 2004).

Spring migration – Recent information indicates spectacled eiders likely make extensive use of the eastern Chukchi Sea spring lead system between departure from the wintering area in March and April and arrival on the North Slope in mid-May or early June. Limited spring observations in the eastern Chukchi Sea have documented tens to several hundred common eiders (*Somateria mollissima*) and spectacled eiders in spring leads and several miles offshore in relatively small openings in rotting sea ice (W. Larned, USFWS; J. Lovvorn, University of Wyoming, pers. comm.). Woodby and Divoky (1982) documented large numbers of king (*Somateria spectabilis*) and common eiders using the eastern Chukchi lead system, advancing in pulses during days of favorable following winds, and concluded that an open lead is probably requisite for spring eider passage in this region. Satellite telemetry data collected by the USGS Alaska Science Center (Figure 3.3; Sexson et al. 2014) suggests that spectacled eiders also use the spring lead system during spring migration.

Adequate foraging opportunities and nutrition during spring migration are critical to spectacled eider productivity. Like most sea ducks, female spectacled eiders do not feed substantially on the breeding grounds, but produce and incubate eggs while living primarily off body reserves (Korschgen 1977, Drent and Daan 1980, Parker and Holm 1990). Clutch size, a measure of reproductive potential, was positively correlated with body condition and reserves obtained prior to arrival at breeding areas (Coulson 1984, Raveling 1979, Parker and Holm 1990). Body reserves must be maintained from winter or acquired during the 4-8 weeks (Lovvorn et al. 2003) of spring staging, and Petersen and Flint (2002) suggest common eider productivity on the western Beaufort Sea coast is influenced by conditions encountered in May to early June during migration through the Chukchi Sea (including Ledyard Bay). Common eider female body mass increased 20% during the 4-6 weeks prior to egg laying (Gorman and Milne 1971, Milne 1976, Korschgen 1977, Parker and Holm 1990). For spectacled eiders, average female body weight in late March in the Bering Sea was 1,550 ± 35 g (n = 12), and slightly (but not significantly) more upon arrival at breeding sites (1,623 ± 46 g, n = 11; Lovvorn et al. 2003), suggesting that spectacled eiders maintain or enhance their physiological condition during spring staging.

3.1.1.1 Abundance and trends

The most recent rangewide estimate of abundance of spectacled eiders was 369,122 (364,190–374,054 90% CI), obtained by aerial surveys of the known wintering area in the Bering Sea in late winter 2010 (Larned et al. 2012). Comparison of point estimates between 1997 and 2010 indicate an average of 353,051 spectacled eiders (344,147-361956 90% CI) in the global population over that 14-year period (Larned et al. 2012).

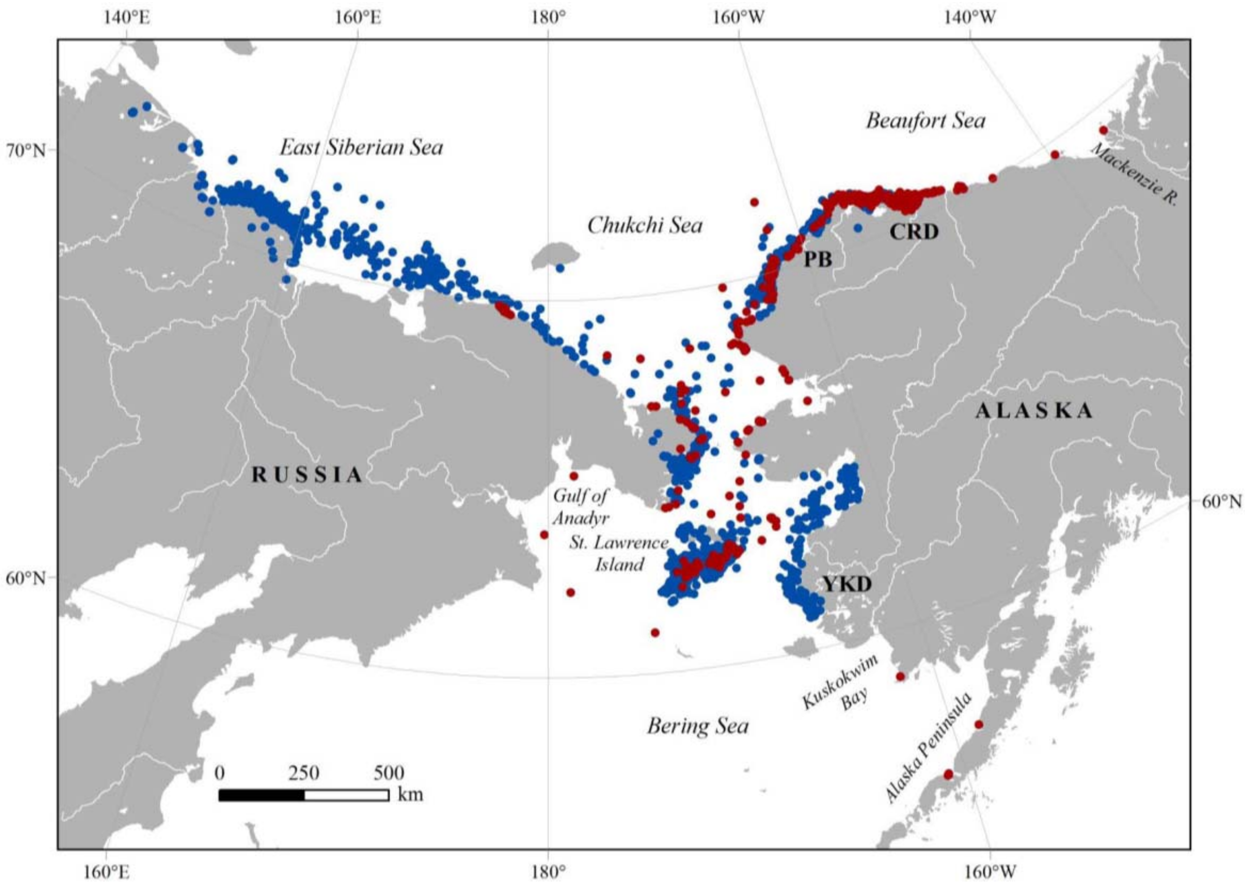


Figure 3.3. Satellite telemetry locations received from 89 adult (blue points, n = 6,813) and 27 juvenile (red points, n = 371) spectacled eiders between 30 May 2008 and 9 August 2012. We implanted satellite transmitters in spectacled eiders in the Yukon-Kuskokwim Delta (YKD) in 2008, at Peard Bay (PB) in 2009, and in the Colville River Delta (CRD) in 2009–2011. From Sexson et al. (2014).

Population indices for North Slope-breeding spectacled eiders prior to 1992 are unavailable. However, Warnock and Troy (1992) documented an 80% decline in spectacled eider abundance from 1981 to 1991 in the Prudhoe Bay area. Since 1992, the Service has conducted annual aerial surveys for breeding spectacled eiders on the ACP. The 2010 population index based on these aerial surveys was 6,286 birds (95% CI, 4,877–7,695; unadjusted for detection probability), which is 4% lower than the 18-year mean (Larned et al. 2011). In 2010, the index growth rate was significantly negative for both the long-term (0.987; 95% CI, 0.974–0.999) and most recent 10 years (0.974; 95% CI, 0.950–0.999; Larned et al. 2011). Stehn et al. (2006) developed a North Slope-breeding population estimate of 12,916 (95% CI, 10,942–14,890) based on the 2002–2006 ACP aerial index for spectacled eiders and relationships between ground and aerial surveys on the YK-delta. If the same methods are applied to the 2007–2010 ACP aerial index reported in Larned et al. (2011), the resulting adjusted population estimate for North Slope-breeding spectacled eiders is 11,254 (8,338–14,167, 95% CI).

The YK-delta spectacled eider population is thought to have declined by about 96% from the 1970s to 1992 (Stehn et al. 1993). Evidence of the dramatic decline in spectacled eider nesting on the YK-delta was corroborated by Ely et al. (1994), who found a 79% decline in eider nesting near the Kashunuk River between 1969 and 1992. Aerial and ground survey data indicated that spectacled eiders declined 9–14% per year from 1985–1992 (Stehn et al. 1993). Further, from the early 1970s to the early 1990s, the number of pairs on the YK-delta declined from 48,000 to 2,000, apparently stabilizing at that low level (Stehn et al. 1993). Before 1972, an estimated 47,700–70,000 pairs of spectacled eiders nested on the YK-delta in average to good years (Dau and Kistchinski 1977).

Fischer and Stehn (2013) used combined annual ground-based and aerial survey data to estimate the number of nests and eggs of spectacled eiders on the coastal area of the YK-delta in 2012 and evaluate long-term trends in the YK-delta breeding population from 1985 to 2012. In a given year, the estimated number of nests reflects the minimum number of breeding pairs in the population and does not include non-nesting individuals or nests that were destroyed or abandoned (Fischer and Stehn 2013). The total number of spectacled eider nests on the YK-delta in 2012 was estimated at 8,062 (SE 1110). The average population growth rate based on these surveys was 1.058 (90% CI = 1.005-1.113) in 2003–2012 and 0.999 (90% CI = 0.986-1.012) in 1985–2012 (Fischer and Stehn 2013). Log-linear regression based solely on the long-term YK-delta aerial survey data indicate positive population growth rates of 1.073 (90% CI = 1.046–1.100) in 2001–2010 and 1.070 (90% CI = 1.058–1.081) in 1988–2010 (Platte and Stehn 2011).

Spectacled eider recovery criteria

The Spectacled Eider Recovery Plan (USFWS 1996) presents research and management priorities with the objective of recovery and delisting so that protection under the ESA is no longer required. Although the cause or causes of the spectacled eider population decline is/are not known, factors that affect adult survival are likely to be the most influential on population growth rate. These include lead poisoning from ingested spent shotgun pellets, which may have contributed to the rapid decline observed in the YK-delta (Franson et al. 1995, Grand et al. 1998), and other factors such as habitat loss, increased nest predation, over harvest, and disturbance and collisions caused by human infrastructure. Under the Recovery Plan, the species will be considered recovered when each of the three recognized populations (YK-delta, North Slope of Alaska, and Arctic Russia): 1) is stable or increasing over 10 or more years and the minimum estimated population size is at least 6,000 breeding pairs, or 2) number at least 10,000 breeding pairs over 3 or more years, or 3) number at least 25,000 breeding pairs in one year. Spectacled eiders do not currently meet these recovery criteria.

3.2 Steller's Eider

The Steller's eider is a small sea duck with circumpolar distribution and the sole member of the genus *Polysticta*. Males are in breeding plumage (Figure 3.4) from early winter through mid-summer. Females are dark mottled brown with a white-bordered blue wing speculum (Figure 3.4). Juveniles are dark mottled brown until fall of their second year, when they acquire breeding plumage.

Figure 3.4. Male and female Steller's eiders in breeding plumage.

Steller's eiders are divided into Atlantic and Pacific populations; the Pacific population is further subdivided into the Russia-breeding and Alaska-breeding populations. The Alaska-breeding population of Steller's eiders was listed as threatened on July 11, 1997 based on:

- Substantial contraction of the species' breeding range on the ACP and Y-K Delta;
  - Steller's eiders on the North Slope historically occurred east to the Canada border (Brooks 1915), but have not been observed on the eastern North Slope in recent decades (USFWS 2002).
- Reduced numbers breeding in Alaska; and
- Resulting vulnerability of the remaining Alaska-breeding population to extirpation (USFWS 1997).

In Alaska, Steller's eiders breed almost exclusively on the ACP and winter, along with the majority of the Russia-breeding population, in southwest Alaska (Figure 3.5). Periodic non-breeding of Steller's eiders, coupled with low nesting and fledging success, has resulted in very low productivity (Quakenbush et al. 2004). In 2001, the Service designated 2,830 mi^2 (7,330 km^2) of critical habitat for the Alaska-breeding population of Steller's eiders, including historical breeding areas on the Y-K Delta, molting and staging areas in the Kuskokwim Shoals and Seal Islands, molting wintering, and staging areas at Nelson Lagoon, and Izembek Lagoon (USFWS 2001). No critical habitat for Steller's eiders has been designated on the ACP.

3.2.1 Life History

Breeding – Steller's eiders arrive in small flocks of breeding pairs on the ACP in early June. Nesting on the ACP is concentrated in tundra wetlands near Barrow, AK (Figure 3.6) and occurs at lower densities elsewhere on the ACP from Wainwright east to the Sagavanirktok River (Quakenbush et al. 2002). Long-term studies of Steller's eider breeding ecology near Barrow indicate periodic non-breeding by the entire local population. From 1991-2010, Steller's eiders nests were detected in 12 of 20 years (Safine 2011). Periodic non-breeding by Steller's eiders near Barrow seems to correspond to fluctuations in lemming populations and risk of nest predation (Quakenbush et al. 2004). During years of peak abundance, lemmings are a primary food source for predators including jaegers, owls, and foxes (Pitelka et al. 1955*a*, Pitelka et al. 1955*b*, MacLean et al. 1974, Larter 1998, Quakenbush et al. 2004). It is hypothesized that Steller's eiders and other ground-nesting birds increase reproductive effort during lemming peaks because predators preferentially select (prey-switch) for hyper-abundant lemmings and nests are less likely to be depredated (Roselaar 1979, Summers 1986, Dhondt 1987, and Quakenbush et al. 2004). Furthermore, during high lemming abundance, Steller's eider nest survival (the probability of at least one duckling hatching) has been reported as a function of distance from nests of jaegers and snowy owls (Quakenbush et al. 2004). These avian predators aggressively defend their nests against other predators and this defense likely indirectly imparts protection to Steller's eiders nesting nearby.

Steller's eiders initiate nesting in the first half of June and nests are commonly located on the rims of polygons and troughs (Quakenbush et al. 2000, 2004). Mean clutch size at Barrow was 5.4 ± 1.6 SD (range = 1–8) over 5 nesting years between 1992 and 1999 (Quakenbush et al. 2004). Breeding males depart following onset of incubation by the female. Nest survival is affected by predation levels, and averaged 0.23 (±0.09, standard error [SE]) from 1991–2004 before fox control was implemented near Barrow and 0.47 (±0.08 SE) from 2005–2012 during years with fox control (USFWS, unpublished data). Steller's eider nest failure has been attributed to depredation by jaegers (*Stercorarius* spp.), common ravens (*Corvus corax*), arctic fox (*Alopex lagopus*), glaucous gulls (*Larus hyperboreus*), and in at least one instance, polar bears (Quakenbush et al. 1995, Rojek 2008, Safine 2011, Safine 2012).

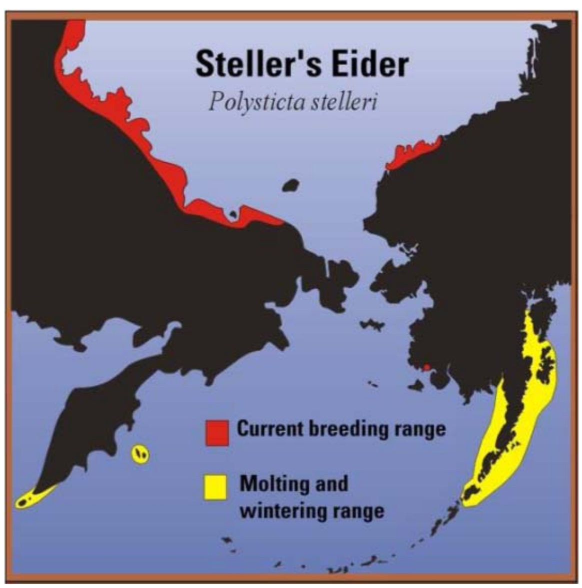


Figure 3.5. Steller's eider distribution in the Bering, Chukchi, and Beaufort seas.

Hatching occurs from mid-July through early August, after which hens move their broods to adjacent ponds with emergent vegetation dominated by *Carex* spp. and *Arctophila fulva* (Quakenbush et al. 2000, Rojek 2006, 2007, and 2008). In these brood-rearing ponds, hens with ducklings feed on aquatic insect larvae and freshwater crustaceans. In general, broods remain within 0.7 km of their nests (Quakenbush et al. 2004); although, movements of up to 3.5 km from nests have been documented (Rojek 2006 and 2007). Large distance movements from hatch sites may be a response to drying of wetlands that would normally have been used for brood-rearing (Rojek 2006). Fledging occurs 32–37 days post hatch (Obritschkewitsch et al. 2001, Quakenbush et al. 2004, Rojek 2006 and 2007).

Information on breeding site fidelity of Steller's eiders is limited. However, ongoing research at Barrow has documented some cases of site fidelity in nesting Steller's eiders. Since the mid-1990s, eight banded birds that nested near Barrow were recaptured in subsequent years again nesting near Barrow. Time between capture events ranged from 1 to 12 years and distance between nests ranged from 0.1 to 6.3 km (USFWS, unpublished data).

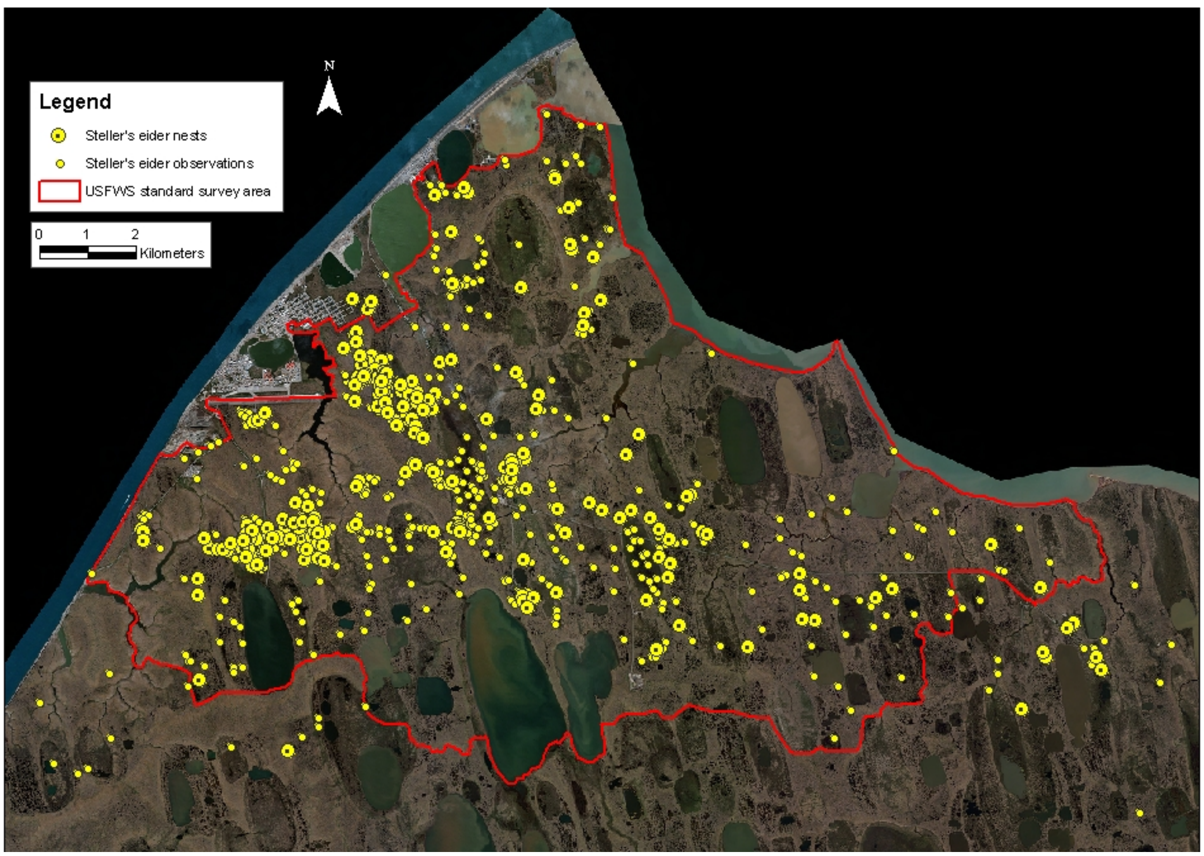


Figure 3.6. Steller's eider nest locations (1991–2010) and breeding pair observations (1999–2010). The red border represents the standard annual survey area. This survey is expanded beyond the standard area in some years.

Localized movements – Timing of departure from the breeding grounds near Barrow differs between sexes and between breeding and non-breeding years. In breeding years, male Steller's eiders typically leave the breeding grounds in late June to early July after females begin incubating (Obritschkewitsch et al. 2001, Quakenbush et al. 1995, Rojek 2006 and 2007). Females with fledged broods depart the breeding grounds in late August and mid-September to rest and forage in freshwater and marine habitat near the Barrow spit prior to fall migration along the Chukchi coast. Females with broods are often observed near the channel that connects North Salt Lagoon and Elson Lagoon (J. Bacon, NSBDWM, pers. comm.). In 2008, 10–30 Steller's eider adult females and juveniles were observed staging daily in Elson Lagoon, North Salt Lagoon, Imikpuk Lake, and the Chukchi Sea from late August to mid-September (USFWS, unpublished data).

Before fall migration in breeding and non-breeding years, some Steller's eiders rest and forage in in coastal waters near Barrow including Elson Lagoon, North Salt Lagoon, Imikpuk Lake, and the vicinity of Pigniq (Duck Camp; Figure 3.7). In breeding years, these flocks are primarily composed of males that remain in the area until the second week of July, while in non-breeding years, flocks are composed of both sexes and depart earlier than in nesting years (J. Bacon, North Slope Borough Department of Wildlife Management [NSBDWM], pers. comm.).

Safine (2012) investigated post-hatch movements of 10 Steller's eider hens with VHF transmitters in 2011. Most (8 of 10) females successfully reared broods to fledging. From late August through early September, females and fledged juveniles were observed in nearshore waters of the Chukchi and Beaufort seas from Point Barrow south along the coast approximately 18 km. During this period, marked Steller's eiders and broods frequented areas traditionally used for subsistence waterfowl hunting (e.g., Duck Camp; Figure 3.7).

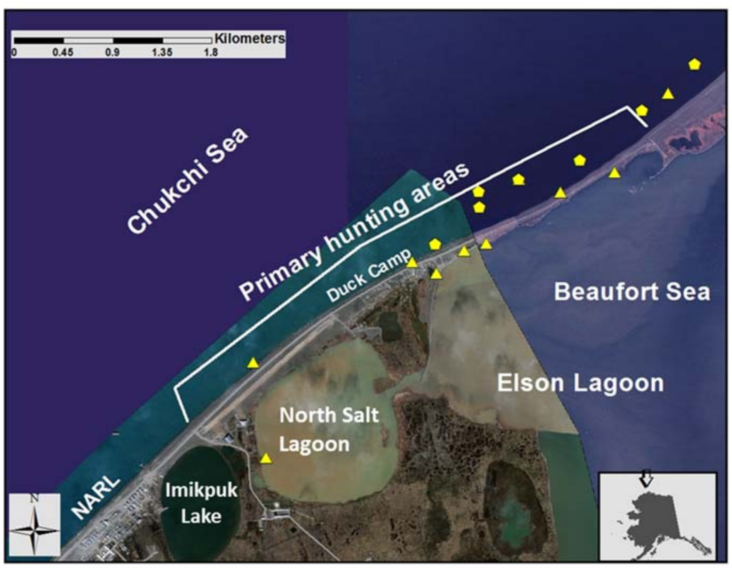


Figure 3.7. Some post-breeding and pre-migration staging areas for Steller's eiders near Barrow, Alaska. Locations of Steller's eider hens with successfully-fledged (triangles) and failed broods (pentagons) from mid-August to early September 2011.

Wing molt – Following departure from the breeding grounds, Steller's eiders migrate to southwest Alaska where they undergo complete flightless molt for about 3 weeks. Preferred molting areas are shallow with extensive eelgrass (*Zostera marina*) beds and intertidal mud and sand flats where Steller's eiders forage on bivalve mollusks and amphipods (Petersen 1980, 1981; Metzner 1993).

The Russia- and Alaska-breeding populations both molt in southwest Alaska, and banding studies found at least some individuals had a high degree of molting site fidelity in subsequent years (Flint et al. 2000). Primary molting areas include the north side of the Alaska Peninsula (Izembek Lagoon, Nelson Lagoon, Port Heiden, and Seal Islands; Gill et al. 1981, Petersen 1981, Metzner 1993) as well as the Kuskoskwim Shoals in northern Kuskokwim Bay (Martin et al. *submitted*). Larned (2005) also reported > 2,000 eiders molting in lower Cook Inlet near the Douglas River Delta, and smaller numbers of molting Steller's have been reported around islands in the Bering Sea, along the coast of Bristol Bay, and in smaller lagoons along the Alaska Peninsula (e.g., Dick and Dick 1971, Petersen and Sigman 1977, Wilk et al. 1986, Dau 1987, Petersen et al. 1991).

Winter distribution – After molt, many Pacific-wintering Steller's eiders disperse throughout the Aleutian Islands, Alaskan Peninsula, and western Gulf of Alaska including Kodiak Island and lower Cook Inlet (Figure 3.8; Larned 2000a, Martin et al. *submitted*), although thousands may remain in molting lagoons unless freezing conditions force departure (USFWS 2002). The Service estimates the Alaska-breeding population comprises only ~ 1% of the Pacific-wintering population of Steller's eiders. Wintering Steller's eiders usually occur in shallow waters (< 10 m deep), within 400 m of shore or in shallow waters further offshore (USFWS 2002). However, Martin et al. (*submitted*) reported substantial use of habitats > 10 m deep during mid-winter, although this use may reflect nocturnal rest periods or shifts in availability of food resources (Martin et al. *submitted*).

Spring migration – During spring migration, thousands of Steller's eiders stage in estuaries along the north coast of the Alaska Peninsula and, in particular, at Kuskokwim Shoals in late May (Figure 3.8; Larned 2007, Martin et al. *submitted*). Larned (1998) concluded that Steller's eiders show strong site fidelity to specific areas[1] during migration, where they congregate in large numbers to feed before continuing northward.

[1] Several areas receive consistent use by Steller's eiders during spring migration, including Bechevin Bay, Morzhovoi Bay, Izembek Lagoon, Nelson Lagoon/Port Moller Complex, Cape Seniavin, Seal Islands, Port Heiden, Cinder River State Critical Habitat Area, Ugashik Bay, Egegik Bay, Kulukak Bay, Togiak Bay, Nanwak Bay, Kuskokwim Bay, Goodnews Bay, and the south side of Nunivak Island (Larned 1998, Larned 2000a, Larned 2000b, Larned et al. 1993).

Figure 3.8. Distribution of Alaska-breeding Steller's eiders during the non-breeding season, based on locations of 13 birds implanted with satellite transmitters in Barrow, Alaska, during June 2000 and June 2001. Marked locations include all those at which a bird remained for at least three days. Onshore summer use areas comprise locations of birds that departed Barrow, apparently without attempting to breed in 2001 (USFWS 2002).

Spring migration usually includes movements along the coast, although some Steller's eiders may make straight line crossings of water bodies such as Bristol Bay (W. Larned, USFWS, pers. comm. 2000). Despite numerous aerial surveys, Steller's eiders have not been observed during migratory flights (W. Larned, USFWS, pers. comm. 2000). Steller's eiders likely use spring leads for feeding and resting as they move northward, although there is little information on distribution or habitat use after departure from spring staging areas.

Migration patterns relative to breeding origin – Information is limited on migratory movements of Steller's eiders in relation to breeding origin, and it remains unclear where the Russia- and Alaska-breeding populations converge and diverge during their molt and spring migrations. Martin et al. (*unpublished data*) attached satellite transmitters to 14 Steller's eiders near Barrow in 2000 and 2001. Despite the limited sample, there was disproportionately high use of

Kuskokwim Shoals by Alaska-breeding Steller's eiders during wing molt compared to the Pacific population as a whole. However, Martin et al. (*submitted*) did not find Alaska-breeding Steller's eiders to preferentially use specific wintering areas. A later study marked Steller's eiders wintering near Kodiak Island, Alaska and followed birds through the subsequent spring (n = 24) and fall molt (n = 16) migrations from 2004–2006 (Rosenberg et al. 2011). Most birds marked near Kodiak Island migrated to eastern arctic Russia prior to the nesting period and none were relocated on land or in nearshore waters north of the Yukon River Delta in Alaska (Rosenberg et al. 2011).

Alaska-breeding population abundance and trends – Stehn and Platte (2009) evaluated Steller's eider population and trends from three aerial surveys on the ACP:

- USFWS ACP survey
  - 1989–2006 (Mallek et al. 2007)
  - 2007–2008 (new ACP survey design; Larned et al. 2008, 2009)
- USFWS North Slope eider (NSE) survey
  - 1992–2006 (Larned et al. 2009)
  - 2007–2008 (NSE strata of new ACP survey; Larned et al. 2008, 2009)
  - Barrow triangle (ABR) survey, 1999–2014 (ABR, Inc.; Obritschkewitsch and Ritchie 2015)

In 2007, the ACP and NSE surveys were combined under a single ACP survey design. Previously, surveys differed in spatial extent, timing, sampling intensity, and duration, and consequently, produced different estimates of population size and trend for Steller's eiders. These estimates, including results from previous analyses of the ACP and NSE survey data (Mallek et al. 2007, Larned et al. 2009), are summarized in Table 3.2. Most observations of Steller's eider from both surveys occurred within the boundaries of the NSE survey (Figure 3.9).

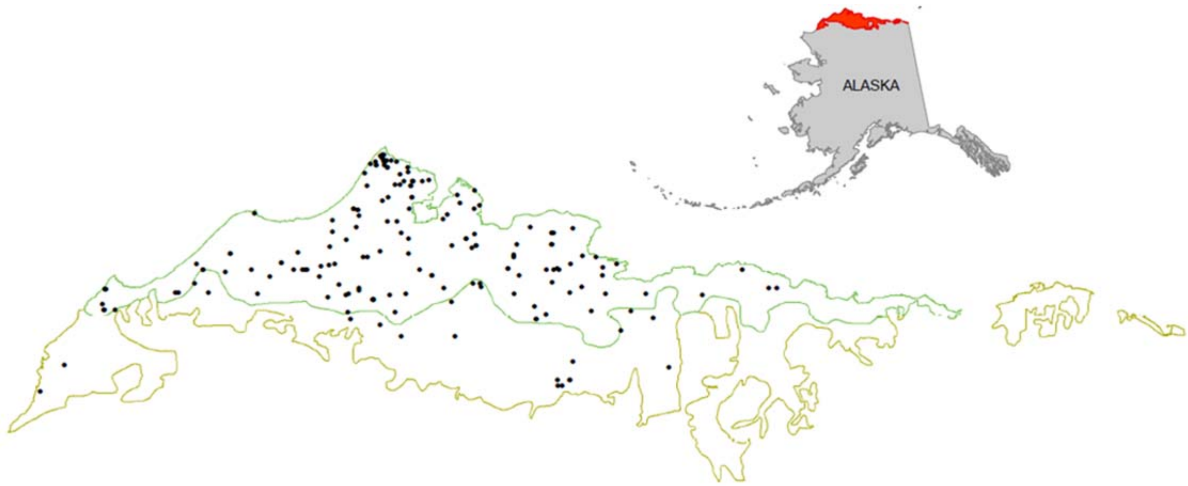


Figure 3.9. All Steller's eider sightings from the Arctic Coastal Plain (ACP) survey (1989–2008) and the North Slope eider (NSE) survey (1992–2006). The ACP survey encompasses the entire area shown (61,645 km^2); the NSE includes only the northern portion outlined in green (30,465 km^2; modified from Stehn and Platte 2009).

Following assessment of potential biases inherent in both surveys, Stehn and Platte (2009) identified a subset of the NSE survey data (1993–2008) that were determined to be "least confounded by changes in survey timing and observers." Based on this subset, the average population index[2] for Steller's eiders on the ACP was 173 (90% CI 88–258) with an estimated growth rate of 1.011 (90% CI 0.857–1.193). Average population size of Steller's eiders breeding on the ACP was estimated at 576 (292–859, 90% CI; Stehn and Platte 2009) assuming a detection probability of 30%[3]. Currently, this analysis provides the best available estimate of the Alaska-breeding Steller's eider population size and growth rate for the ACP. Note that these estimates are based on relatively few actual observations of Steller's eiders with none detected in some years.

The annual "Barrow triangle" (ABR) survey provides more intensive coverage (50%, 1999–2004; 25–50%, 2005–2014) of the northern portion of the ACP. This survey has been conducted south of Barrow since 1999 over a 2,757 km^2 area north of 70 degrees 50 minutes North and between the shorelines of the Chukchi Sea and Admiralty Bay (Figure 3.10) to compliment ground surveys closer to Barrow. Estimated Steller's eider density for the ABR survey area ranges from <0.01–0.03 birds/km^2 in non-nesting years to 0.03–0.08 birds/km^2 in nesting years. The estimated average population index for Steller's eiders within the Barrow triangle was 99.6 (90% CI 55.5–143.7; Stehn and Platte 2009) with an estimated growth rate of 0.934 (90% CI 0.686–1.272). If we assume the same 30% detection probability applied to NSE estimates, average population size of Steller's eiders breeding in the Barrow triangle area would be 332 (185–479, 90% CI).

Breeding population near Barrow, Alaska – The tundra surrounding Barrow supports the only significant concentration of Steller's eiders nesting in North America. Barrow is the

[2] Geographically extrapolated total Steller's eiders derived from NSE survey counts.
[3] Detection probability of 30% with a visibility correction factor of 3.33 was selected based on evaluation of estimates for similar species and habitats (Stehn and Platte 2009).

northernmost community on the ACP and standardized ground surveys for eiders have been conducted near Barrow since 1999 (Figure 3.6; Rojek 2008). Counts of males are the most reliable indicator of Steller's eider presence because females are cryptic and often go undetected in counts. The greatest concentrations of Steller's eiders observed during Barrow ground surveys occurred in 1999 and 2008 with 135 and 114 males respectively (Table 3.2; Safine 2011). Total nests found (both viable[4] and post-failure) ranged from 0–78 between 1991 and 2011, while the number of viable nests ranged from 0–27. Steller's eider nests were found in 14 of 22 years (64%) between 1991 and 2012 (Safine 2013).

Table 3.2. Steller's eider males, nests, and pair densities recorded during ground-based and aerial surveys conducted near Barrow, Alaska 1999–2012 (modified from Safine 2013).

	Overall ground-based survey area			Standard Ground-based Survey Area[a]		Aerial survey of Barrow triangle		
Year	Area (km^2)	Males counted	Pair density (males/km^2)	Males counted	Pair density (males/km^2)	Males counted	Pair density (males/km^2)[b]	Nests found near Barrow
1999	172	135	0.78	132	0.98	56	0.04	36
2000	136	58	0.43	58	0.43	55	0.04	23
2001	178	22	0.12	22	0.16	22	0.02	0
2002	192	1	<0.01	0	0	2	<0.01	0
2003	192	10	0.05	9	0.07	4	<0.01	0
2004	192	10	0.05	9	0.07	6	<0.01	0
2005	192	91	0.47	84	0.62	31	0.02	21
2006	191	61	0.32	54	0.40	24	0.02	16
2007	136	12	0.09	12	0.09	12	0.02	12
2008	166	114	0.69	105	0.78	24	0.02	28
2009	170	6	0.04	6	0.04	0	0	0
2010	176	18	0.10	17	0.13	4	0.01	2
2011	180	69	0.38	59	0.44	10	0.01	27
2012	176	61	0.35	55	0.41	37	0.03	19

[a]Standard area (the area covered in all years) is ~134 km^2 (2008 – 2010) and ~135 km^2 in previous years.
[b]Actual area covered by aerial survey (50% coverage) was ~1408 km^2 in 1999 and ~1363 km^2 in 2000 – 2006 and 2008. Coverage was 25% in 2007 and 2010 (~682 km^2) and 27% in 2009 (~736 km^2). Pair density calculations are half the bird density calculations reported in ABR, Inc.'s annual reports (Obritschkewitsch and Ritchie 2011).

3.2.2 Steller's Eider Recovery Criteria

The Steller's Eider Recovery Plan (USFWS 2002) presents research and management priorities that are re-evaluated and adjusted periodically, with the objective of recovery and delisting so that protection under the ESA is no longer required. When the Alaska-breeding population was listed as threatened, factors causing the decline were unknown, although possible causes identified were increased predation, overhunting, ingestion of spent lead shot in wetlands, and

[4] A nest is considered viable if it contains at least one viable egg.

habitat loss from development. Since listing, other potential threats have been identified, including exposure to other contaminants, disturbance caused during scientific research, and climate change, but causes of decline and obstacles to recovery remain poorly understood.

Criteria used to determine when species are recovered are often based on historical abundance and distribution, or on the population size required to ensure that extinction risk, based on population modeling, is tolerably low. For Steller's eiders, information on historical abundance is lacking, and demographic parameters needed for accurate population modeling are poorly understood. Therefore, the Recovery Plan for Steller's Eiders (USFWS 2002) establishes interim recovery criteria based on extinction risk, with the assumption that numeric population goals will be developed as demographic parameters become better understood. Under the Recovery Plan, the Alaska-breeding population would be considered for delisting from threatened status if it has ≤ 1% probability of extinction in the next 100 years, and each of the northern and western subpopulations are stable or increasing and have ≤ 10% probability of extinction in 100 years.

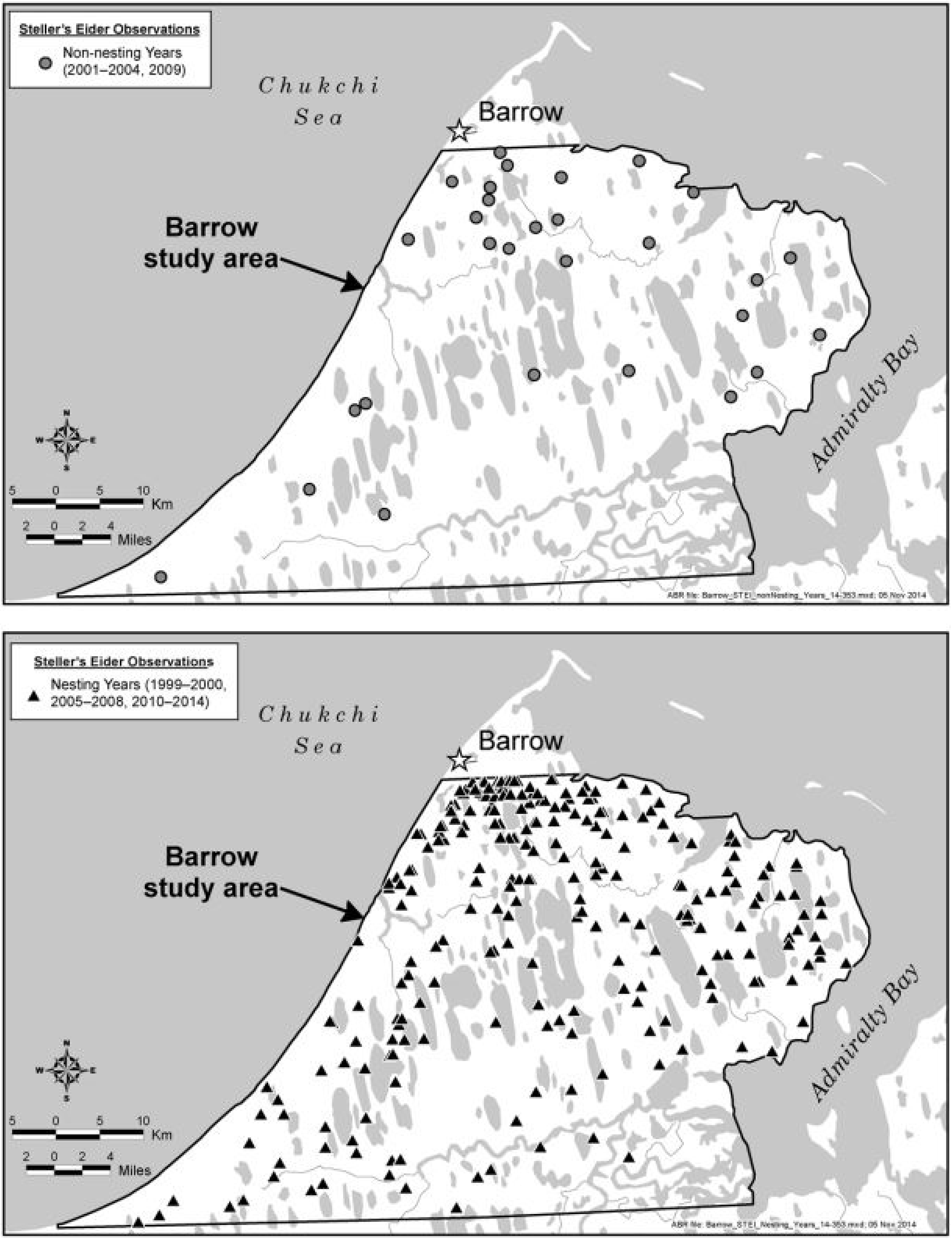


Figure 3.10. Locations of Steller's Eiders observed by ABR, Inc. during aerial surveys in non-nesting (top) and nesting years (bottom) near Barrow, Alaska, June 1999–2014 (Obritschkewitsch and Ritchie 2015).

3.3 Polar Bear

3.3.1 Status and Distribution

Due to threats to its sea ice habitat, on May 15, 2008 the Service listed the polar bear (*Ursus maritimus*) as threatened (73 FR 28212) throughout its range under the ESA. In the U.S., the polar bear is also protected under the MMPA and the Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES) of 1973.

Polar bears are widely distributed throughout the Arctic where the sea is ice-covered for large portions of the year (Figure 3.11). The number of polar bears is estimated to be 20,000-25,000 with 19 recognized management subpopulations or "stocks" (Obbard et al. 2010). The International Union for Conservation of Nature and Natural Resources, Species Survival Commission (IUCN/SSC) Polar Bear Specialist Group ranked 11, four, and three of these stocks as "data deficient," "reduced," and "not reduced," respectively (Obbard et al. 2010). The status designation of "data deficient" for 11 stocks indicates that the estimate of the worldwide polar bear population was made with incomplete information.

Figure 3.11. Distribution of polar bear stocks throughout the circumpolar basin (from Obbard et al. 2010).

3.3.2 Life History

For a complete life history of the polar bear, please see 73 FR 28212. We briefly describe the polar bear's food habits below.

Sea ice provides a platform for hunting and feeding, for seeking mates and breeding, for denning, for resting, and for long-distance movement. Ringed seals are the polar bear's primary food source, and areas near ice edges, leads, or polynyas where ocean depth is minimal are the most productive hunting grounds (Durner et al. 2004). While polar bears primarily hunt seals for food, they may occasionally consume other marine mammals (73 FR 28212). While the main food source of polar bears is ice seals, bowhead whale carcasses have been available to polar bears as a food source on the North Slope since the early 1970s (Koski et al. 2005) and therefore may affect their distribution locally. Barter Island (near Kaktovik) has had the highest recorded concentration of polar bears on shore (17.0 ± 6.0 polar bears/100 km) followed by Barrow (2.2 ± 1.8) and Cross Island (2.0 ± 1.8; Schliebe et al. 2008). Unusual numbers of polar bears were observed in 2012 in the vicinity of the bowhead whale carcass "bonepile" on Barter Island; the USFWS observed a minimum, maximum, and average of 24, 80, and 52 bears respectively (USFWS 2012). The high number of bears on/near Barter Island compared to other areas is thought to be due in part to the proximity to the ice edge and high ringed seal densities (Schliebe et al. 2008), as the whale harvest is at Kaktovik is lower than that at Barrow or Cross Island.

The use of whale carcasses as a food source likely varies among individuals and years. Stable isotope analysis of polar bears in 2003 and 2004 suggested that bowhead whale carcasses comprised 11%-26% (95% CI) of the diets of sampled polar bears in 2003, and 0%-14% (95% CI) in 2004 (Bentzen et al. 2007). Polar bears depend on sea ice to hunt seals, and temporal and spatial availability of sea ice is predicted to decline. Thus, polar bear use of whale carcasses may increase in the future.

3.3.3 Threats to the Polar Bear

The arctic is losing sea ice, which is predicted to negatively affect polar bear populations. The loss rate of ice thickness is increasing (Haas et al. 2010), and trends in arctic sea ice extent and area (see http://nsidc.org/arcticseaicenews/faq/#area_extent for explanation of these terms) are negative (-12.2% and -13.5 %/decade, respectively; Comiso 2012). Declines in sea ice are more pronounced in summer than winter (NSIDC, 2011a, b). Positive feedback systems (i.e., sea-ice albedo) and naturally occurring events, such as warm water intrusion into the Arctic and changing atmospheric wind patterns, can cause fragmentation of sea ice, reduction in the extent and area of sea ice in all seasons, retraction of sea ice away from productive continental shelf areas throughout the polar basin, reduction of the amount of heavier and more stable multi-year ice, and declining thickness and quality of shore-fast ice (Parkinson et al. 1999, Rothrock et al. 1999, Comiso 2003, Fowler et al. 2004, Lindsay and Zhang 2005, Holland et al. 2006, Comiso 2006, Serreze et al. 2007, Stroeve et al. 2008). These climatic phenomena may also affect seal abundances, the polar bear's main food source (Kingsley 1979, DeMaster et al. 1980, Amstrup et al. 1986, Stirling 2002).

Warming-induced habitat degradation and loss are negatively affecting some polar bear stocks, and unabated global warming is expected to reduce the worldwide polar bear population (Obbard et al. 2010). Loss of sea ice habitat due to climate change is identified as the primary threat to polar bears (Schliebe et al. 2006, 73 FR 28212, Obbard et al. 2010). Patterns of increased temperatures, earlier spring thaw, later fall freeze-up, increased rain-on-snow events (which can cause dens to collapse), and potential reductions in snowfall are also occurring. However, threats to polar bears will likely occur at different rates and times across their range (Obbard et al. 2010).

Because the polar bear depends on sea ice for its survival, loss of sea ice due to climate change is its largest threat worldwide, although polar bear subpopulations face different combinations of human-induced threats (Obbard et al. 2010). Arctic summer sea ice reached its lowest average extent in 2012 and has declined 13% since 1979 (NSIDC). The largest human-caused loss of polar bears is from subsistence hunting of the species, but for most subpopulations where subsistence hunting of polar bears occurs, it is a regulated and/or monitored activity (Obbard et al. 2010). Other threats include accumulation of persistent organic pollutants in polar bear tissue, tourism, human-bear conflict, and increased development in the Arctic (Obbard et al. 2010). Because uncertainty exists regarding the numbers of bears in some stocks and how human activities interact to ultimately affect the worldwide polar bear population, conservation and management of polar bears at the worldwide population level is challenging.

4 Environmental Baseline

Regulations implementing the ESA (50 CFR §402.02) define the environmental baseline to include the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area. Also included in the environmental baseline are anticipated impacts of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions contemporaneous with the consultation in progress. In this section, past oil and gas activities in the Action Area are discussed first, followed by the baseline for each species.

The environmental baseline also includes the effects of climate change on listed species and designated critical habitat. This BO considers ongoing and projected changes in climate using terms as defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is “very likely” (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide (CO^2) emissions from use of fossil fuels (IPCC 2007, Solomon et al. 2007). Various types of changes in climate can have direct or indirect effects on most species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007).

High latitude regions such as Alaska’s arctic waters and the North Slope are thought to be especially sensitive to the effects of climate change (Quinlan et al. 2005, Schindler and Smol 2006, Smol et al. 2005). While climate change will likely affect ecological communities in the arctic, it is difficult to predict with specificity or reliability how these effects will manifest. Biological, climatological, and hydrologic components of the ecosystem are interlinked and operate on multiple spatial, temporal, and organizational scales with feedback between the components (Hinzman et al. 2005). This BO uses expert judgment to weigh relevant information, including uncertainty, in consideration of climate change.

4.1 Past Oil and Gas Activities in the Chukchi Sea Planning Area

Prior to Lease Sale 193 in 2008, three high-resolution geological and geophysical exploration surveys were conducted in 2006 and one geological and geotechnical survey was conducted in 2007.

The Action Area contains 460 oil and gas lease blocks in the Chukchi Planning Area. Limited oil and gas activities have occurred since leases were issued as part of Lease Sale 193. Statoil conducted a site survey and geotechnical soil investigation in 2011, and Shell Gulf of Mexico, Inc. (Shell) conducted on-lease shallow hazard, site clearance, and ice gouge surveys in 2013. In 2008, 2010, and 2013, one geological and geophysical survey per year was conducted. Industry has drilled six exploration wells, five of which were permanently abandoned (BOEM 2015b). In September 2012, Shell drilled a shallow “top hole” that was temporarily abandoned that same season; Shell intends to finish drilling this well in the near future, has received permits from the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) in support of exploratory drilling, and will likely seek other necessary approvals in the near future, including from BOEM and BSEE. Exploration has not yet resulted in development and production activities (BOEM 2015a). BOEM estimates, however, that viable oil accumulations could be present in the Chukchi Sea Planning Area (BOEM 2015a).

4.2 Other Activities in the Action Area

This environmental baseline also includes impacts of proposed and ongoing Federal projects. These include:

- Activities permitted by BOEM, BSEE, BLM, USACE, and EPA for Industry-related development in the OCS;
- Activities within the NPR-A managed by the BLM;
  - The Greater Moose’s Tooth 1 Oil and Gas Development Project in the NPR-A;
  - Annual summer programmatic for activities in the NPR-A (e.g., the 2014 summer programmatic BO);
  - BLM permits in the NPR-A for winter travel on- and offshore for non-oil and gas activities;
- Numerous open-water and on-ice research projects in the OCS;
- Numerous research projects across the North Slope;
- The Unified Plan for cleanup activities after oil spills (in progress);
- U.S. Coast Guard operations;
- Passive and preventative polar bear deterrence measures;
- Incidental take of polar bears and Pacific walrus authorized using Letters of Authorization (LOAs) pursuant to the Beaufort and Chukchi Sea Incidental Take Regulations (ITRs) pursuant to section 101(a)(5) of the MMPA;

- intentional take of polar bears authorized using LOAs pursuant to sections 101(a)(4)(A), 109(h), and 112(c) of the MMPA;
- Polar bear research conducted by the U.S. Geological Survey, Marine Mammal Management Office of the Fish and Wildlife Service, and the North Slope Borough;
- Non-Federal activities such as vessel transit and shipping in the Action Area;
- Proposed projects at Barrow such as an airport expansion and new subdivision;
- Activities pursuant to the proposed USACE permit for the Alaska Stand-alone Gas Pipeline (ASAP); and
- excavation and fill of wetlands authorized using USACE permits.

4.3 Spectacled and Steller's Eiders

The North Slope-breeding population of spectacled eiders (approximately 12,916 breeding birds) and Steller's eiders (approximately 576 breeding birds) occupy terrestrial and marine portions of the Action Area for significant portions of their life history. Spectacled eiders breed, molt, and migrate in the Action Area, and Steller's eiders breed and migrate in the Action Area. Spectacled eiders nest throughout much of the ACP, whereas Steller's eiders have limited distribution across the ACP and highest breeding density near Barrow. Neither species is present in the Action Area from approximately November 15 to April 15.

Both species have undergone significant, unexplained declines in their Alaska-breeding populations. Factors that may have contributed to the current status of spectacled and Steller's eiders are discussed below and include, but are not limited to, toxic contamination of habitat, increased predator populations, harvest, and impacts of development, scientific research, and climate change. Factors that affect adult survival may be most influential on population growth rates. Recovery efforts for both species are underway in portions of the Action Area. Because similar factors most likely affect the baseline of spectacled and Steller's eiders, we present factors for these species together.

4.3.1 Use of the Chukchi Sea

While we have some information regarding migration routes of spectacled eiders (e.g., Sexson et al. 2014, Sexson 2015), specific information regarding these routes for Alaska-breeding Steller's eiders is lacking. In spring spectacled eiders move through spring leads in the sea ice, including those in Ledyard Bay, consistent with patterns exhibited by other sea duck species that migrate from wintering areas in the Bering Sea to breed in coastal Alaska (Sexson et al. 2014); Steller's eiders likely exhibit a similar migration pattern. In summer and autumn they return to use open waters along the Chukchi Sea coast, with spectacled eiders remaining in the area to molt. Large numbers of molting spectacled eiders are present in Ledyard Bay from late June through late October (Larned et al. 1995, Petersen et al. 1999).

A recent study in which spectacled eider were marked with satellite telemetry devices at coastal areas adjacent to Peard Bay and in the Colville River delta has provided information regarding how this species uses the eastern Chukchi Sea (approximately within 70 km of the coast of northern Alaska) during migration (Sexson et al. 2014, Sexson 2015). Spectacled eiders used this area during pre-breeding migration, breeding, post-breeding migration, and/or post-fledging dispersal (Figure 4.1, Figure 4.2, Figure 4.3, and Figure 4.4). Adult males that used the eastern Chukchi Sea during post-breeding migration arrived in early July and departed in early September, although departure dates varied substantially, ranging from 4 July to 5 October (Sexson et al. 2014). Consequently, sustained occupancy among adult males during post-breeding migration ranged from 30–97 days (Sexson et al. 2014). Adult females that used the eastern Chukchi Sea during post-breeding migration arrived in August and departed in October (Sexson et al. 2014), although the timing of arrival during post-breeding migration varied considerably; arrival occurred as early as 15 July and as late as 28 September. Consequently, the duration of sustained occupancy among adult females during post-breeding migration ranged from 16–84 days. Juveniles that fledged in tundra wetlands near adjacent to the Beaufort Sea arrived in the eastern Chukchi Sea in early October and stayed for 13–29 days before departing by late October. Thus, spectacled eiders can use the eastern Chukchi Sea continuously from pre-breeding staging through post-fledgling dispersal.

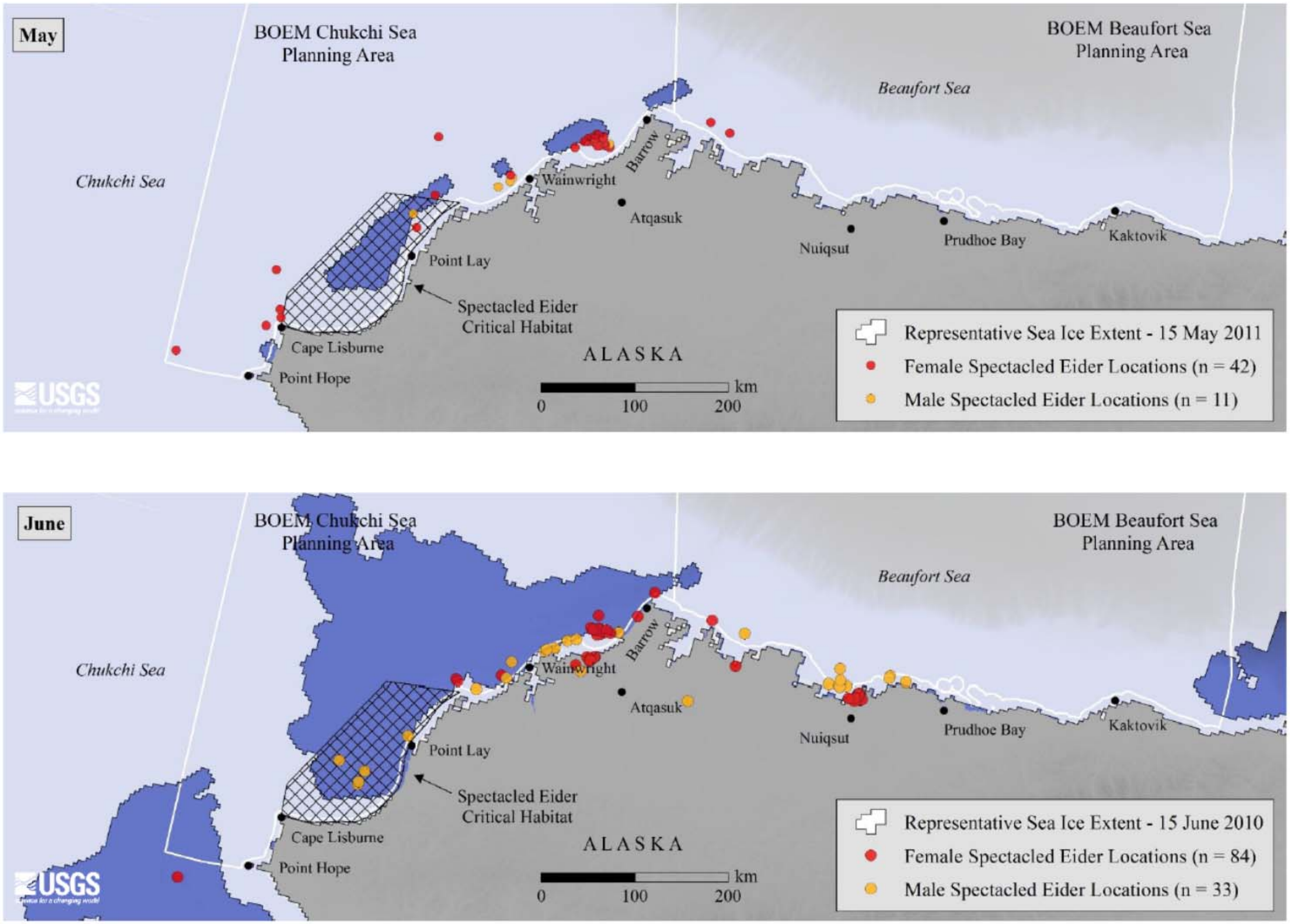
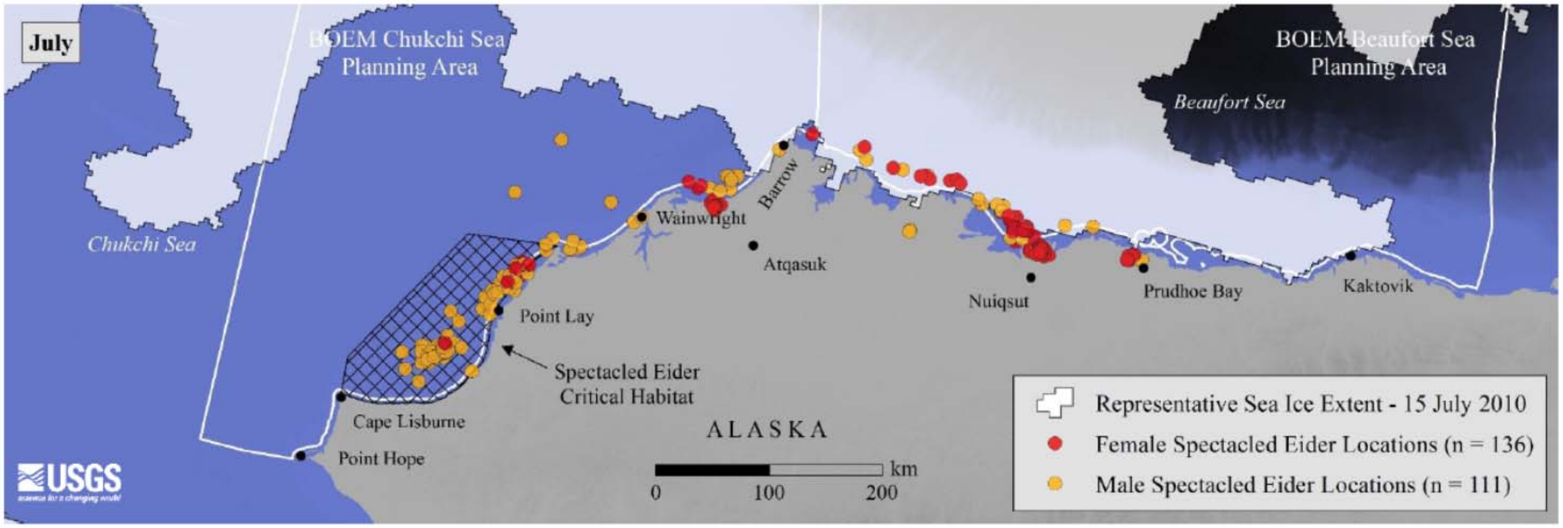


Figure 4.1. Presence of telemetered spectacled eiders in the Beaufort and Chukchi Seas in May and June. From Sexson (2015).



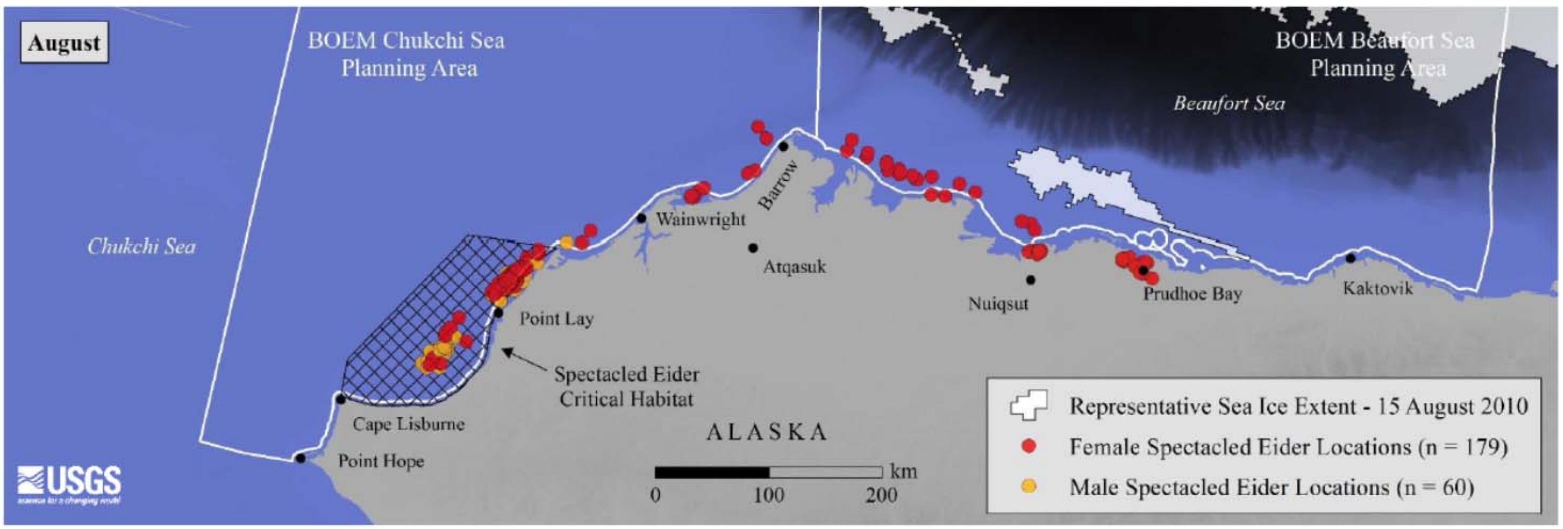


Figure 4.2. Presence of telemetered spectacled eiders in the Beaufort and Chukchi Seas in July and August. From Sexson (2015).

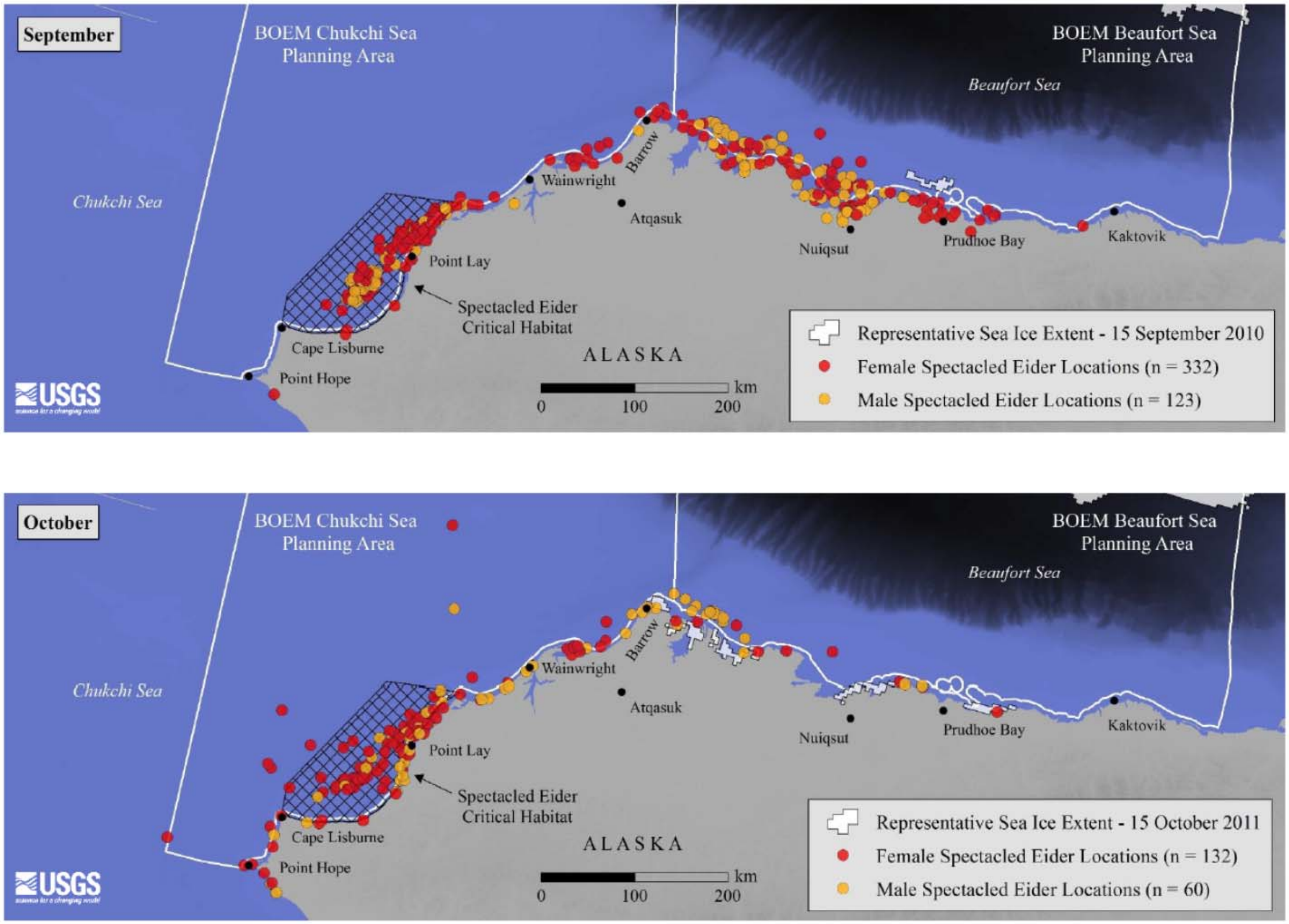


Figure 4.3. Presence of telemetered spectacled eiders in the Beaufort and Chukchi Seas in September and October. From Sexson (2015).

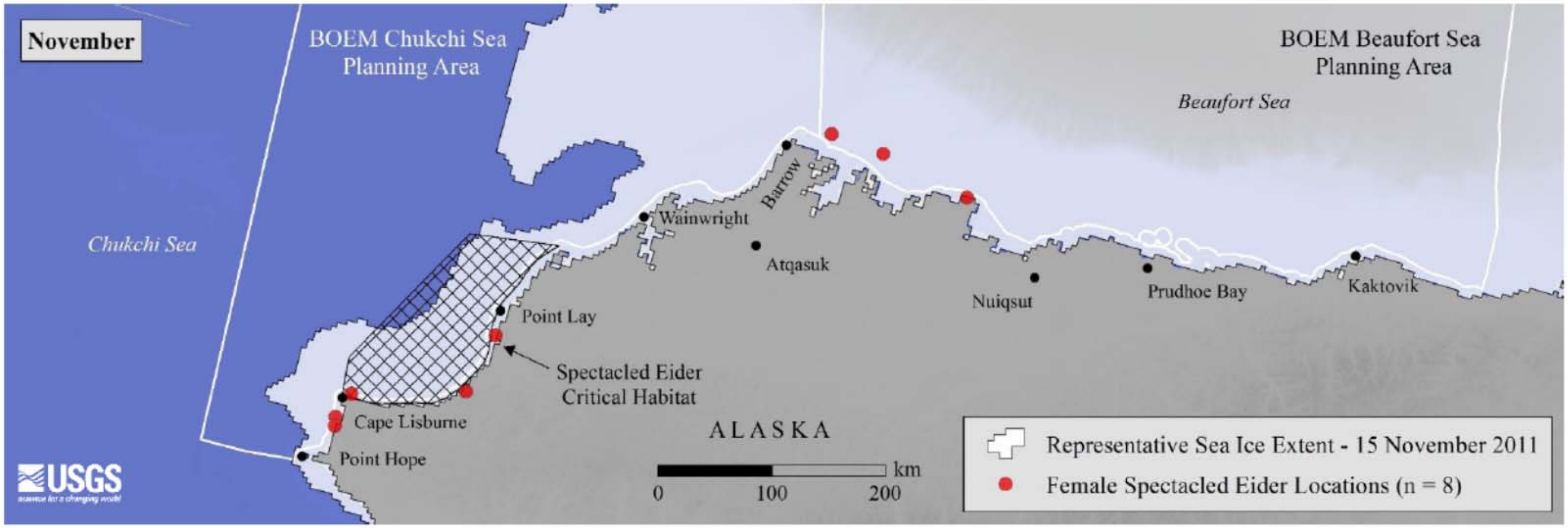


Figure 4.4. Presence of telemetered spectacled eiders in the Beaufort and Chukchi Seas in November. From Sexson (2015).

While spectacled eiders can be numerous portions of the Action Area, current information indicates they occur only sporadically in prospects that may be developed. For example, surveys of the Greater Hanna Shoal area (Klondike, Burger, and Statoil prospects) recorded a single spectacled eider in the Klondike Prospect area on 8 September 2009 and a single spectacled eider off transect in Burger Prospect area on 16 September 2009 (Gall et al. 2014). Steller's eiders have not been documented in these prospects.

4.3.2 Possible Threats in the Action Area

4.3.2.1 Toxic Contamination of Habitat

The primary known contaminant threat to spectacled and Steller's eiders in the Action Area is ingestion of spent lead shot deposited in tundra wetlands or nearshore marine waters used for foraging. Lead is likely available to eiders that feed in areas used for hunting on the ACP, particularly breeding hens and ducklings, with shallow freshwater wetlands near villages likely having the highest lead shot concentrations. The effect of exposure varies, but lethal and sublethal responses can occur (Hoffman 1990). Blood samples from hens breeding near Barrow in 1999 showed that all (7 of 7) had been exposed to lead (indicated by > 0.2 ppm lead in blood) and one had experienced lead poisoning (> 0.6 ppm; Figure 4.5). Lead isotope analysis confirmed the lead in these samples originated from lead shot rather than other potential environmental sources (Trust et al. 1997, Matz et al. 2004). Use of lead shot for hunting waterfowl is prohibited nationwide, and its use for hunting all birds is specifically prohibited on the North Slope. The Service has collaborated with other government and tribal organizations to minimize the sale and use of lead shot. Reduced availability of lead shot in stores and the paucity of spent shell casings from shells with lead shot at popular hunting sites suggests that the use of this type of ammunition has been greatly reduced and continues to decline on the North Slope.

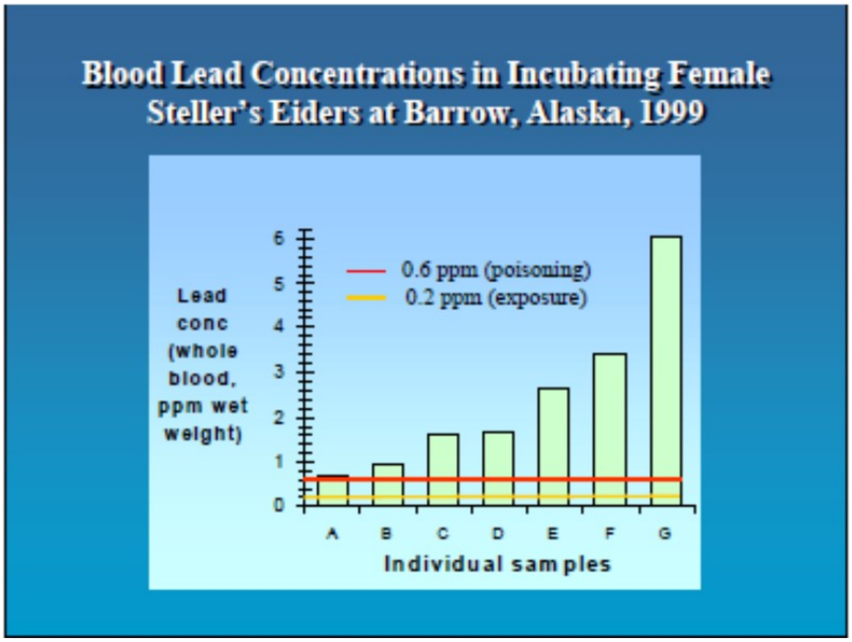


Figure 4.5. Blood lead concentrations in incubating female Steller's eiders at Barrow, Alaska, 1999.

A few contaminated legacy industrial and military sites exist within the Action Area; however, these sites pose minor if any, contamination risk to listed eiders.

4.3.2.2 Increased Predator Populations

Predator and scavenger populations may be increasing on the North Slope near sites of human habitation such as villages and industrial infrastructure (Eberhardt et al. 1983, Day 1998, Powell and Bakensto 2009). Reduced fox trapping, anthropogenic food sources in villages and oil fields, and avian nesting and fox denning sites on human-built structures may have resulted in increased gull, raven, and fox numbers (Day 1998, USFWS 2002). These anthropogenic influences on predator populations and predation rates may have affected eider populations, but this has not been substantiated. Increasing predator populations, however, are a concern, and Steller's eider studies at Barrow attributed poor breeding success to high predation rates (Obritschkewitsch et al. 2001). In years when arctic fox removal was conducted at Barrow prior to and during Steller's eider nesting, nest success appears to have increased substantially (Safine 2012), reinforcing that nest depredation may be a significant population-level influence.

4.3.2.3 Subsistence Harvest

Prior to the listing of Steller's and spectacled eiders under the ESA, some level of subsistence harvest of these species occurred across the North Slope (Braund et al. 1993). Hunting for spectacled and Steller's eiders was closed in 1991 by Alaska State regulations and Service policy, and outreach efforts have been conducted by the North Slope Borough, BLM, and the Service to encourage compliance. Harvest surveys indicate that listed eiders are taken during subsistence hunting on the North Slope, although estimates of the number taken are imprecise and numerous unquantifiable biases compromise the reliability of estimates. Continued efforts to eliminate shooting are being implemented in North Slope villages, particularly at Barrow where Steller's eiders regularly nest near important subsistence hunting areas. Intra-service consultations for the Migratory Bird Subsistence Hunting Regulations are conducted annually.

4.3.2.4 Impacts from Development and Disturbance

While development activities may adversely affect listed eiders, these species were not listed as a result of the impacts of development. The majority of eider breeding habitat on the ACP remains unaltered by humans, although limited portions of each species' breeding habitat have been impacted by fill of wetlands, the presence of infrastructure that presents collision risk, and other human activities that may cause disturbance of birds or increase populations of nest predators. These impacts have resulted from the gradual expansion of communities (e.g., Barrow), limited military facilities such as the Distant Early Warning (DEW) Line sites at Point Lonely and Cape Simpson, and, more recently, oil development since construction of the Prudhoe Bay field and TAPS in the 1970s. Gradual expansion is likely to continue for all of these sources except perhaps military facilities.

Oil development is gradually spreading westwards across the North Slope from the original hub at Prudhoe Bay. Given industry's interest in NPR-A as expressed by lease sales, seismic surveys, drilling of exploratory wells, construction of the Alpine field, and requests for permits from the BLM and USACE for Greater Mooses Tooth 1 in 2014-2015, expansion of industrial development is likely to continue. Development in NPR-A may also facilitate development in more remote, currently undeveloped areas.

4.3.2.5 Research Impacts

Scientific, field-based research is also increasing in arctic Alaska as interest in climate change and its effects on high latitude areas continues. While many of these activities have no impacts on listed eiders because they occur in seasons when eiders are absent or use remote sensing tools, on-the-ground activities and tundra aircraft landings likely disturb a small number of listed eiders annually. The BLM consults annually with the Service regarding permitted summer research activities in the NPR- A.

4.3.2.6 Climate Change

Climatic changes are occurring throughout the arctic, including on the Alaska's North Slope. Arctic landscapes are dominated by lakes and ponds (Quinlan et al. 2005), such as those used by listed eiders for feeding and brood rearing. In many areas these arctic water bodies are draining and drying out during summer as the underlying permafrost thaws (Smith et al. 2005, Oechel et al. 1995), and are losing water through increased evaporation and evapotranspiration resulting from longer ice-free periods, warmer temperatures, and longer growing seasons (Schindler and Smol 2006, Smol and Douglas 2007). Productivity of lakes and ponds appears to be increasing as a result of nutrient inputs from thawing soil and an increase in degree days (Quinlan et al. 2005, Smol et al. 2005, Hinzman et al. 2005, Chapin et al. 1995). Changes in water chemistry and temperature are also resulting in changes in the algal and invertebrate communities that form the basis of the food web in these areas (Smol et al. 2005, Quinlan et al. 2005).

Historically, sea ice has served to protect shorelines from erosion; this protection, however, has decreased as sea ice decreases in extent and duration (USGS 2006). With the reduction in summer sea ice, the frequency and magnitude of coastal storm surges has increased. These can cause breaching of lakes and inundation of low-lying coastal wetland areas, killing salt-intolerant plants and altering soil and water chemistry, and hence, the fauna and flora of the area (USGS 2006). Coupled with thawing permafrost, the inundation of the shoreline due to lack of sea ice has significantly increased coastal erosion rates (USGS 2006), potentially reducing the quality or quantity of coastal tundra nesting habitat.

Changes in precipitation patterns, air and soil temperature, and water chemistry are also affecting tundra vegetation communities (Hinzman et al. 2005, Prowse et al. 2006, Chapin et al. 1995), and boreal species are expanding their ranges into tundra areas (Callaghan et al. 2004). Changes in the distribution of predators, parasites, and disease-causing agents resulting from climate change could have significant effects on listed species and other arctic fauna and flora. Climate change may also result in mismatched timing of migration and development of food in arctic ponds (Callaghan et al. 2004), and changes in the population cycles of small mammals such as lemmings to which many other species, including nesting Steller's eiders (Quakenbush and Suydam 1999), are linked (Callaghan et al. 2004).

Regional-scale environmental shifts may also be underway in the Chukchi Sea that could affect spectacled and Steller's eider populations. Ice thickness generally increases from the Siberian Arctic to the Canadian Archipelago, due mostly to convergence of drifting sea ice (Walsh 2005). Rothrock et al. (1999; cited in Walsh 2005) found a decrease of about 40% (1.3 m) in the sea-ice draft (proportional to thickness) in the central Arctic Ocean by comparing sonar data obtained from submarines during two periods: 1958–1976 and 1993–1997. Wadhams and Davis (2000; cited in Walsh 2005) provide further submarine-measured evidence of reductions in sea ice thickness in the Arctic Ocean. Satellite imagery has documented a downward trend of 13.3% per decade in September sea ice extent (historically when sea ice extent is at its minimum); in fact, the ten lowest September sea ice extents have all occurred in the last ten years, with 2012 representing the record low (Figure 4.6; NSDIC 2014). From 1979 through 2009, satellite data from 10 arctic regions indicated that nine of 10 regions experienced trends towards earlier spring melt and later autumn freeze onset (Markus et al. 2009). For the entire arctic, the melt season length has increased by about 20 days during this period (Markus et al. 2009). The Chukchi/Beaufort seas region, which is within the range of listed eiders, has experienced a strong trend toward later autumn freeze-up date and longer ice-free seasons (Markus et al. 2009). Such changes in sea ice extent and duration would likely affect Steller's and spectacled eider populations.

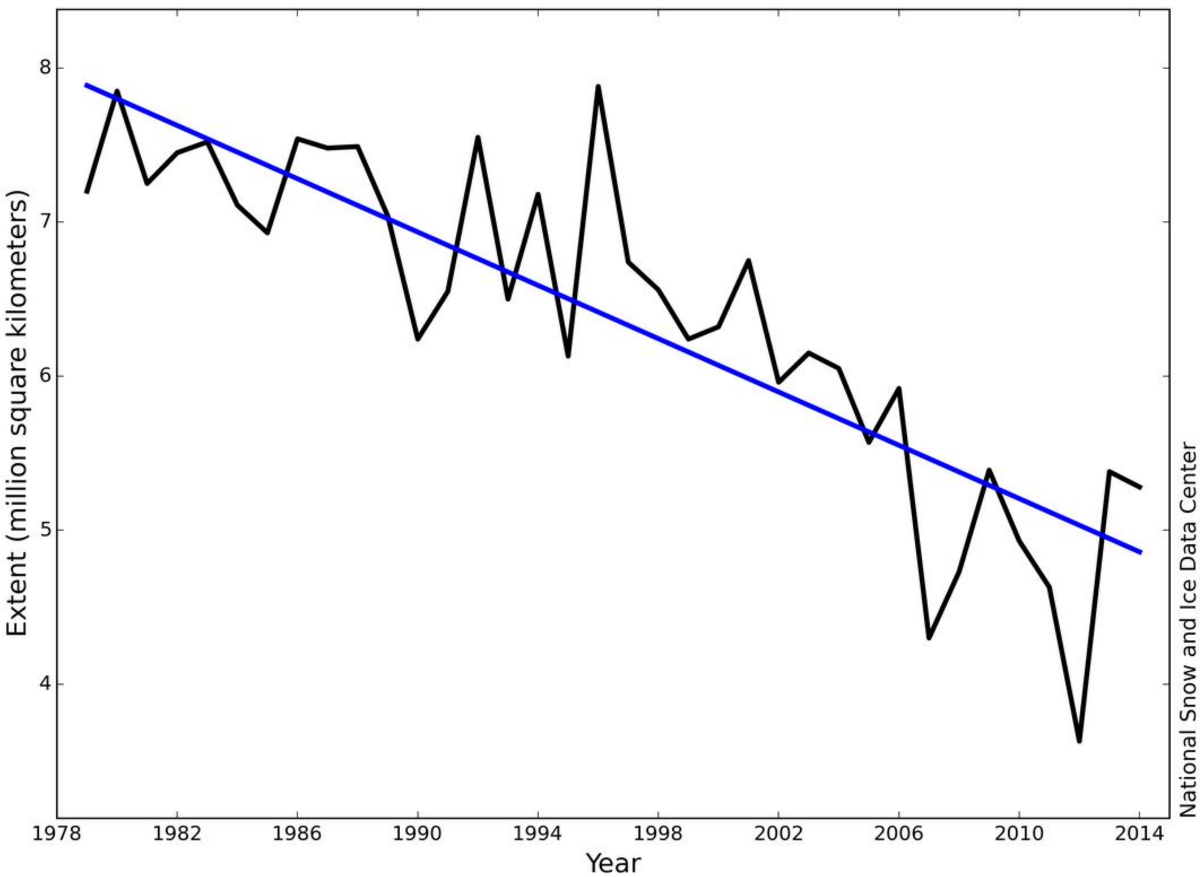


Figure 4.6. Average arctic sea ice extent in September from 1979 through 2014. From NSIDC (2014).

While listed eider populations would likely be affected by climate change-induced ecological shifts in their terrestrial and marine environments, the direction or magnitude of these impacts cannot be predicted with reasonable reliability.

4.4 Spectacled Eider Critical Habitat: Ledyard Bay Critical Habitat Unit

Several key environmental factors, such as good water quality and lack of contamination, contribute to what can be considered the current good condition of Primary Constituent Elements (PCEs) of LBCHU. Current industrial impacts are minimal, and pollution and/or sediments occur at very low levels. The majority of water flowing into this marine environment is not subject to human activity or stressors and is considered unimpaired (Alaska's Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report). There are no Section 303(d) impaired waterbodies identified within the Arctic Subregion by the State of Alaska. Background hydrocarbon concentrations in Chukchi Sea appear to be biogenic (naturally-occurring) and on the order of 1 part per billion or less; concentrations in the Hope Basin and Chukchi Sea are entirely biogenic in origin and are typical of levels found in unpolluted marine water and sediments. A study of heavy metals in sediments collected from portions of the eastern Chukchi in the 1990's (Naidu 2005) found concentrations were low and the environment was considered "pristine," although elevated levels have been found in very localized areas around old drill sites away from Ledyard Bay (Trefry et al. 2012, Trefry et.al. 2014). Therefore, the LBCHU is currently largely in natural condition, free of physical modification or significant pollutants in either its water and sediments, and its physical and biological processes are functioning and promote production of a rich and abundant benthic community upon which spectacled eiders feed when they occupy the LBCHU.

Molting spectacled eiders in LBCHU depend on the marine benthic community to meet their high nutritional requirements during the energetically demanding molt period. Feder et al. (1989, 1994*a*, 1994*b*) found a different substrate (muddy-gravel) and invertebrate community in the western LBCHU than sites sampled further east. This information suggests the western LBCHU is less favorable for molting spectacled eiders than the central and eastern LBCHU. Satellite telemetry locations of spectacled eiders corroborate this idea, as locations of spectacled eiders were higher in the eastern over the western portions of LBCHU (Figure 4.1, Figure 4.2, Figure 4.3, and Figure 4.4).

4.5 Polar Bears

Two stocks or populations of polar bears occur in the Action Area: the Alaska-Chukotka (A-C; formerly called Chukchi Sea) and Southern Beaufort Sea (SBS) stocks (Figure 4.7). The stocks overlap in the eastern Chukchi Sea/western Beaufort region, but have been distinguished by animal movement data and tissue contaminants (Amstrup et al. 2004, Amstrup et al. 2005). Furthermore, most denning in Alaska occurs by the SBS stock dens in Alaska, due to the relative proximity of the Beaufort Sea's ice edge to terrestrial habitats during fall when some pregnant females come ashore. Both stocks range beyond the U.S.; the A-C population ranges into Russia, and the SBS population ranges into Canada.

The highest number of polar bears in the Action Area occurs on land during fall and winter when some polar bears enter the coastal environment as they abandon melting sea ice, search for food on/near land (e.g., whale carcasses), or search for suitable den sites (pregnant females). Bears may also spend a short time on land to move to other areas. If fall storms, melting sea ice, and/or ocean currents deposit bears on land, they may remain along the coast or on barrier islands for several weeks until sea ice returns. Polar bears do not use the Chukchi Sea and adjacent Alaska coastline in the same manner they use the Beaufort Sea and the adjacent North Slope (Craig Perham, MMM-FWS, pers. com.). The number of bears using the Alaska coastline of the Chukchi Sea during the open-water season would likely be lower than the number of bears using the Beaufort Sea coastline. Interactions with polar bears in the Chukchi Sea would most likely occur with offshore facilities and would be related to their proximity to ice.

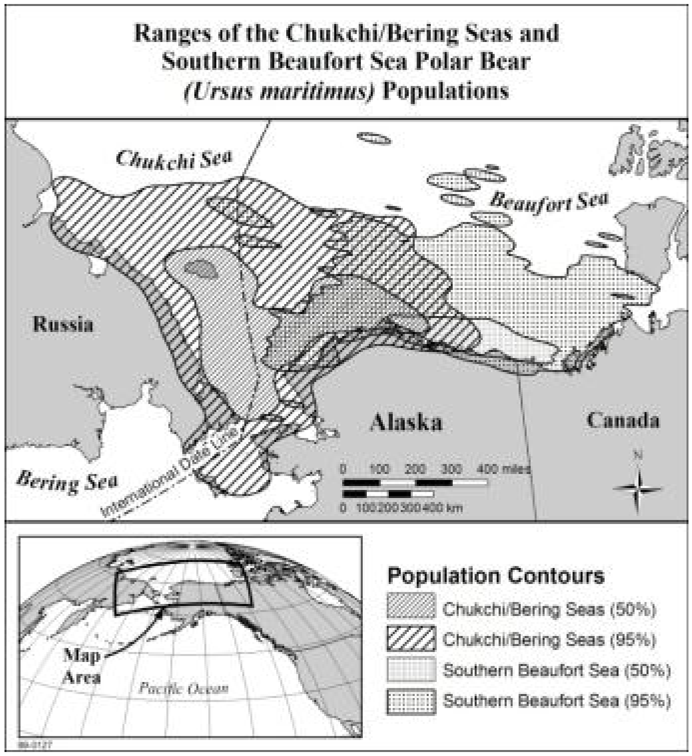


Figure 4.7. Ranges of Alaska polar bear stocks (73 FR 28212).

4.5.1 Alaska-Chukotka Stock

The A-C stock is widely distributed on the pack ice of the northern Bering Sea, Chukchi Sea, and eastern portions of the Eastern Siberian seas (Figure 4.7; Garner et al. 1990, Garner et al. 1994, Garner et al. 1995), and the constant movement of pack ice influences the movement of these polar bears; these variables make obtaining a reliable population size estimate from mark and recapture studies challenging. For example, polar bears of this stock move south with advancing ice during fall and winter and north in advance of receding ice in late spring and early summer (Garner et al. 1990). Thus, the most recent (early 1990s) A-C stock estimate of 2,000-5,000 animals (Belikov 1993) based on incomplete aerial den surveys has little management value. Expert opinion estimates the size of the subpopulation as approximately 2,000 polar bears (Aars et al. 2006). Currently, the Polar Bear Specialist Group (PBSG) lists the A-C subpopulation as “data deficient” based uncertainty in the level of human-caused removals, current population size, and current population growth rate (http://pbsg.npolar.no/en/status/populations/chukchi-sea.html).

4.5.2 Southern Beaufort Sea Stock

The most recent estimate of the SBS stock, which used an open population mark/recapture analysis, estimated a population size of 907 bears in 2010 (90% C.I. 606-1,212; Bromaghin et al. 2015), down from a previous estimate of 1,526 bears (95% CI = 1,211; 1,841) in 2006 (Regehr et al. 2006). Available trend data suggests this stock has experienced varying periods of stability and decline over the past few decades. Little or no growth was observed during the 1990s (Amstrup et al. 2001). An overall population decline rate of 3% per year was reported from

2001-2005 (Hunter et al. 2007). Regehr et al. (2006, 2009) reported declining survival and recruitment from 2004 through 2006, which were years when summer and fall sea ice were reduced (NSIDC 2014). This led to a 25-50% decline in abundance, which was hypothesized to result from unfavorable ice conditions that limited access to prey, and possibly, low prey abundance (Bromaghin et al. 2015). For reasons not understood, survival of adults and cubs began to improve in 2007 (Bromaghin et al. 2015), which was a record low year for September sea ice (NSIDC 2007). Abundance was comparatively stable between 2008 and 2010.

Shipboard surveys conducted for the Chukchi Sea Environmental Studies Program (CSESP) resulted in a total of 6 polar bear sightings (7 individual bears) in or near the Action Area during 2013 (Figure 4.8) (Aerts et al. 2014). Overall, the effort yielded a sighting rate of approximately 0.08 individual bears per 100 km-1. All bears were observed during August, during the open water season. Most bears were on ice floes (5 bears, including a mother-cub pair); two bears were observed swimming.

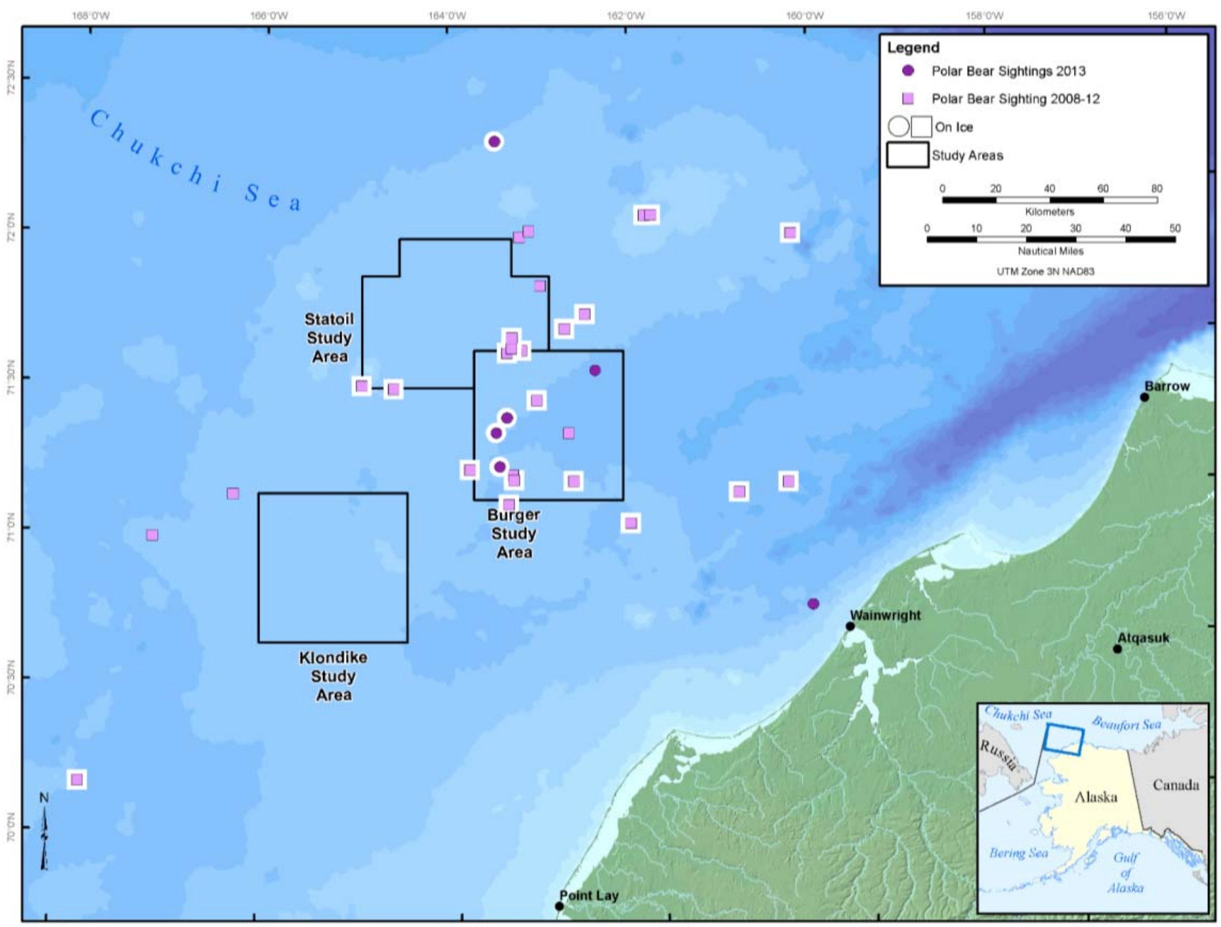


Figure 4.8. All polar bear sightings (i.e., including all effort types and sea states) recorded on sea ice and in the water in the Chukchi Sea during CSESP surveys in 2013 (purple circles) and 2008–2012 (pink squares). From Aerts et al. 2014.

4.5.3 Threats and Possible Stressors in the Action Area

The two main stressors in the Action Area for polar bears are loss of sea ice resulting from climate change and subsistence hunting. Other factors such as oil and gas development, research, and contaminants are also discussed in this section.

4.5.3.1 Loss of Sea Ice

Declines in sea ice have occurred in optimal polar bear habitat in the southern Beaufort and Chukchi seas since at least 1985, and even greater declines are predicted to occur in these regions in the 21st century (Durner et al. 2009). These stocks are vulnerable to large-scale dramatic seasonal fluctuations in ice movements which result in decreased abundance and access to prey and increased energetic costs of hunting. The A-C and the SBS are currently experiencing the initial effects of changes in sea ice conditions (Rode et al. 2010, Regehr et al., 2009, Hunter et al. 2007, Bromaghin et al. 2015). Regehr et al. (2010) found that the vital rates of polar bear survival, breeding rates, and cub survival declined with an increasing number of ice-free days/year over the Continental Shelf, and suggested that declining sea ice affects these vital rates via increased nutritional stress.

Regional-scale environmental shifts may be underway in the Chukchi Sea that may affect polar bear populations. Ice thickness generally increases from the Siberian Arctic to the Canadian Archipelago, due mostly to convergence of drifting sea ice (Walsh 2005). Rothrock et al. (1999; cited in Walsh 2005) found a decrease of about 40% (1.3 m) in the sea-ice draft (which is proportional to thickness) in the central Arctic Ocean by comparing sonar data obtained from submarines during two periods: 1958–1976 and 1993–1997. Wadhams and Davis (2000; cited in Walsh 2005) provide further submarine-measured evidence of reductions in sea ice thickness in the Arctic Ocean. Satellite imagery has documented a downward trend in September sea ice extent (historically when sea ice extent is at its minimum; Figure 4.6, NSIDC 2014). From 1979 through 2009, satellite data from 10 Arctic regions indicated that nine of 10 regions experienced trends towards earlier spring melt and later autumn freeze onset (Markus et al. 2009). For the entire Arctic, the melt season length had increased by about 20 days during this period (Markus et al. 2009). The Chukchi/Beaufort seas region, which is within the range of polar bears, has experienced a strong trend toward later autumn freeze-up date and longer ice-free seasons (Markus et al. 2009). Such changes in sea ice extent and duration will likely affect polar bear population trends. Details regarding the status of polar bears in light of climate change are presented below.

Historically, sea ice has protected shorelines from erosion; this protection, however, has decreased as sea ice decreases in extent and duration. With the reduction in summer sea ice, the frequency and magnitude of coastal storm surges has increased. These storm surges can cause breaching of lakes and inundation of low-lying coastal wetland areas, killing salt-intolerant plants and altering soil and water chemistry, and hence, the fauna and flora of the area (USGS 2006). Coupled with thawing permafrost, the inundation of the shoreline due to lack of sea ice has significantly increased coastal erosion rates (USGS 2006), potentially reducing the quality or quantity of habitats such as bluffs with vegetation that catch snow in which polar bears den along the Chukchi and Beaufort seas.

4.5.3.2 Subsistence Harvest

The U.S. manages subsistence hunting through international, bi-lateral, and user-to-user agreements. The signing of the *Multilateral Agreement on the Conservation of Polar Bears* in 1973 pledged action to protect polar bear habitat and a commitment to manage polar bear populations in accordance with sound conservation practices based on the best available scientific data. Sustainable harvest levels are set by the Inuvialuit-Inupiat (I-I) Council (Canada-Alaska) and the U.S.-Russia Polar Bear Commission (Commission) for the Southern Beaufort Sea and Alaska-Chukotka polar bear populations, respectively.

Southern Beaufort Sea population – In 1988 the I-I Council established a sustainable harvest quota for the SBS population of 80 polar bears. In 2010 the Council adjusted the quota downward to 70 polar bears (email T. DeBruyn, August 13, 2010) based on a revised population estimate of 1,526 (Regehr et al. 2006; email T. DeBruyn, August 13, 2010). The reported annual average U.S. removals from the SBS population from 2008 to 2014 was 20 (note that reporting for 2014 is not likely complete). The reported average U.S. removals from the Chukchi Sea population from 2008 to 2014 was 26 polar bears (again, noting that reporting for 2014 is likely not complete). In response to a new report released by the USGS in 2014, the PBSG revised the population estimate for polar bears in the Southern Beaufort Sea to be 907. This information will be considered by the I-I Council at their 2015 meeting.

Alaska-Chukotka population – Russia and the U.S. signed the *Agreement between the United States of America and the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population* (Bilateral Agreement) in 2000 which established the U.S.-Russia Polar Bear Commission (Commission) and provides a common legal, scientific, and administrative framework to manage the shared A-C polar bear population; implementing legislation for the Bilateral Agreement was signed in the U.S. on January 12, 2007. Based upon reliable science and Traditional Ecological Knowledge, in June 2010 the Commission adopted an annual take limit of the A-C polar bear population of 19 females and 39 males (DeBruyn et al. 2010). Harvest will be split evenly between Native peoples of Alaska and Chukotka. The Alaskan share of the harvest is 29 polar bears per year.

4.5.3.3 Oil and Gas Activities

Two sets of Incidental Take Regulations (ITRs), one for the Chukchi Sea and another for the Beaufort Sea, have been issued under the MMPA for oil and gas activities in and adjacent to the these seas since the 1990s. The effects of issuing the current ITRs on polar bears are considered part of the environmental baseline. Oil and gas companies can obtain LOAs under the appropriate regulations based on the location of the activities. As part of the LOAs issued pursuant to these regulations, the oil and gas industry is required to report the number of polar bears observed and their response.

4.5.3.4 Polar Bear Research

Polar bear research takes place in the Action Area. The long-term goal of research programs is to gain information on the ecology and population dynamics of polar bears to help inform management decisions, especially in light of climate change. These activities may cause short-term injury to individual polar bears targeted in survey and capture efforts and may incidentally disturb other individuals nearby. In rare cases, research efforts may lead to injury or death of polar bears. Polar bear research is authorized through permits issued under the MMPA. These permits include estimates of the maximum number of bears likely to be directly harassed, subjected to biopsy darting, captured, etc., and include a condition that halts a study if a specified number of deaths, usually four to five, occur during the life of the permit; permits are typically issued for a five-year period.

4.5.3.5 Other Activities

Polar bear viewing at sites such as subsistence whale bone piles may result in disturbance of polar bears by humans on foot, ATVs, snow machines, vessels, and other vehicles. Although difficult to quantify, these disturbances are usually temporary and are confined to areas limited in number and extent, which likely limits the extent and severity of their impact.

4.5.3.6 Environmental Contaminants

Exposure to environmental contaminants may affect polar bear survival or reproduction. Three main types of contaminants in the Arctic are thought to pose the greatest potential threat to polar bears: petroleum hydrocarbons, persistent organic pollutants (POPs), and heavy metals. No large oil spills from oil and gas activities have occurred in marine waters of arctic Alaska to date. Contamination of the Arctic and sub-Arctic regions through long-range transport of pollutants has been recognized for over 30 years (Bowes and Jonkel 1975, Proshutinsky and Johnson 2001, Lie et al. 2003). Arctic ecosystems are particularly sensitive to environmental contamination due to the slower rate of breakdown of POPs, including organochlorine compounds (OCs), relatively simple food chains, and the presence of long-lived organisms with low rates of reproduction and high lipid levels that favor bioaccumulation and biomagnification. Consistent patterns between OC and mercury contamination and trophic status have been documented in Arctic marine food webs (Braune et al. 2005). While polar bears can come into contact with other chemicals in the Action Area if they are not properly disposed of or secured, this occurs rarely and has affected only one or two bears every few years.

5 Effects of the Action

This section of the BO analyzes direct, indirect, interrelated, and interdependent effects of the proposed Action on listed eiders, polar bears, and the LBCHU. We describe anticipated effects of the first incremental step (exploration of the anchor field) followed by impacts that may result from future incremental steps (exploration of the satellite field and development, production, and decommissioning of both fields) for each species and the LBCHU. The Service determined the following potential effects may occur:

Listed eiders:

- Habitat loss
- Disturbance and displacement
- Collisions and disorientation
- Increased predator habitat
- Accidental shootings
- Authorized discharges
- Small spills

- Large spills (future incremental steps only)

LBCHU:
- Effects to PCEs
- Disturbance within the LBCHU
- Authorized discharges
- Small spills
- Large spills (future incremental steps only)

Polar bears:
- Disturbance and displacement
- Human-polar bear interactions
- Authorized discharges
- Small spills
- Large spills (future incremental steps only)

Oil Spills:
Based on BOEM's (2015b) oil spill scenario, small spills (< 1,000 barrels) are likely to occur during all incremental steps, and we analyzed small spills for each species and the LBCHU in each incremental step. Large spills (≥ 1,000 barrels) could occur only during future incremental steps, and very large (≥ 150,000 barrels) oil spills are unlikely to occur during any incremental step. Due to its complexity, the large and very large oil spill is discussed in a separate section.

5.1 First Incremental Step

This section assesses the impact of exploration and delineation of the anchor field, including seismic surveys, exploratory drilling, construction or expansion of onshore infrastructure, and associated aircraft, vessel, and vehicle operations. Exploration and delineation of the anchor field would take place offshore, while construction of exploration shorebases would take place onshore in coastal environments. Some activities proposed during the first incremental step include mitigation measures that could minimize effects on listed species and the LBCHU.

5.2 Listed Eiders – First Incremental Step

This section separates the evaluation of impacts from habitat loss on listed eiders into two sections: *Impacts to offshore habitat* and *Impacts to onshore habitat*. This separation reflects that the mechanisms of impact are different in these environments, and based on the project description provided by BOEM and BSEE (2015), the lack of specificity regarding possible actions in the terrestrial environment could result in a significant range of potential impacts to listed eiders.

5.2.1 Habitat loss

5.2.1.1 Impacts to offshore habitat

Permanent structures in high-quality habitats may affect birds by rendering those habitats permanently unsuitable and relegating birds to lower quality habitats. However, permanent structures in the marine environment during the first incremental step would be limited to capped and abandoned exploratory wells on the sea floor. While listed eiders forage on the sea floor, these capped wells would have an extremely small footprint compared to the expansive extent of available marine habitat. Therefore, the Service expects that effects of permanent habitat loss on listed eiders in the marine environment from the first incremental step would be extremely minor.

5.2.1.2 Impacts to onshore habitat

Temporary ice roads – We would not anticipate significant long-term habitat loss from temporary ice road operations associated with the first incremental step. Research indicates that damage from ice roads occurs on higher, drier sites with little or no damage in wet or moist tundra areas when ice roads are used (Pullman et al. 2003). Jorgenson (1999) found impacts were limited to isolated patches of scuffed high microsites and crushed tussocks. McKendrick (2003) studied several riparian willow areas and found although some branches were damaged, the affected plants survived. Because listed eiders prefer to nest in low moist tundra areas (Anderson and Cooper 1994, Anderson et al. 2009), we anticipate limited damage in higher drier tundra habitat from ice roads would not adversely affect listed eiders.

Permanent gravel fill — Habitat loss could occur through direct or indirect effects. Direct habitat loss occurs when extraction or placement of gravel fill permanently renders tundra habitat incapable of being used for nesting or brood rearing. We also anticipate indirect habitat loss via disturbance or displacement within a zone of influence surrounding new development from on-pad activities, road operations, and maintenance activities. The two principal mechanisms through which disturbance and displacement can adversely affect listed eiders on their breeding grounds are:

1. Disturbing incubating or brood-rearing hens, potentially exposing eggs or small young to inclement weather and predators; and
2. Displacing adults and/or broods from preferred habitats during pre-nesting, nesting, brood rearing, and staging for migration.

In the discussion below, we describe the range of potential breeding habitat loss for listed eiders resulting from potential development or expansion of infrastructure to support shorebase construction during the first incremental step. During the first incremental step, direct, permanent habitat loss would result from the extraction or placement of gravel fill, in support of up to 3 terrestrial shorebases, possibly impacting up to 337 acres (1.4 km^2) of wetlands each (Table 2.3). In addition to an estimated direct loss of 1.4 km^2 of wetlands for development or expansion of a single shorebase (BOEM 2015), indirect habitat loss may occur through disturbance and displacement of eiders in the surrounding zone of influence. To estimate impacts from disturbance and displacement in adjacent habitat, we generally assume an additional 200 m (656.17 ft) zone beyond the footprint of proposed infrastructure reflects the area within which indirect effects of disturbance or displacement may occur. Given this assumption, the area of total habitat loss for construction of a single shorebase during the first incremental step, including indirect disturbance or displacement in the adjacent 200 m zone of influence, is estimated to be 802 acres (3.24 km^2). Although the potential locations of up to 3 shorebases are unknown, BOEM and BSEE indicate coastal facilities would likely be located near Wainwright or Barrow, or otherwise along the Chukchi Sea coast between Icy Cape and Point Belcher (BOEM 2015).

5.2.1.2.1 Effects to nesting spectacled eiders

Our assessment of potential impacts uses estimates of spectacled eider density constructed from data collected during the 2007-2010 ACP aerial waterfowl survey (Larned et al. 2011). These density categories were developed at a coarse regional scale and are not site- or habitat-specific; however, they provide a reasonable perspective on the variation in density of breeding spectacled eiders in the action area. Distribution on a local scale may vary based on the availability of preferred habitats.

Estimated spectacled eider density between Barrow and Icy Cape ranged from 0-1.531 spectacled eiders/km^2 (Larned et al. 2011). To estimate the range of spectacled eider pairs potentially disturbed or displaced by a prospective shorebase located somewhere within this geographic region, we applied the medians of the lowest and highest density categories (0.014 and 0.9785 spectacled eiders/km^2) multiplied by the total estimated affected area 802 acres (3.24 km^2). We assume the estimated number of pairs displaced equates to the number of nests or broods that may be affected. We also assume that spectacled eiders will be present and attempt to nest annually in the action area. Finally, we assume that displaced pairs will not move and successfully nest elsewhere, which is an unproven and conservative assumption. Applying these assumptions and this logic, we estimate the proposed action would impact between 0.7 and 47.5 spectacled eider nests over an estimated 30-year project life[5]:

$$0.014 \text{ spectacled eiders/km}^2 \times 0.5 \text{ nests/pair} \times 3.24 \text{ km}^2 \times 30 \text{ yrs} = 0.68 \text{ nests}$$

$$0.978 \text{ spectacled eiders/km}^2 \times 0.5 \text{ nests/pair} \times 3.24 \text{ km}^2 \times 30 \text{ yrs} = 47.53 \text{ nests}$$

Therefore, we estimate a broad range of potential impacts to nesting spectacled eiders, between 1-48 nests, from direct and indirect effects of habitat loss associated with construction of a single shorebase during the first incremental step.

5.2.1.2.2 Effects to nesting Steller's eiders

Throughout the majority of the action area, the nesting density of Steller's eiders is so low that habitat loss of even a few kilometers would likely have a negligible effect on nesting Steller's eiders. Near Barrow however, where the species concentrates for nesting, a project footprint of this size (3.24 km^2 of combined direct and indirect habitat loss) would conceivably have bearing on the level of impact to Steller's eider production. However, because the size and location of project infrastructure near Barrow are unspecified, we provide a rough approximation of potential impacts to nesting Steller's eiders below.

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[5] Use and maintenance of the proposed infrastructure would take place beyond the assumed 5-year duration of the first incremental step. Therefore, we generally assume permanent gravel infrastructure on the North Slope would have a minimum 30-year project life.

For the of purposes of this evaluation, we estimated the potential number of Steller's eider nests impacted by multiplying the average density of breeding pairs within the Service's standard survey area near Barrow in 1999–2012 (Safine 2013; 0.262 Steller's eider breeding pairs/km^2) by the estimated affected area (3.24 km^2). As with spectacled eiders, we assume the estimated number of pairs displaced equates to the number of nests or broods that may be affected. We also assume that Steller's eiders will be present and attempt to nest annually in the action area. Finally, we assume that displaced pairs will not move and successfully nest elsewhere, which is an unproven and conservative assumption. Applying these assumptions and this logic, we estimate the proposed action would cause the failure of roughly 13 Steller's eider nests over an estimated 30-year project life:

$$0.262 \text{ Steller's eider pairs/km}^2 \times 0.5 \text{ nest/pair} \times 3.24 \text{ km}^2 \times 30 \text{ yrs} = 12.73 \text{ nests}$$

Therefore, we estimate up to 13 Steller's eiders nests could be impacted due to habitat loss from construction of a single shorebase near Barrow during the first incremental step. Furthermore, given that the highest density of nesting Steller's eiders occurs near Barrow, and their population is comparatively small (approximately 576 individuals; Stehn and Platte 2009), the siting of terrestrial shorebases and associated infrastructure in proximity to Barrow may have significant bearing on the level of impact to Steller's eider production.

5.2.1.3 Conclusion – effects of habitat loss on listed eiders

Although impacts to nesting and brood-rearing listed eiders from development or expansion of onshore infrastructure are conceivable during the first incremental step, we acknowledge the estimated impacts are based on a set of conservative assumptions and incorporate a number of uncertainties. We also emphasize that depending on the characteristics of terrestrial infrastructure associated with the first incremental step, potential impacts may be different from the estimated impacts presented here. Potential impacts would depend on the number, location, and size of shorebases and the associated material sites excavated to provide fill. Given the lack of specificity regarding these factors in the EDS, at this time we are unable to accurately estimate impacts to listed eiders from development or expansion of onshore infrastructure during the first incremental step.

5.2.2 Disturbance

The severity of disturbance depends on the duration, frequency, and timing of the action causing the disturbance. Disturbance that results in changes to behavior (e.g., flushing or diving) may increase energetic costs, especially for birds that may be already energetically stressed from cold, lack of food, or a physiologically demanding life cycle stage such as molt. Birds may also be displaced from preferred habitats to areas where resources are less abundant or of lower quality. During the first incremental step, disturbance and displacement of listed eiders could occur from aircraft operations, vessel traffic, or acoustic sources associated with deep-penetration and high-resolution seismic surveys and exploratory drilling.

5.2.2.1 Aircraft operations

Aircraft may disturb listed eiders in the action area as they migrate, forage, nest, or molt. While specific information regarding listed eider response to disturbance in the marine environment is lacking, we expect that they would exhibit a similar response to king eiders; therefore we consider the response of king eiders to be a reliable surrogate for evaluating effects of disturbance on listed eidersin the marine environment. King eiders in western Greenland dove when survey aircraft approached (Mosbech and Boertmann 1999). Bird response varied with time of day, and increased with decreasing aircraft altitude. After a preliminary dive by nearly all birds, over 50% remained submerged until the aircraft passed. Also, molting king eiders appeared to be sensitive to aircraft engine noise, and flushed, dove, or swam from that disturbance, sometimes leaving the area for several hours (Frimer 1994).

BOEM and BSEE anticipate low numbers of aircraft operations would support actions associated with the first incremental step. For example, during exploration surveys, aircraft would be used only for search and rescue efforts. During open water exploratory drilling, BOEM and BSEE estimate 1 or more helicopters would make 1-6 flights/day. These aircraft would transport personnel and supplies between drill ships and shorebases, likely Barrow and/or Wainwright. To minimize impacts to listed eiders and other avian species during sensitive life history periods, BOEM and BSEE would require aircraft to avoid flying below an altitude of 1,500 feet over the LBCHU between July 1 and November 15 (the period when molting spectacled eiders are present), and over the spring lead system between April 15 and June 10 (when listed eiders may be present) unless it is unsafe to do so (Lease Stipulation No. 7). Fixed-wing flights at this altitude are not expected to disturb or adversely affect listed species (Mosbech and Boertmann 1999), although altitude restrictions would be impracticable and therefore ineffective during inclement weather. However electronic tracking of actual flight altitudes would help to analyze how often weather conditions allow for compliance with the intent of the stipulation.

Evidence suggests that some birds may habituate to certain sources of disturbance or avoid impacts associated with certain areas (USFWS 2005). For example, some spectacled eiders nest and rear broods near the Deadhorse airport, indicating that some individuals tolerate occasional aircraft noise. Individual tolerance is expected to vary, and the intensity of disturbance, in most cases, would be less than that experienced by birds at the Deadhorse airport.

Disturbance to nesting spectacled and Steller's eiders during the first incremental step would likely be further limited due to their extremely low density across the North Slope. Spectacled eiders nest in loose aggregations in preferred habitat types (Bart and Earnst 2005), but across the ACP of the North Slope breeding-season density has averaged approximately 0.165 spectacled eiders/km^2 (Larned et al. 2010). In some years, Steller's eiders are so rare they go undetected during extensive aerial surveys. Steller eider pair densities have ranged between 0 and 1 male/km^2 between 1999 and 2012 in their core nesting area near Barrow (USFWS 2013). Because 1) a low number of flights are anticipated; 2) with the exception of LBCHU, listed eiders occur at very densities in the action area; and 3) protections included in the flight altitude mitigation measures would minimize disturbance to listed eiders, particularly in LBCHU, we expect only minor, temporary effects on listed eiders from aircraft disturbance during the first incremental step.

5.2.2.2 Vessel traffic

There are a variety of vessel-based operations in the first incremental step. Two large vessels would be used for seismic surveys, one in open water and one in ice, and there would also be two MODUs operating simultaneously in open water. These larger vessels would each have some smaller vessel support or ice breaking, and there would be 1–2 barge trips during each of 2 years of potential shorebase construction. Vessel traffic impacts on listed eiders include periodic disruption of behavior. However, vessel operations would only affect listed eiders if birds are present in the same area and at the same time as vessels. For example, most spectacled eiders breeding on the ACP make regular use of the lease-sale areas, and each sex/age cohort may be affected differently, depending on time and location. In the most extreme case, an estimated 33,192 spectacled eiders have been counted in the LBCHU during the latter portion of the molting season (Petersen et al. 1999). While eiders molting in the LBCHU would have the ability to depart an area by swimming away from disturbances, this movement would come at an energetic cost, and birds may be displaced to areas of lower desirability. Frequent or prolonged disturbance from vessels could result in energy expenditures that prolong the molt or decrease energy reserves available for winter survival. As most of these eiders are believed to be successfully breeding females and hatch-year juveniles, even a seemingly trivial impact to individual fitness (caused by repeated or prolonged vessel disturbance) imposed on a large number of birds could result in reduced overwinter survival and decreased population size, productivity, and/or recruitment.

In spring and early summer, large numbers of listed eiders may occupy the Chukchi Sea lead system. Nearshore areas of the Chukchi Sea are often the first ice-free areas available to spring migrants, and these open-water areas can support dense concentrations of birds if migrants arrive but cannot continue on because eastern destinations remain snow or ice covered. As birds staging in spring leads return to their breeding grounds, changes in their fitness or nutritional status could prevent or affect future reproductive efforts.

No exploratory drilling would occur within the LBCHU because no leases exist there. However, support vessels could occasionally transit the area. From November 16 through June 30, listed eiders are rarely present, and vessels would not be expected to encounter them in large numbers. Because Lease Stipulation No. 7 requires vessels associated with exploration and drilling to avoid operations within LBCHU between July 1 and November 15 (except for reportable marine casualties as defined in 46 CFR 4.05-1, or hazardous conditions as defined by 33 CFR 160.204, in which case the incursion must be reported to BOEM and BSEE within 24 hours, and BOEM and BSEE will report the activity to the Service within 48 hours), impacts to listed eiders would be avoided during this time.

The majority of spring leads are closer to the coastline than the leased area, and leads rarely open in the vicinity of the leased area (Mahoney 2012). Vessels transiting through the lead system may cause short-term disturbance, but the effects would likely be limited due to the brief duration of a vessel transit and the relatively low numbers of vessels that may enter the area (BOEM and BSEE estimate up to two MODUs with up to 31 support vessels annually; BOEM 2015). Given the relatively low number of vessels and restrictions on vessel activity in areas where large numbers of listed eiders could occur (LBCHU and spring lead system), it is unlikely that vessels would encounter these species. Individual birds that do encounter vessels during the first incremental step would likely only experience minor, temporary changes in behavior such as moving away to a perceived safe distance.

5.2.2.3 Deep-penetration and high-resolution seismic activity sources

Seismic work, exploratory/delineation drilling, and related support activities would typically be conducted from vessels during ice-free, open-water periods. The first incremental step includes two marine seismic survey/exploration/delineation surveys (1/year) of up to 90 days duration, and five smaller scope acoustic surveys, that would allow leaseholders to investigate the potential for future oil or gas production.

Seismic surveys generate intense energy pulses in the water column. Seismic survey vessels typically move slowly through an area, and "ramp up" the airgun array (gradually increase the decibel level) before starting a survey or after a power down. Airgun use during seismic surveys results in both vertical and horizontal sound propagation. Vertical propagation would be less likely than horizontal propagation to impact listed eiders, because it is less likely that birds would be directly beneath the array. Although there is variation in attenuation rates depending on bottom slope and composition, sound from airgun arrays can be detected using hydrophones at ranges of 50-75 km in water 25-50 m deep (Richardson et al. 1995).

Little is known about avian behavioral response to seismic acoustics; however, in a study of long-tailed ducks (*Clangula hyemalis*) in the Beaufort Sea, Lacroix et al. (2003) found no significant difference in numbers of ducks in an area before and after seismic survey work. In some survey areas, long-tailed ducks were observed to dive more frequently than in undisturbed areas, but the cause (vessel versus seismic acoustic source) was unclear. Nevertheless, listed eiders foraging in the water column or on the seafloor could be exposed to underwater seismic noise. It is conceivable that birds could be near enough to marine seismic or geohazard survey sound sources to be injured by a pulse, although the threshold for physiological damage, especially to the auditory system, for marine birds is unknown. However, because seismic vessels move slowly through a survey area and airgun arrays are required to ramp up as seismic activities begin, listed eiders in the vicinity of the survey would likely depart the area before injury occurs. Furthermore, seismic surveys typically require a single pass over a given line and repeated seismic disturbance in a particular location would not be expected. Therefore, the effects of disturbance on listed eiders from open-water seismic survey operations would likely be similar to those of disturbance from vessel traffic.

Furthermore, temporal separation exists between areas used by high numbers of listed eiders (e.g., LBCHU and the spring lead system) and open-water seismic surveys. Although open-water seismic work would occur from July through November, activities during the first incremental step are not permitted within LBCHU after July 1 when molting spectacled eiders may be present. Listed eiders migrating in fall may encounter seismic vessels, however we anticipate these birds would experience only minor, temporary disturbance such as departing the area to a perceived safe distance. Data from satellite telemetered spectacled eiders in 1994 -1996 (Petersen et al. 1995, 1999) and 2009 – 2012 (Sexson et al. 2014) indicate that spectacled eiders may be present in the eastern Chukchi Sea lead system as early as May (Figure 4.1); although disturbance to listed eiders in the spring lead system from open-water seismic surveys is not anticipated, because open-water surveys are not expected to commence until July. Similarly, because in-ice seismic surveys would be conducted from October through December, when the majority of listed eiders are not present (some spectacled eiders may remain in the action area through November; Sexson 2014), we expect in-ice seismic surveys would affect at most, a few individual listed eiders, and effects would be limited to minor and temporary impacts on behavior and would not be expected to result in injury or death.

While seismic airguns have the potential to alter the availability of invertebrate food sources, Vella et al. (2001) concluded that there are generally few behavioral or physiological effects unless the organisms are very close (within meters) to a powerful noise source. Consequently, noises from seismic airguns are not likely to decrease the availability of invertebrate crustaceans, bivalves, or mollusks.

5.2.2.4 Exploratory drilling

In addition to vessels transiting to and from exploratory drill sites (discussed above), exploratory drilling may disturb or displace listed eiders from the immediate area of the exploration site. However, due to low densities of listed eiders in the majority of the leased area, listed eiders are unlikely to be present and encounter exploratory drilling activities and be disturbed. Furthermore, exploratory drilling activities are limited to a relatively small spatial area and are stationary, allowing birds that are adjacent to exploratory drilling to depart the area or habituate to the disturbance. Additionally, in areas where large numbers of listed eiders may be present, BOEM and BSEE would impose mitigation measures on exploratory drilling operations. For example, Lease Stipulation No. 7 (Appendix A) would require vessels associated with exploratory drilling operations in the leased area to avoid operating in or traversing the spring lead system between April 15 and June 10. Additionally, during spring, ice covers the majority of the lease area; and because exploratory drilling operations would not commence until June, few listed eiders would be likely to encounter exploratory drilling operations during the first incremental step. Therefore, effects of disturbance from exploratory drilling during the first incremental step on listed eiders are expected to be minor and temporary.

5.2.2.5 Collisions and disorientation

Migratory birds suffer considerable mortality from collisions with man-made structures (Manville 2004). Birds involved in collisions with man-made structures may also experience severe injuries, including concussions, internal hemorrhaging, and broken bones. Birds are particularly at risk of collision when visibility is impaired by darkness or inclement weather (Weir 1976). In a study of avian interactions with offshore oil platforms in the Gulf of Mexico, collision events were more common, and more severe (i.e., the number of collision incidents increased) during poor weather (Russell 2005). There is also evidence that lights on structures, particularly red steady-state lights, result in disorientation which increases collision risk (Reed et al. 1985, Russell 2005, numerous authors cited by Manville 2000). Strike rate may also be related to flight behavior, in particular, altitude (Anderson and Murphy 1988). Johnson and Richardson (1982) in their study of migratory behavior along the Beaufort Sea coast, reported that 88% of eiders flew below an estimated altitude of 10 m (32 ft) and well over half flew below 5 m (16 ft). Day et al. (2004 and 2005) also noted eider species may be particularly susceptible to collisions with offshore structures as they fly low (mean flight altitude 12.1±0.8 m) and at relatively high speeds (approximately 45 mph) over water.

Although limited, the best data available for estimating collision risk to listed eiders for Lease Sale 193 is bird encounter data recorded during Shell's 2012 exploratory drilling season in the Chukchi Sea. Eiders comprised 13% of avian encounters during Shell's 2012 drilling season (i.e., 17 of 131 total encounters, BOEM unpublished data 2015). Those 17 collisions included 13 king and 4 common eiders, and occurred over approximately 60% of a normal duration drilling season. Unlike passerines, or other perching birds, seaducks would be extremely unlikely to alight deliberately on vessels or drilling structures to rest, therefore we believe these encounters represent collisions resulting in severe injury or death. Of the 17 eider collisions, two were recorded on MODUs, and 15 on support vessels. Because 2 MODUs and 10 other vessels operated during Shell's 2012 season, collisions per vessel would equate to:

2 collisions ÷ 2 MODUs = 1 collision per MODU per season; and

15 collisions ÷ 10 support vessels = 1.5 collisions per support vessel per season.

These rates are based on reported collisions for king and common eiders during a single season in the Chukchi Sea. Listed eider species were not among the seaduck collisions recorded in 2012, however spectacled and Steller's eiders moving through the Chukchi Sea during spring, summer, and fall would also be at risk of colliding with MODUs and vessels associated with the first incremental step.

Assuming that spectacled and Steller's eiders are equally as vulnerable to collisions as king and common eiders, and because there is no basis to assume otherwise, we would expect collisions to occur in proportion to species abundance. Based on a total of 705,380 eiders (529,271 king and 176,109 common eiders) recorded during migration counts near Barrow in late summer and fall of 2002 (Quakenbush and Suydam 2004[6]), we very roughly estimate the risk of collisions to be:

1 collision per MODU per season ÷ 705,380 eiders = 0.0000014 collisions per MODU per season; and

1.5 collisions per support vessel per season ÷ 705,380 eiders = 0.0000021 collisions per support vessel per season

While these collision rates are small, they may result in impacts for listed eiders moving through the Chukchi Sea.

We can approximate the number of potential collisions for spectacled and Steller's eiders by applying the rates calculated for king and common eiders (above), to the estimated abundance of spectacled and Steller's eiders using aerial survey data for pre-nesting eiders on the North Slope (Stehn et al. 2006, Stehn and Platte 2009)[7]. These surveys estimate spectacled and Steller's eiders number approximately 12,916 (Stehn et al. 2006) and 576, respectively (Stehn and Platte 2009). Therefore, we estimate listed eider collision rates for MODUs would be:

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[6]This survey was based on observed counts from a fixed location. It employed a subset of time intervals and extrapolated the data to account for intervals during which no observations were made. Because the majority of king and common eiders nest in Northern Canada, we believe these counts reasonably estimate the number of king and common eiders passing through Arctic Alaska. Listed eiders were not detected during these migration counts, presumably due to the comparative scarcity and identification challenges for spectacled and Steller's eiders.

[7] These surveys were based on aerial observations of a subset of available nesting habitat on the North Slope. The data were then extrapolated to account for available nesting habitat that was not surveyed.

12,916 spectacled eiders × 0.0000014 collisions per MODU per season = 0.018 spectacled eiders per MODU per season

576 Steller's eiders × 0.0000014 collisions per MODU per season = 0.00081 Steller's eiders per MODU per season

Similarly, collision rates for support vessels are estimated as:

12,916 spectacled eiders × 0.0000021 collisions per vessel per season = 0.027 spectacled eiders per vessel per season

576 Steller's eiders × 0.0000021 collisions per vessel per season = 0.0012 Steller's eiders per vessel per season

If these figures represent the number of collisions expected per listed eider moving through the Chukchi Sea, we can then approximate the number of collisions expected for each vessel type by applying collision rates to the number of vessels anticipated during the first incremental step. Two MODUs and up to 31 additional vessels (7 for seismic exploration, 16 for drilling support, and 8 for oil spill response; Table 2.4) would be in operation during the first incremental step. Therefore, estimated collisions for listed eiders would be calculated as follows:

For MODUs:	0.018 spectacled eider per MODU × 2 MODUs = 0.036 spectacled eiders
	0.00081 Steller's eider per MODU × 2 MODUs = 0.0016 Steller's eiders
For support vessels:	0.027 spectacled eider per vessel × 31 vessels = 0.837 spectacled eiders
	0.0012 Steller's eider per vessel × 31 vessels = 0.037 Steller's eiders

Because a typical open-water season would conceivably last from June through November, we estimate a full exploration and delineation season would be approximately 180 days (we would not anticipate listed eider collisions during in-ice seismic surveys because very few eiders would be expected to be present during in-ice work). We must therefore adjust the estimates calculated above, which were based on a single season of approximately 108 days, to estimate collisions over 5 seasons[8] of 180 days.

For spectacled eiders:

0.036 spectacled eider collisions ÷ 108 days = 0.00033 collisions per day; therefore,
0.00033 collisions per day × 180 days × 5 yrs = **0.30 spectacled eider collisions for MODUs**

0.837 spectacled eider collisions ÷ 108 days = 0.0078 collisions per day; therefore,
0.0078 collisions per day × 180 days × 5 yrs = **6.98 spectacled eider collisions for vessels**

[8] The duration of the first incremental step is estimated to be 5 years.

Therefore, we estimate approximately 7 total spectacled eider collisions with MODUs and support vessels during the first incremental step.

For Steller's eiders:

0.0016 Steller's eider collisions ÷ 108 days = 0.000015 collisions per day; therefore,
0.000015 collisions per day × 180 days × 5 yrs = **0.0133 Steller's eider collisions for MODUs**

0.037 Steller's eider collisions ÷ 108 days = 0.00034 collisions per day; therefore,
0.00034 collisions per day × 180 days × 5 yrs = **0.31 Steller's eider collisions for vessels**

Therefore, we estimate approximately 1 or fewer Steller's eider collisions with MODUs and support vessels during the first incremental step.

The reliability of these estimates may be limited due to a number of inherent biases. For example, 1) collisions are often episodic, and those resulting from light attraction in inclement weather may be particularly so, such that observations collected on a few vessels in a single year may not be representative of collisions in general; 2) monitoring for collisions is difficult and an unknown number of collisions may go undetected, even by trained bird observers; and 3) low visibility often coincides with increased collisions (Ronconi et al. 2015), which may increase the number of undetected collisions. However, these estimates are based on the best information available. Because the most recent population estimate for North Slope-breeding spectacled eiders is 12,916 (10,942–14,890, 95% CI), and 576 (292-859, 90% CI) for Steller's eiders, we would not anticipate population level effects from the loss of approximately 7 spectacled and 1 or fewer Steller's eiders from collisions during the first incremental step.

Mitigation Measures
In an effort to reduce collision risk resulting from bird attraction to lighted structures, BOEM and BSEE will require that vessels minimize the use of high-intensity work lights, especially within the 20-m bathymetric contour. BOEM and BSEE will also require exterior lights be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather; otherwise lights will be turned off. Interior and navigational lights will remain on for safety. Lessees are also required to implement lighting protocols aimed at minimizing outward-radiating light from exploratory drilling structures.

In summary, we anticipate the likelihood of listed eider collisions with vessels and MODUs during the first incremental step would be low because 1) listed eider density in the action area is low; 2) due to the low number of vessels compared to the size of the action area, few listed eiders would be expected to encounter MODUs or support vessels during the first incremental step; 3) activities are not permitted within the LBCHU when the highest concentrations of listed eiders would be present; and 4) mitigation measures for vessel lighting may reduce the potential for attracting or disorienting eiders in flight. However, the Service estimates that up to 7 spectacled eiders and 1 or fewer Steller's eiders would suffer injury or death in collisions with MODUs and support vessels during the first incremental step.

5.2.2.6 Increased predator populations

Onshore structures associated with construction of exploration shorebases during the first incremental step could increase the number of potential nesting and perching sites for ravens. In addition, these structures could increase the availability of anthropogenic food and nesting or denning (e.g., for foxes) resources for predators. The effects of predation on listed eider reproduction, however, are extremely uncertain, and we are unable to estimate effects of increased predation on listed eiders from activities associated with the first incremental step with any reliability.

Mitigation measures – Structural design features that do not allow predators to construct nesting or denning sites, as well as measures that minimize access to anthropogenic sources of food and nesting material could reduce the impacts of increased predator populations on listed eiders. However, successful implementation of these measures may be difficult. For example, a lease stipulation for the Liberty project requiring new infrastructure to avoid facilitating increased predator populations has been largely unsuccessful at preventing ravens from nesting (e.g., ravens nested in May 2014). While implementation and enforcement of lease stipulations that specifically address waste management and infrastructure design could reduce effects of increased predator populations, at least some potential remains for new infrastructure to provide additional habitat or other resources for predators.

5.2.2.7 Accidental shooting

Prior to the ESA listing of spectacled and Alaska-breeding Steller's eiders, some level of subsistence harvest of these species, occurred across the North Slope (Braund et al. 1993). Some accidental shooting continues despite prohibitions against taking these species. Construction or expansion of onshore infrastructure for exploration shorebases could facilitate increased subsistence access to currently remote areas (e.g., up to 1 mile of new road is proposed for shorebase access), increasing the risk of accidental shooting. With the exception of the Barrow area, construction of shorebase infrastructure would occur in areas where listed eiders occur in low densities. However, if onshore infrastructure were ultimately sited near Barrow, where the highest density of nesting Steller's eiders occurs, the increased risk of accidental shooting, especially for adult breeding females, may have significant bearing on the level of impact to Steller's eider production and could slow the survival and recovery of this species.

5.2.2.8 Discharges

5.2.2.8.1 Authorized discharges

Discharges of drilling muds (lubrication for drill bits) and cuttings (material removed from drill holes) during exploratory or delineation drilling could increase the turbidity of waters surrounding benthic habitat. These conditions could influence the ability of listed eiders to forage effectively, especially for benthic prey. Discharges of drilling mud and cuttings could also conceivably impact listed eiders through contamination of individual birds or important benthic feeding habitats. For example, BOEM and BSEE noted changes in species composition, abundance, or biomass of the benthic biota resulting from the release of synthetic-based mud cuttings were generally detected at distances of 50 m to 500 m from well sites. These biological effects can be attributed to chemical toxicity of discharges, organic enrichment, and deposition of fine particles in drilling wastes (MMS 2008 citing Hurley and Ellis 2004). While the recovery of benthic communities was documented, generally within one year of completion of the well, a decrease in benthic invertebrate species richness and abundance could occur at a distance of 50 m for up to two years after exploratory drilling ceased (MMS 2008 citing Hurley and Ellis 2004). However, the EPA regulates discharge of drilling muds, cuttings, and other materials to the marine environment, and the Chukchi Sea exploration NPDES general permit (AKG-28-8100) for oil and gas exploration facilities on the OCS is currently in effect and would mandate specific discharge limits.

In addition to drilling mud and cuttings, discharges of grey or ballast water from vessel or platform operations could take place during the first incremental step. However, these discharges would also be authorized under the Chukchi Sea exploration NPDES general permit (AKG-28-8100), and EPA regulations (40 CFR 125.122) would require a determination that the permitted discharge would not cause unreasonable degradation to the marine environment. Furthermore, because authorized discharges during the first incremental step would occur over relatively short periods of time (weeks or months at specific locations), impacts to water quality from authorized discharges would be expected to be localized and short term.

Given 1) the relatively small impact area associated with exploratory drilling in relation to the size of the lease area; 2) the low number of wells expected the area (BOEM and BSEE estimate up to 28 exploratory or delineation wells could be drilled during the first incremental step); and 3) limits on discharges enforced through the NPDES permit process, the Service anticipates only minor impacts to listed eiders from discharges of drilling mud, cuttings, ballast and grey water during the first incremental step.

5.2.2.8.2 Small spills

Exposure to oil may impact listed eiders in several ways, depending on the volume, location, and timing of a spill and the severity of exposure. For example, waterfowl that directly contact even small amounts of oil may lose the hydrophobic, insulative properties of their feathers and suffer impaired thermoregulation. These birds may become wet, hypothermic, or potentially drown (Jenssen 1994), particularly if the oil exposure occurs in cold environments (Piatt et al. 1990). Birds exposed to oil may also suffer reduced reproductive success. Mortality of embryos and nestlings has been documented by exposure to small amounts of hydrocarbons (light fuel oil, crude oil, or weathered oil) transferred to offspring by adults with lightly oiled plumage (Parnell et al. 1984, Hoffman 1990, Szaro et al. 1980, and Stubblefield et al. 1995). Furthermore, birds that ingest oil in the course of normal foraging or preening behaviors may experience toxicological effects including gastrointestinal irritation, pneumonia, dehydration, red blood cell damage, impaired osmoregulation, immune system suppression, hormonal imbalance, inhibited reproduction, retarded growth, and abnormal parental behavior (Albers 2003, Briggs et al. 1997, Epply 1992, Fowler et al. 1995, Hartung and Hunt 1966, and Peakall 1982). Birds also bioaccumulate hydrocarbons and are vulnerable to both accute and sublethal effects from contaminated food supplies (Albers 2003).

Based on information provided by BOEM and BSEE (BOEM 2015), approximately 20 small refined oil spills (<1,000 bbl) would be reasonably foreseeable during the first incremental step. Although low-volume spills could occur during exploration surveys, drilling operations, or refueling, due to safety measures in place (operation-specific spill prevention and oil spill response plans), these unauthorized discharges are expected to be uncommon. Furthermore, due to low densities of spectacled and Steller's eiders in the action area, we expect the likelihood of listed eiders encountering oil from a small spill in either the marine or terrestrial environment would be very low. Small offshore spills would be expected to be contained or weather quickly (within a few hours to a few days), and small onshore spills would likely be completely and rapidly recovered (e.g., oiled soil or tundra would be removed and disposed of properly). Although disturbance of listed eiders could occur during cleanup efforts for small spills, this level of disturbance is expected to be minor and temporary as birds would be expected to move away to a perceived safe distance (USFWS 2010). Furthermore, disturbance from cleanup activities is likely to be extremely infrequent and limited to a small geographic area, and would therefore impact very few individual eiders.

Because 1) small spills are expected to occur infrequently and be of low volume; 2) spectacled and Steller's eider density in the Chukchi Sea and terrestrial habitat in the action area is very low; 3) small spills are expected to be contained or weather quickly; and 4) eiders would likely avoid disturbance associated with areas of active cleanup, listed eiders are extremely unlikely to encounter oil from a small spill during the first incremental step. Therefore, although the effects of small-volume spills on listed eiders would depend on 1) the location and timing of the spill; and 2) the speed and success of cleanup efforts, small spills resulting from the first incremental step are expected to affect, at most, a very few of individuals.

5.2.2.8.3 Large and very large spills

Based on information provided by BOEM and BSEE (BOEM 2015), spills >1,000 bbl are not reasonably likely to occur during the first incremental step. Rather, based on BOEM and BSEE's oil spill risk analysis, the only type of larger spill that would potentially occur during this step would be a VLOS (>150,000 bbl) from loss of well control resulting in a long duration flow. However, such an event would be extremely unlikely to occur because a loss of well control incident is extremely rare and is therefore not reasonably certain as a result of the first incremental step. Therefore, while the effects of a VLOS would likely result in injury or death of an unknown number of listed eiders, a VLOS is not considered to be an effect of the first incremental step within the meaning of the ESA, because it is not reasonably certain to occur.

5.2.3 Spectacled Eider Critical Habitat: Ledyard Bay Critical Habitat Unit – First Incremental Step

Ledyard Bay Critical Habitat Unit (LBCHU) is an important migration and molting area for spectacled eiders, and the Primary Constituent Elements (PCEs) in this unit are: (1) marine waters greater than 5 m (16.4 ft) and less than or equal to 25 m (82.0 ft) in depth; (2) the associated marine aquatic flora and fauna in the water column; and (3) the underlying marine benthic community.

5.2.3.1 Effects to PCEs

Effects of disturbance on PCE 1 within the LBCHU - Support vessels could occasionally transit through LBCHU, however no exploratory drilling would occur within the LBCHU because no leases exist there (the nearest lease block is approximately 20 mi (32.2 km) distant (BOEM 2015). Temporal overlap between vessel traffic and large concentrations of eiders within the LBCHU would also be minimized. For example, from November 16 through June 30, listed eiders are rarely present in the LBCHU, and vessels would not be expected to encounter them in large numbers. Furthermore, because Lease Stipulation No. 7 requires vessels associated with exploration and drilling to avoid operations within LBCHU between July 1 and November 15, impacts to listed eiders would be avoided during this time. In addition, given the size of LBCHU and the relatively small number of vessels that could operate within it at any one time, we do not anticipate vessel traffic during the first incremental step would appreciably effect spectacled eider access to LBCHU such that the function and conservation value of the LBCHU for spectacled eider would be reduced.

Minimization measures – Lease Stipulation No. 7 requires vessels associated with exploration and drilling to avoid operations within LBCHU between July 1 and November 15 (except for reportable marine casualties as defined in 46 CFR 4.05-1, or hazardous conditions as defined by 33 CFR 160.204, in which case the incursion must be reported to BOEM and BSEE within 24 hours, and BOEM and BSEE will report the activity to the Service within 48 hours. BOEM and BSEE may also require additional mitigation measures during the first incremental step to minimize the effects of disturbance on spectacled eider access to the LBCHU.

Effects of small spills on PCEs - A small oil spill in the Lease Area during the first incremental step could reach the LBCHU and potentially affect PCEs and the ability of spectacled eiders to use this area. Small spills during the first incremental step would be expected to be rare (approximately 20), of very low volume (<1,000 bbl), and largely recoverable (BOEM 2015). Furthermore, in order for small spills to affect PCEs in the LBCHU, they would need to occur within or adjacent to this critical habitat area. Given the low number activities expected within the LBCHU during the first incremental step this would be unlikely. Because 1) spills during the first incremental step would be uncommon and low volume; 2) the area affected by these spills would be small; 3) most of the oil would be quickly recovered; and 4) the likelihood of spills occurring within or adjacent to the LBCHU is low, we do not expect small spills would have long-term effects that would diminish the function or conservation value of the LBCHU for molting or migrating spectacled eiders.

Effects of authorized discharges on the marine benthic community – Because no leases exist within the LBCHU, no drilling would occur there. Therefore, it is unlikely that an appreciable volume of drilling muds or cuttings discharged during exploratory drilling would reach the LBCHU. Discharges from exploratory drilling would result in the deposition of sediment that could affect flora and fauna in the water column and the underlying benthic community through toxicity (PCEs 2 and 3). However, these effects would be localized and limited to the area surrounding the 28 proposed exploration wells, each of which would be at least 20 miles from the LBCHU. Furthermore, prevailing currents would likely carry discharged material in an easterly direction; away from the LBCHU. Therefore, significant adverse effects to PCEs 2 and 3 from exploratory drilling discharges are not anticipated, and they are not expected to appreciably reduce the function and conservation value of the LBCHU for spectacled eiders.

5.3 Effects to Polar Bears from the First Incremental Step

With the exception of proposed construction and use of onshore infrastructure, the majority of activities during the first incremental step, would take place offshore within the lease area. Most polar bears occur in the active ice zone, far offshore, hunting throughout the year. Polar bears also spend limited time on land to feed or move to other areas, although melting sea ice may result in increased numbers of polar bears in the terrestrial environment. Therefore, although they occur at low densities, polar bears may occur year-round throughout the action area in marine or terrestrial environments.

Impacts to polar bears could result from the first incremental step primarily through disturbance, increased polar bear-human interactions, unauthorized discharges, and habitat loss. Because the majority of activities during the first incremental step take place outside the polar bear denning period (mid-November through mid-April), the following analysis focuses on effects to transient (non-denning) bears unless otherwise stated.

5.3.1 Disturbance

The severity of impacts resulting from disturbance depends on the duration, frequency, and timing of the action causing the disturbance. Disturbance that results in changes to behavior may increase energetic costs, especially for bears that may be already energetically stressed from cold, lack of food, or other physiologically demanding events (e.g., long distance swims). Bears may also be displaced from preferred habitats to areas where resources are less abundant or of lower quality. During the first incremental step, disturbance and displacement of polar bears could occur from aircraft operations, vessel traffic, or acoustic sources associated with deep-penetration and high-resolution seismic surveys, exploratory drilling, and on-shore activities associated with construction and maintenance of shorebases.

5.3.1.1 Aircraft operations

During the first incremental step, exploration surveys and drilling operations would be supported by helicopter and fixed-wing aircraft. Exploration surveys and drilling operations would also be supported by helicopters to transport personnel and equipment to offshore worksites. The number of daily trips expected during exploration surveys and drilling operations would depend on the operation, although BOEM and BSEE estimate 1 or more helicopters would make 1- 6 flights/day (Table 2.4). Helicopter operations would be conducted at 1,000 to 1,500 feet AGL/ASL unless safety dictates otherwise.

Prolonged or repeated overflights of fixed-wing aircraft for monitoring purposes, or helicopters used in support of offshore operations could disturb transient polar bears. For example, during aerial surveys conducted by the Service, researchers reported 14.2% to 28.9% of polar bears changed their behavior when surveys were conducted at an altitude of 300 feet (Rode 2008, 2009, 2010). Similar to other sources of disturbance, polar bears may respond to aircraft by departing the area, possibly at energetic cost. However, given the low density of polar bears in the action area, we would expect disturbance of polar bears by aircraft operations to be infrequent. Furthermore, because BOEM and BSEE would require aircraft to avoid flying below an altitude of 1,500 ft, we would expect the effects of aircraft disturbance on polar bears would be minimized. Therefore, given that 1) polar bears occur at very low densities in the action area; 2) a low number of flights is anticipated; and 3) protections included in the flight altitude mitigation measures would minimize disturbance, we expect aircraft disturbance associated with the first incremental step would be minor and temporary, such that injury or death to transient bears would not be anticipated.

5.3.1.2 Vessel traffic

There are a variety of vessel-based operations in the first incremental step. Two large vessels would be used for seismic surveys, one in open water and one in ice, and there would also be two MODUs operating simultaneously in open water. These larger vessels would each have some smaller vessel support or ice breaking, and there would be 1–2 barge trips during each of 2 years of potential shorebase construction. The impacts of vessel disturbance on polar bears would likely be limited to disruption of behavior. Frequent or prolonged disturbance from vessels could result in energy expenditures that decrease energy reserves available for winter survival. Furthermore, although vessels in the action area may cause disturbance, the effects would likely be limited due to the brief duration of a vessel transit and the relatively low numbers of vessels that may operate in the area at any given time (BOEM and BSEE estimate two drillships with up to 31 additional vessels; 7 for exploration, 16 for drilling support, and 8 for oil spill response; BOEM 2015).

Given that polar bears occur at very low densities, and few vessels would operate within the action area at any one time, we would expect encounters with vessels to be infrequent. Furthermore, we would expect individual polar bears that do encounter vessels during the first incremental step would likely only experience minor, temporary changes in behavior such as moving away to a perceived safe distance. For these reasons we expect vessel disturbance associated with the first incremental step would be minor and temporary, such that injury or death to transient bears would not be anticipated. Therefore, population-level impacts would not be expected from disturbance associated with vessel traffic during the first incremental step.

5.3.1.3 Deep penetration and high resolution seismic activity sources

Seismic work, exploratory/delineation drilling, and related support activities would typically be conducted from vessels during ice-free, open-water periods. The first incremental step includes two marine seismic survey/exploration/delineation surveys (1/year) of up to 90 days duration, and five smaller scope acoustic surveys, that would allow leaseholders to investigate the potential for future oil or gas production.

Seismic surveys generate intense energy pulses in the water column. Seismic survey vessels typically move slowly through an area, and "ramp up" the airgun array (gradually increase the decibel level) before starting a survey or after a power down. Airgun use during seismic surveys results in both vertical and horizontal sound propagation. Although there is variation in attenuation rates depending on bottom slope and composition, sound from airgun arrays can be detected using hydrophones at ranges of 50-75 km in water 25-50 m deep (Richardson et al. 1995). However, because polar bears typically swim at the surface with their heads above waterline, underwater seismic noises would likely be weak or undetectable to polar bears (Greene and Richardson 1988, Richardson et al. 1995). Therefore, it is unlikely these noises would cause auditory impairment or other physical effects.

In addition, LOAs issued pursuant to the Chukchi Sea ITRs under the MMPA require mitigation measures for seismic survey operations in the Chukchi Sea. For example, marine mammal observers would be required on seismic vessels and would instruct the vessel's captain to power-down airgun arrays if polar bears enter the 190 db ensonification zone. This mitigation measure may reduce the likelihood of adverse effects to polar bears. These and additional mitigation measures would likely be required for future seismic survey work in the lease area as a condition for MMPA authorization. Given 1) the low number of seismic surveys proposed; 2) the tendency for seismic surveys to avoid areas and periods of heavy sea ice (preferred polar bear habitat); 3) polar bear swimming behavior; and 4) mitigation measures required by current and future LOAs, the Service concludes it is unlikely that propagation of seismic sounds would result in the injury or death of a polar bear.

Individual response of polar bears to seismic survey vessels is likely to vary. However, because seismic vessels move slowly through a survey area and airgun arrays are required to ramp up as seismic activities begin, polar bears in the vicinity of the survey would likely depart the area before injury occurs. Furthermore, seismic surveys typically require a single pass over a given line and repeated seismic disturbance in a particular location would not be expected. Therefore, the effects of disturbance on polar bears from open-water seismic survey operations would likely be similar to those of disturbance from vessel traffic.

Because in-ice surveys would most likely take place in new ice where polar bears are unlikely to den, the chance of encountering an ice-denning bear is extremely low. In the Chukchi Sea, polar bears den at extremely low densities in multi-year ice where pressure ridges facilitate snow accumulation. Icebreakers generally avoid these conditions for operational reasons (e.g., safety, time, and fuel efficiency). Therefore, we expect effects of icebreaking for in-ice seismic surveys on polar bears would be extremely unlikely.

5.3.1.4 Vehicle traffic

Vehicles traveling on terrestrial or offshore ice roads could conceivably disturb polar bears in the action area. However, given the low density of polar bears in the Chukchi Sea we anticipate disturbance from vehicle traffic would be uncommon. Additionally, we expect disturbance would be minor and temporary because transient bears would be able to respond to human presence or disturbance by departing the area. Furthermore, the Service expects that potential adverse effects to transient polar bears would be reduced by the lessee’s compliance with existing and future authorizations issued under the MMPA, such as LOAs issued under the Chukchi Sea ITRs.

5.3.2 Increased human polar bear interactions

Although polar bears may be encountered by MODUs or vessels during open water or in-ice seismic surveys and exploratory drilling, we would not anticipate direct human-polar bear interactions from vessel-based operations. However, polar bears may also be encountered in the terrestrial environment during construction and on-going use of proposed coastal infrastructure. Given the low density of polar bears in the action area, we would expect these encounters to be infrequent during the first incremental step.

However, polar bears may need to be hazed if they approach work areas. Many acoustic and vehicular deterrence methods (starting a vehicle or revving an engine) are not likely to harm polar bears (75 FR 61631). Polar bears could experience temporary disturbance and stress from some deterrence activities and may depart the area. Under current or future LOAs, trained individuals would likely be permitted to use mechanisms (e.g., chemical repellants, electric fences, and firearm projectiles) to harass or deter polar bears away from personnel and equipment. Bears that are deterred using more aggressive methods (e.g., direct contact projectiles from firearms), would likely experience stress, short-term pain, and could be bruised. In extremely rare circumstances, if performed incorrectly, a polar bear may be severely injured or die.

Although lessees with LOAs would have authorization to use projectiles to deter bears away from personnel, we expect the majority of deterrence events would not involve contact with the bear (Level B Harassment under the MMPA[9]), and most would cause only minor, temporary, behavioral changes (e.g., the bear departs the area). We anticipate very few deterrence events would necessitate techniques that would physically contact a bear, such as projectiles. For example, from 2006 through 2010, the entire North Slope oil and gas industry reported sightings of 1,414 polar bears, of which 209 (15%) were intentionally deterred (USFWS 2013). During those previous events, between 0-5 polar bears were deterred using bean bags and between 0-1 with rubber bullets annually. Given (1) that approximately 15% of bears encountered by industry have been subject to deterrence (USFWS 2013); (2) the low density of bears in the action area; (3) the unlikely event that deterrence would result in injury; and (4) the extremely low likelihood that deterrence would result in impacts, we expect the proposed action would have sublethal effects to a few individual polar bears.

5.3.3 Discharges

5.3.3.1 Authorized discharges

Discharges of drilling muds (lubrication for drill bits) and cuttings (material removed from drill holes) during exploratory or delineation drilling would be small in scale and would likely dissipate quickly. Furthermore the EPA regulates discharge of drilling muds, cuttings, and other materials to the marine environment, and the Chukchi Sea exploration NPDES general permit (AKG-28-8100) for oil and gas exploration facilities on the OCS is currently in effect and would mandate specific discharge limits.

In addition to drilling mud and cuttings, discharges of grey or ballast water from vessel or platform operations could take place during the first incremental step. However, these discharges would also be authorized under the Chukchi Sea exploration NPDES general permit (AKG-28-8100), and EPA regulations (40 CFR 125.122) would require a determination that the permitted discharge would not cause unreasonable degradation to the marine environment. Furthermore, because authorized discharges during the first incremental step would occur over relatively short periods of time (weeks or months at specific locations), impacts to water quality from authorized discharges would be expected to be localized and short term.

Given 1) the relatively small impact area associated with exploratory drilling in relation to the size of the lease area; 2) the low number of wells expected in the area (BOEM and BSEE estimate up to 28 exploratory or delineation wells could be drilled during the first incremental step); and 3) limits on discharges imposed by the NPDES permit process, the Service anticipates

[9] Level B Harassment - 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 but which does not have the potential to injure a marine mammal or marine mammal stock in the wild.

only minor impacts to polar bears from discharges of drilling mud, cuttings, ballast and grey water during the first incremental step.

5.3.4 Effects of oil on polar bears

Oil is highly toxic to polar bears (St. Aubin 1990), and oil and toxic substance spills may result from the first incremental step. The volume, location, and timing of a spill will influence the number of polar bears affected, and exposure to oil can affect polar bears in several ways. For example, polar bears in the marine or terrestrial environment that come in contact with spilled oil, or inhale volatile compounds (e.g., aromatic hydrocarbons), could suffer damage to their digestive, respiratory, and central nervous systems. Effects of oil-contaminated fur, or ingestion of oil or other chemicals, range from short-term impacts to death (Oritsland et al. 1981). When contacted by oil, fur loses its insulative properties, and irritation or damage to the skin from oil contamination may further contribute to impaired thermoregulation. Bears may also be affected by ingesting oil, either through grooming, nursing, or consumption of contaminated prey (Stirling 1990), and polar bears may not avoid feeding or scavenging on typical prey items due to oiling (St. Aubin, 1990; Neff, 1990; Derocher and Stirling, 1991). Oil ingestion may produce pathological effects, depending on the amount of oil ingested and the individual physiological state of the bear. These effects could be fatal if a large amount of oil is ingested or if volatile compounds are drawn into the lungs (76 FR 47010: 47029-47030). Oil also remains highly toxic to polar bears, even after aromatic hydrocarbons have dissipated (St. Aubin 1990). Ingestion of sub-lethal amounts of oil can have a variety of physiological effects on a polar bear, for example ingested petroleum hydrocarbons can irritate or destroy epithelial cells lining the stomach and intestine, thereby affecting motility, digestion, and absorption. Therefore, oiled bears could potentially suffer a range of harmful effects from encounters with oil spills.

Only pregnant female polar bears den, and due to extremely low densities of denning polar bears in the Chukchi Sea, we would not anticipate impacts from oil spills on denning bears. However, the majority of the population is transient year-round, and potential effects of a spill to transient bears would likely vary with timing and location (USFWS 2006). For example, polar bears may occupy the margin of advancing or retreating sea ice in fall or spring to access important feeding areas over the Chukchi Sea continental shelf (which has spatial overlap with the Lease Area). Polar bears occupying this transitional ice would be at risk from oil spills during these time periods (USFWS 2006). Furthermore, if spills were to occur in the fall or spring, sea ice conditions would likely hinder response and cleanup activities. Similarly, spill response and cleanup during winter may be delayed or complicated if spills were to occur either above or below solid ice.

Transient polar bears are more likely to occupy sea ice than to be found in open water or on land, however they may swim considerable distances from ice to land, and vice versa (USFWS 2006). Swimming polar bears would conceivably be at risk of encountering oil spilled in the marine environment, although the likelihood would be remote due to the extremely low density of polar bears during open-water periods. Furthermore, individual bears or small groups in the terrestrial environment may be vulnerable if spilled oil were to contact the Chukchi Sea coastline or Wrangel or Herald islands, where bears sometimes congregate to feed on walrus and whale carcasses (USFWS 2006). In summary, despite their low density and transient nature, non-denning polar bears in the marine or terrestrial environment would conceivably be at risk from oil spills during the first incremental step.

5.3.5 Small spills

Based on information provided by BOEM and BSEE (BOEM 2015), approximately 20 small refined oil spills (<1,000 bbl) would be reasonably foreseeable during the first incremental step. Although low-volume spills could occur during exploration surveys, drilling operations, or refueling, due to safety measures in place (operation-specific spill prevention and oil spill response plans), these unauthorized discharges are expected to be uncommon. Furthermore, because small spills would be expected to occur during operations where the lessee is present onsite, the recovery rate for small spills would be high (BOEM 2015). Small offshore spills would be expected to be contained or weather quickly (within a few hours to a few days), and small onshore spills would likely be cleaned up completely and rapidly (e.g., oiled soil or tundra would be removed and disposed of properly). Additionally, due to low densities of polar bears in the Chukchi Sea, bears are not likely to occur in marine or terrestrial environments where activities and potential oil spills associated with the first incremental step would take place. Furthermore, polar bears may be deterred from entering areas of active cleanup for the safety of personnel and bears. Although disturbance of polar bears could occur during cleanup efforts for small spills, this level of disturbance is expected to be minor and temporary as bears would be expected to move away to a perceived safe distance (USFWS 2010). Furthermore, disturbance from cleanup activities is likely to be extremely infrequent and limited to a small geographic area, and would therefore impact very few bears.

Because 1) small spills are expected to occur infrequently and be of low volume; 2) polar bear density in the Chukchi Sea and terrestrial environment in the action area is very low; 3) small spills are expected to be contained or weather quickly; and 4) bears would be deterred from entering areas of active cleanup, polar bears are extremely unlikely to encounter oil from a small spill during the first incremental step. Therefore, although the effects of small-volume spills on polar bears would depend on 1) the location and timing of the spill; 2) the speed and success of cleanup efforts; and 3) efforts to deter bears from cleanup areas, small spills resulting from the first incremental step would be expected to at most, affect very small numbers of individuals.

5.3.6 Large and very large spills

Based on information provided by BOEM and BSEE (BOEM 2015), spills ≥1,000 bbl are not reasonably likely to occur during the first incremental step. Rather, based on BOEM and BSEE's oil spill risk analysis, the only type of larger spill that would potentially occur during this step would be a VLOS (>150,000 bbl) from loss of well control resulting in a long duration flow. However, such events would be extremely unlikely to occur based on previous loss of well control incidences, and therefore would not be reasonably certain as a result of the first incremental step. Therefore, while the effects of a VLOS could result in injury or death of polar bears, a VLOS is not considered to be a direct or indirect effect of the first incremental step.

In summary, we have identified how polar bears could be impacted by oil and analyzed the likelihood of bears contacting spilled oil during the first incremental step. Given that small spills would, by definition, be small in volume and highly recoverable, the likelihood of impacts to polar bears from small spills during the first incremental step is negligible. Furthermore, the likelihood of a VLOS would be so low during the first incremental step impacts to polar bears from a VLOS would be discountable.

5.3.7 Habitat loss

Terrestrial habitat

Habitat loss would occur through construction or expansion of gravel infrastructure for up to three exploration shorebases, impacting approximately 337 acres (1.4 km^2) of coastal tundra within the action area. It is possible a small amount of terrestrial denning habitat may be destroyed or altered by project activities; however, denning habitat does not limit population size (C. Perham, pers. comm. in USFWS 2008). Therefore, the small amount of terrestrial denning habitat lost in the action area would likely have a negligible impact on denning bears.

Interdependent and Interrelated Actions - Listed Species and Critical Habitat

Interdependent actions are defined as actions having no independent utility apart from the proposed Action, while interrelated actions are defined as actions that are part of a larger action and depend upon the larger action for their justification (50 CFR §402.02). MMPA authorization issued to oil and gas companies has required, and likely will require the development of polar bear interaction plans, and these plans could include polar bear deterrence. Deterrence activities are necessary tools to prevent the lethal take of polar bears or potential for injury to personnel. Because polar bears could ultimately be subject to intentional deterrence, we consider such deterrence activities to be an interrelated action to the proposed Action.

The Service issues LOAs to appropriately-trained individuals which authorize intentional taking of polar bears for both human and bear safety pursuant to sections 101(a)(4)(A), 109(h), and 112(c) of the MMPA. In a separate consultation, the Service concluded that acoustical and vehicular deterrence methods that anyone can perform are not likely to adversely affect polar bears (75 FR 61631), and these methods would not require authorization via LOAs. Intentional take LOAs would allow trained individuals to use other mechanisms (e.g., pyrotechnical cartridges, heavy equipment, and direct contact deterrents such as bean bags and rubber bullets projected from a shotgun) to deter polar bears away from oil and gas infrastructure and personnel. The Service requires mitigation measures and determines minimum standardized training in the use of deterrence methods. Because most activities that may occur in the first incremental step take place at sea in non-ice conditions, intentional take from activities occurring during the first incremental step is anticipated to be extremely rare.

Even if deterrence events were to occur, most are not likely to involve contact with the bear and would likely cause only minor, temporary behavioral changes (e.g., a bear runs or swims away). Because deterrence events are more likely to occur during the future incremental steps, we evaluate the effects of deterrence events fully in the section entitled *Interrelated and Interdependent Effects* when we evaluate effects of future incremental steps.

Increased community development – Expansion of industry activity in and around coastal villages during the first incremental step may increase demands on housing and other community infrastructure, which could lead to additional excavation and fill of tundra habitat, and further development of communication utilities such as powerlines. Excavation and fill of tundra would permanently destroy breeding habitat, and overhead powerlines pose a collision risk for listed eiders. Furthermore, expansion of onshore activity during the first incremental step may increase anthropogenic disturbance and attraction of predators (e.g., ravens and foxes) that could negatively impact listed eider production. Breeding and brood-rearing habitat permanently lost to construction or expansion of infrastructure near Barrow may have significant bearing on the level of impact to listed eiders, particularly the survival and recovery of Steller's eiders.

Community expansion resulting from increased industry activity in and around coastal villages could also lead to more human-polar bear interactions with community residents. Increased human-polar bear interactions in and around villages would pose safety concerns for humans and bears alike, and polar bears that approach these communities would potentially be subject to increased subsistence harvest. However, given existing polar bear detection and deterrence measures employed by community residents and the North Slope Borough Department of Wildlife Management, an appreciable level of increased risk of polar bear interactions with community residents would likely be minimized.

Furthermore, given conservation practices afforded through the 1973 Polar Bear Agreement and U.S. Russian Polar Bear Treaty, which established sustainable quotas and restrictions regarding denning females, family groups, and methods of hunting, we anticipate increased polar bear harvest due to more frequent human-polar bear interactions from increased human activity near coastal villages would be low. Furthermore, reporting requirements under the MMPA's marking and tagging program require all harvested polar bears be tagged by a representative of the Service to monitor subsistence harvest and control illegal hunting, trade, and transport of marine mammal parts. Given (1) the low density of polar bears in the action area; (2) provisions included in the 1973 Polar Bear and Inuvialuit-Inupiat Polar Bear Management Agreements; and (3) MMPA reporting requirements, we expect increased subsistence harvest of polar bears in the action area would be low, and population-level effects from increased harvest as a result increased human activity associated with the first incremental step are not anticipated.

Increased U.S. Coast Guard presence – Commensurate with increased offshore industry activities in the Chukchi Sea, we would expect U.S. Coast Guard (USCG) operations to increase. Like industry vessels, USCG vessels could encounter listed eiders and polar bears in the action area and would be most likely to affect these species through disturbance or displacement. However, due to the comparatively low number of USCG vessels likely to be used, impacts of disturbance and displacement from USCG operations would likely be relatively minor.

5.3.8 Conclusion for the first incremental step

5.3.8.1 Listed eiders

In evaluating impacts of the proposed project to spectacled and Steller's eiders, the Service identified potential adverse effects from collisions, and habitat loss through disturbance and displacement. Using methods explained in the *Effects of the Action* section, the Service estimates loss of approximately 7 spectacled eiders (including adults and/or fledged juveniles) and 1 or fewer Steller's eiders from collisions with MODUs and vessels.

In addition, we estimate a range in potential loss of production from about 1 to 48 spectacled eider nests and from 0 to 13 Steller's eider nests from direct and indirect loss of nesting habitat associated with development of a single shorebase during the first incremental step (Table 2.3). We acknowledge these estimated impacts are based on a set of conservative assumptions and incorporate a number of uncertainties, however. We also emphasize that depending on the characteristics of terrestrial infrastructure associated with the first incremental step, potential impacts may be different from the estimated impacts presented here. Potential impacts would depend on the number, location, and size of shorebases and the associated material sites excavated to provide fill. Given the lack of specificity regarding these factors in the EDS, at this time we are unable to accurately estimate impacts to listed eiders from development or expansion of onshore infrastructure during the first incremental step. Furthermore, because the highest density of nesting Steller's eiders occurs near Barrow, and their population is comparatively small (approximately 576 individuals), the siting of terrestrial shorebases and associated infrastructure in proximity to Barrow may have significant bearing on the level of impact to Steller's eider production.

In addition to adverse effects from collisions and habitat loss, listed eiders could be impacted by disturbance from aircraft, vessel traffic, seismic surveys, and exploratory drilling, as well as authorized discharges and small oil spills. However, due to 1) the low density of listed eiders in the action area; 2) the low number of activities compared to the size of the action area; 3) mitigation measures such as flight altitudes and timing restrictions for activities within the LBCHU; 4) limits on authorized discharges enforced through the NPEDES permit process; 5) low numbers and volumes of small spill anticipated; and 5) due to spill prevention and reponse measures, spilled oil would be expected to be completely recovered or dissipate quickly, we anticipate impacts from these factors would be limited to a few individual listed eiders resulting in only minor, temporary changes in behavior, and would be unlikely to result in injury or death.

5.3.8.2 LBCHU

Impacts to the LBCHU from activities authorized during the first incremental step of the proposed Action are anticipated to have at most only minor, short-term impacts to the primary constituent elements and habitat qualities, and are therefore not likely to diminish the function and conservation value of critical habitat. No exploration wells or other permanent structures are anticipated within the LBCHU because no leases occur there. Therefore, potential impacts to spectacled eiders, would be limited to the temporary effects of human presence and activity and would not include residual impacts to the habitat or its features.

Although small spills would be reasonably foreseeable during the first incremental step, they would be by definition so limited in size that oil or other spilled substances would likely evaporate, weather, or be mostly recovered. By virtue of their size, they would also likely cover a limited areal extent, and would be unlikely to persist long enough to reach the LBCHU if spilled elsewhere. Moreover, given the limited volumes of small spills, effects on the biological and physical features of critical habitat would likely be short term and localized, and therefore would not diminish the function and conservation value of the LBCHU for spectacled eiders.

Spills of greater volume would not be likely to occur during the first increment. According to analysis by BOEM and BSEE, large and very large oil spills would be so unlikely during the first incremental step as to be considered not reasonably foreseeable. Therefore, they would not be considered a direct or indirect effect of the first increment within the meaning of the ESA.

In summary, although the Service identified potential impacts to the LBCHU from disturbance and small spills, due to 1) minimization measures designed to reduce or avoid industry impacts to the LBCHU (e.g., Lease Stipulation No. 7); 2) the low likelihood and volume of spills during the first incremental step; and 3) spill prevention and response measures in place, these effects would be expected to have at most only minor, short-term impacts to the primary constituent elements and habitat qualities, and are therefore not likely to diminish the function and conservation value of the LBCHU for spectacled eiders.

5.3.8.3 Polar bears

We have identified potential impacts to polar bears from activities proposed during the first incremental step. As described in the *Effects of the Action*, activities that may result from the action could affect polar bears through disturbance and increased human interactions, oil spills, and habitat loss. A very small number of polar bears may also be affected through human-polar bear interactions that may result in subsistence harvest.

Transient (non-denning) polar bears may be affected by human presence and activities such that they change their behavior and movements, either moving away from the source of disturbance, or in rare cases they may be attracted, which could occasionally result in the need to haze the individual(s) involved. Based on successful management of human-bear interactions in recent decades, we anticipate that most interactions would result in only minor, temporary changes in behavior that would not adversely affect the individual polar bears involved. Although intentional deterrence actions would occasionally be employed, they would be designed and closely managed to de-escalate encounters and protect polar bears and humans alike, and would therefore be expected to avoid, rather than cause, injuries or death of polar bears. Therefore, we expect interactions resulting in injury or death of polar bears would be unlikely during the first incremental step, and expect at most sublethal effects to at most a few individual polar bears from human-polar bear interactions.

As noted in the *Effects of the Action*, small spills would be expected to occur in the first incremental step. However, it is highly unlikely that polar bears would be significantly affected because small volumes of spilled oil would likely evaporate, weather, or be almost entirely recovered. Moreover, the density of polar bears is low in most of the Action Area so it is unlikely that polar bears would encounter oil or other substances from a small spill. Further, spill response activities would cause significant local disturbance which would likely displace polar bears from the spill site, further decreasing chances of contact with spilled substances.

Spills of greater volume would not be likely to occur during the first incremental step. According to analysis by BOEM and BSEE, large and very large oil spills would be so unlikely during the first incremental step as to be considered not reasonably foreseeable. Therefore, they are not considered to be direct or indirect effects of the first increment within the meaning of the ESA.

Although some loss of terrestrial denning habitat would occur, because denning habitat does not limit population size, we expect that the small amount of denning habitat lost within the action area during the first incremental step would likely have a negligible impact on denning bears.

Therefore, given that 1) disturbance and human-polar bear interactions would be unlikely to result in the injury or death of a bear; 2) due to small volumes and spill prevention and response measures, small spills would be expected to at most, affect very few individuals; and 3) large or very large oil spills would be extremely unlikely to occur; and 4) habitat loss would be minor, we do not expect population-level impact to occur as a result of activities proposed during the first incremental step.

5.4 Future Incremental Steps

This section assesses the impact of future exploration and development activities, including production of the anchor field, exploration, development, production of the satellite field, and decommissioning of both fields. Development, production, and decommissioning would take place on- and offshore, and could include construction of permanent infrastructure (e.g., shorebases, subsea and terrestrial pipelines, roads, pump stations), use of aircraft and vessels, operation of facilities, and decommissioning of infrastructure. The Proposed Action includes mitigation measures that could minimize effects on listed species and the LBCHU.

5.4.1 Listed Eiders – Future Incremental Steps

5.4.1.1 Habitat Loss

While a minimal amount of foraging habitat could be lost in the offshore environment, most listed eider habitat lost during future incremental steps would occur onshore as nesting and brood-rearing habitat.

5.4.1.1.1 Habitat Loss - Offshore

Offshore infrastructure would include eight platforms installed over ~20 years (five in the anchor field, three in the satellite field) with associated pipelines, subsea templates, and subsea production wells. This infrastructure would impact a small area of the sea floor, with some structures above the water surface. Platforms and wells will not be located within Ledyard Bay, spring leads, or other areas used by large numbers of listed eiders. Oil and gas pipelines, however, could be routed through these areas buried in the substrate. Given the relatively small size of the offshore footprint described by BOEM within Ledyard Bay and other high-use areas, adverse effects would likely occur infrequently and be limited in extent. Additionally, most impacts to habitat offshore would be temporary because platforms and seafloor infrastructure would be removed, and benthic areas disturbed by pipeline burial would recover.

5.4.1.1.2 Habitat Loss - Onshore

Direct and secondary impacts to breeding and brood-rearing listed eider habitat could occur during future incremental steps. Direct, permanent loss could result from onshore excavation and fill in support of a production shorebase, pipelines, a 300-320-mile road, and other infrastructure, possibly impacting 2,015 acres of wetlands. The shorebase would be located at pipeline landfall, which could occur near Wainwright or Barrow, or elswhere on the coast between Icy Cape and Point Belcher. About five times as much excavation and fill, and thus permanent loss of listed eider nesting and brood-rearing habitat, could occur during future incremental steps as compared to the first step (Table 2.3 and Table 2.6; BOEM 2015a). Secondary habitat degradation could occur from 1) dust and gravel spray during construction and facility operation, and 2) altered hydrology associated with excavation, fill, and ice road construction.

Although we anticipate adverse effects to listed eiders from onshore excavation and fill during future incremental steps, as during the first incremental step, our analysis is based on conservative assumptions and incorporates a number of uncertainties. The range of potential impacts is large because the location and footprint size is unresolved; the description of onshore infrastructure may be encompassed by, or exceed impacts presented here.

Development could occur near Barrow, which is a high-density breeding area for spectacled eiders (Larned et al. 2011) and Alaska-breeding Steller's eiders (Quakenbush et al. 2002). In particular, habitat loss near Barrow could affect a significant number of Alaska-breeding Steller's eiders because 1) this area supports the highest known breeding density of this species; and 2) potential development associated with the first incremental step, growth of the Barrow community, and future incremental steps could impact a substantial proportion of nesting and brood-rearing habitat.

5.4.1.2 Disturbance and Displacement

Disturbance and displacement could occur on- and offshore. Effects of disturbance and displacement will likely be greater during future incremental steps than the first incremental step, and impacts would depend upon the duration, frequency, and timing of a given activity, as well as tolerance of disturbance by individuals.

5.4.1.2.1 Disturbance and Displacement – Offshore

As during the first incremental step, disturbance and displacement could occur from aircraft operations, vessel traffic, and acoustic sources associated with open-water seismic surveys and exploratory drilling. Vessels (barges and other support vessels) and aircraft (fixed-wing and helicopters) could transport materials and personnel to on- and offshore facilities, and the number and frequency of vessel and aircraft operations would likely be significantly higher during development and decommissioning than production (Table 2.5).

Disturbance associated with seismic surveys and exploratory drilling would occur in the satellite field, and some disturbance could result from platform operations in the anchor field. As described in the *Effects* section of the first incremental step, disturbance from vessel, aircraft, open-water seismic, and drilling operations on listed eiders may include flushing and displacement at some energetic cost to individual birds. Because listed eiders generally occur at low densities in the Leased Area, we expect few listed eiders to be present and encounter open-water seismic, exploratory drilling operations and production platform operations. Depending upon the frequency of operations and routes traversed by vessels and aircraft, impacts could range from negligible (few listed eiders disturbed infrequently) to substantial (for example, vessels or aircraft repeatedly disturbing flocks of molting spectacled eiders in Ledyard Bay).

5.4.1.2.2 Disturbance and Displacement – Onshore

Onshore industrial activities such as facility operations and transportation of personnel and equipment could disturb listed eiders. Disturbance during the nesting and brood-rearing could adversely affect individuals by: 1) flushing females from nests or brood-rearing habitats, which would expose eggs or ducklings to inclement weather and predators; and 2) displacing adults or broods from preferred habitats during pre-nesting, nesting, and brood rearing, leading to reduced foraging efficiency and higher energetic costs. Individual tolerance and potential for habituation to disturbance would likely vary among individuals, and the relationships between oil and gas activities and listed eider distribution, breeding effort, and reproductive performance have not been demonstrated. When estimating or enumerating effects, we generally assume listed eiders avoid nesting within 200 m of infrastructure with human activities, or do so with reduced success, although empirical support for this assumption is lacking. We expect impacts from disturbance to occur for the length of the EDS, 77 years over an area possibly stretching from Icy Cape to Prudhoe Bay. If development occurred in areas supporting high densities of listed eiders, the resulting disturbance during breeding and brood-rearing could have substantial localized impacts on reproduction potential of listed eiders, and impacts near Barrow could conceivably result in population-level effects on Alaska-breeding Steller's eiders).

Mitigation measures – While impacts to listed eider nesting and brood-rearing habitat may result from actions authorized by BOEM and enforced by BSEE in the Leased Area, onshore activities would be subject to permits, authorizations, conditions, stipulations, and best management practices (BMPs) as recommended or required by the appropriate land-based resource and management agencies such as the USACE and BLM. We anticipate BOEM and BSEE will be involved in analyzing authorizations in the terrestrial environment resulting from LS 193 to ensure mitigation measures are included.

5.4.1.3 Collisions and Disorientation

As during the first incremental step, listed eiders may be disoriented and drawn to artificial lighting of MODUs and vessels, particularly during migration, thus increasing collision risk; platforms would pose a collision risk not present during the first incremental step, and the number of structures and vessels would be greater. Location and timing of vessel and drilling structure operations would also influence collision risk.

We expect that when listed eiders collide with infrastructure, they suffer severe injuries or death. We cannot directly estimate the number of collisions, but can indirectly estimate the methods described in the first incremental step; collision rates were estimated using observations from the 2012 Shell exploratory drilling operation in the Chukchi and Beaufort seas (with a 108-day duration) and eiders surveys on the North Slope. We assume collisions could occur over a 180-day period representing the open water season when MODUs, vessels, and listed eiders are present in the Chukchi Sea. Our calculations focus on activities in the Leased area, and we assume a similar collision rate for MODUs and platforms.

While encounters could occur throughout the entire projected project life, the highest offshore collision risk would occur when the highest number of MODUs, platforms, and vessels are operating. According to BOEM (2015) the highest level of activity could occur 1) during initial years of satellite field development; and 2) initial years of decommissioning. During the initial phases of satellite field development, 8 MODUs (and/or platforms) and 67 vessels could operate simultaneously; 11 MODUs (and/or platforms) and 65 vessels could operate simultaneously during initial phases of decommissioning. We estimated the number of spectacled and Alaska-breeding Steller's eiders that may collide with MODUs and vessels in the Chukchi Sea using the same method in the *Effects* of the first incremental step:

Spectacled eiders:

Satellite development:

For MODUs and platforms: ([8 MODUs and platforms x 0.018 spectacled eiders per MODU (or platform)] ÷ 108 days[10]) x 180[11] days = **0.24 spectacled eider collisions per season**

For vessels: ([67 vessels x 0.027 spectacled eiders per vessel] ÷ 108 days) x 180 days = **3.02 spectacled eider collisions per season**

Decommissioning:

For MODUs and platforms: ([11 MODUs and platforms x 0.018 spectacled eiders per MODU (or platform)] ÷ 108 days) x 180 days = **0.330 spectacled eider collisions per season**

For vessels: ([65 vessels x 0.027 spectacled eiders per vessel] ÷ 108 days) x 180 days = **2.93 spectacled eider collisions per season**

Alaska-breeding Steller's eiders:

Satellite development:

For MODUs and platforms: ([8 MODUs and platforms x 0.00081 Steller's eider per MODU (or platform)] ÷ 108 days) x 180 days = **0.012 Steller's eider collision per season**

For vessels: ([67 vessels x 0.0012 Steller's eider per MODU] ÷ 108 days) x 180 days = **0.134 Steller's eider collision per season**

Decommissioning:

For MODUs and platforms: ([11 MODUs and platforms 0.00081 Steller's eider per MODU (or platform)] ÷ 108 days) x 180 days = **0.0149 Steller's eider collision per season**

For vessels: ([65 vessels x 0.0012 Steller's eider per MODU] ÷ 108 days) x 180 days = **0.130 Steller's eider collision per season**

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[10] Length of the 2012 Shell exploratory drilling operation in the Chukchi and Beaufort seas

[11] Estimated overlap of listed eiders and offshore infrastructure in the Chukchi Sea when most collisions may occur

Our estimates indicate about three to four spectacled and fewer than one Alaska-breeding Steller's eider could collide with offshore infrastructure and vessels each season during initial development of the satellite field and initial phases of decommissioning. The presence of structures and vessels will persist for decades, with collisions occurring less frequently during other development and production phases.

In the *Effects* section for the first incremental step, we listed several biases inherent in estimated collision estimates that are also relevant here. Additional biases during future incremental steps include: 1) we assumed the same collision rate for MODUs and platforms, which may not be accurate; 2) listed eider collision rates with vessels could be higher during nearshore pipeline installation than during drilling in the Leased Area because eiders generally migrate closer to shore than in the Leased Area; 3) listed eiders may also collide with onshore structures. The frequency of collisions would depend on the distance of infrastructure from the coast; and 4) bird disorientation could also occur during gas production operations during a loss of control (flaring) or during normal operations when a small amount of natural gas is released. Some migrating birds may become disoriented by light produced during these conditions, especially during darkness or inclement weather, and collide with the platform structure. Data collected during exploratory drilling may improve our ability to estimate collision rates during future incremental steps. These estimates, however, are based on the best information available.

Mitigation measures – As discussed during the effects analysis of the first incremental step, mitigation measures may also lower collision injury and mortality, although the effectiveness of these measures is unclear. Mitigation measures were implemented during Shell's 2012 drilling, and while no listed eider collisions between vessels or MODUs occurred, collisions between other seaducks (BOEM 2015a) and vessels and MODUs indicate such encounters with listed eiders are possible.

Because the most recent population estimate for North Slope-breeding spectacled eiders is 12,916 (10,942–14,890, 95% CI), and 576 (292-859, 90% CI) for Steller's eiders, we would not anticipate population-level effects from an annual collision loss during future incremental steps of approximately four spectacled and fewer than one Steller's eiders.

5.4.1.4 Increased Predation

We expect onshore structures associated with the Proposed Action to increase the number of potential nesting and perching sites for ravens and increase availability of anthropogenic food and nesting/denning (e.g., for foxes) resources for predators. The effects of predation on listed eider reproduction, however, are extremely uncertain, and we are unable to estimate effects in the Action Area with reliability.

5.4.1.5 Accidental Shootings

Prior to the listing of Alaska-breeding Steller's and spectacled eiders under the ESA, some level of subsistence harvest of these species occurred across the North Slope (Braund et al. 1993). Harvest continues despite prohibitions against taking these species. New development could increase access to currently remote areas, increasing risk. Construction of most infrastructure will occur in areas where listed eiders occur in low densities (i.e., the proposed gas pipeline road would most likely be built south of where most listed eiders breed). Accidental shootings of

Steller's eiders, however, could occur if new development allows increased access to new hunting areas near Barrow. The shooting of adults, especially breeding females, could slow the survival and recovery of this species, as the recovery of this species would require increasing the numbers breeding adults, especially females.

Mitigation measures – Infrastructure features designed to prevent ravens from building nests and foxes from denning and measures that minimize access to anthropogenic sources of food and nesting material could minimize the impact of increased predator populations on listed eiders. Successful implementation of such measures, however, is difficult. For example, a lease stipulation requiring new infrastructure to avoid the artificial enhancement of predator populations for the Liberty project has been largely unsuccessful at preventing ravens from nesting there (e.g., May 2014). While implementation and enforcement of a lease stipulation that specifically addresses waste management and infrastructure design could reduce effects of increased predator populations, new infrastructure could provide new predator habitat or other resources.

5.4.1.6 Authorized Discharges

Toxic contamination from disposal of drilling muds and cuttings could potentially occur. However, given that only a small fraction of listed eider prey base would likely be affected by a relatively small project footprint, the Service anticipates only minor impacts would occur. At this time BOEM is uncertain if drilling muds would be disposed of at sea or barged for treatment at an onshore landfarm, but disposal on land could further minimize toxin exposure in the marine environment because we would not expect listed eiders to contact drilling wastes at onshore facilities.

5.4.1.7 Small Spills

Although small spills are likely to occur in future incremental steps, we do not expect listed eiders would be significantly affected. Based on recovery rates from small spills in the Beaufort and Chukchi seas to date, small spills are expected to be of very low volumes, and the oil is likely to evaporate, weather, or be almost entirely recovered prior to listed eiders contacting it (BOEM 2015b). Therefore, even if a small spill reaches the marine environment, there is a low likelihood these species would be affected. Accordingly, based on BOEM's oil spill risk analysis, the low volume and small area expected to be impacted by small spills, and the sparse distribution of listed eiders over much of the Action Area, we anticipate that adverse impacts to listed eiders from small oil spills are not likely to occur during future incremental steps.

5.4.2 Ledyard Bay Critical Habitat Unit – Future Incremental Steps

5.4.2.1 Effects to PCEs

Vessel and aircraft restrictions stated within BOEM and BSEE's Stipulation 7 regarding access to LBCHU (BOEM 2015a) relate only to exploratory and delineation drilling operations. Thus, vessels (barges and support vessels) and aircraft (fixed-wing and helicopters) could transport materials and personnel to onshore and offshore facilities during future incremental steps through LBCHU, and pipelines could transect the LBCHU. We expect vessels to minimally affect, and aircraft to have no effect, on PCEs. Pipelines would occupy relatively small portions of the LBCHU, minimally affecting the PCEs of marine waters greater than 5 m and equal to or less than 25 m and marine aquatic flora and fauna in the water column. Burying pipelines through the LBCHU would disturb the benthos and the PCE of the marine benthic community. Because the location of potential pipelines is unknown, the precise location and extent of disturbance to the benthic community is uncertain. However, effects to the benthic community would likely be short term, as benthos will likely recolonize the area (BOEM 2015a) and a relatively small portion of the benthos and LBCHU would be affected. Thus, we expect impacts of future incremental steps on PCEs to be temporary and have few long-term effects that would diminish the function and conservation value of the LBCHU for molting spectacled eiders.

5.4.2.2 Disturbance within the LBCHU

We previously analyzed impacts of disturbance on spectacled eiders; in this section we evaluate effects of preventing molting spectacled eiders access to PCEs within the LBCHU. While we expect minimal effects on PCEs, some activities could displace molting spectacled eiders from resource-rich areas. Because spectacled eiders use some areas of LBCHU more than others (Sexson 2015, Figure 4.1, Figure 4.2, Figure 4.3, and Figure 4.4), availability of PCEs would depend on the overlap between industry activities and areas used most frequently (that are presumably resource rich) by molting spectacled eiders. Depending upon the frequency of operations and routes traversed by vessels, aircraft, and pipelines, impacts on the PCE availability could range from negligible (if minimal traffic occurred within resource-rich areas) to substantial (vessels or aircraft repeatedly prevent large molting flocks of spectacled eiders from accessing PCEs in resource-rich areas). Displacement of molting spectacled eiders could last through decommissioning and would likely be greatest if pipelines transverse the LBCHU.

5.4.2.3 Authorized Discharges

Because no leases exist within the LBCHU, no drilling would occur there. Therefore, it is unlikely that an appreciable volume of drilling muds or cuttings discharged during drilling would reach the LBCHU. Discharges from drilling would result in the deposition of sediment that could affect flora and fauna in the water column and the underlying benthic community through toxicity. However, these effects would be localized and limited to the area surrounding wells, each of which would be at least 20 miles from the LBCHU. Furthermore, prevailing currents would likely carry discharged material in an easterly direction; away from the LBCHU. Therefore, significant adverse effects to PCEs from drilling discharges are not anticipated, and they are not expected to appreciably reduce the function and conservation value of the LBCHU for spectacled eiders.

5.4.2.4 Small Spills

Small spills projected to occur from the proposed Action are expected to be of very low volume and largely recoverable. Small spills could temporarily contaminate a very small area within the LBCHU boundary containing flora and fauna in the water column; although some oil from small spills could also contaminate the underlying benthic community, this is less likely than contamination within the water column. Spills would have to occur directly adjacent to or within the LBCHU for these effects to occur, and few activities are likely to occur in this area. Additionally, effects of such contamination would be minimized through oil evaporation, weathering, and recovery efforts. If small spills do occur the area affected would be small, and most of the spilled oil would evaporate, weather, or would be recovered; therefore, we do not expect small spills would have long-term effects that would diminish the function and conservation value of the LBCHU for molting spectacled eiders.

5.4.2.5 Minimization Measures

BOEM would require mitigation measures during exploration of the satellite field to be followed during future incremental steps to minimize effects of disturbance on the availability of the LBCHU. Exact details of this mitigation would be developed when a project is proposed.

5.4.3 Polar Bears – Future Incremental Steps

As during in the first incremental step, impacts to polar bears during future incremental steps could occur primarily through on- and offshore disturbance, increased polar bear-human interactions, small oil spills, and habitat loss; the scale and frequency of these impacts, however, would be greater during future incremental steps.

The polar bear effects section for the first incremental step describes effects of 1) disturbance from aircraft, vessel traffic, seismic activity sources, onshore vehicle traffic, and human-polar bear interactions; 2) contact with spilled oil and other toxic substances; and 3) habitat loss in the terrestrial environment. As we also expect these impacts to result from actions taking place in future incremental steps, the analysis below focuses on additional impacts that could result from future incremental steps not expected to occur during the first incremental step. Due to an expected increase in polar bear impacts in the terrestrial environment, our analysis focuses on impacts on non-denning (transient) and denning polar bears onshore unless otherwise stated.

5.4.3.1 Effects on Non-denning Polar Bears

Possible habituation or conditioning to noise – Because onshore activities could occur for decades, polar bears near routine industrial noise may habituate to it and show less vigilance than bears not exposed to such stimuli. For example, during the ice-covered seasons of 2000–2001 and 2001–2002, active dens were found within 0.4 km and 0.8 km (0.25 mi and 0.5 mi) of remediation activities on Flaxman Island in the Beaufort Sea with no observed impact to the polar bears (Smith et al. 2007). Habituation to stimulus such as noise is generally considered to be positive because polar bears could experience less stress from industrial activity; however, it could also increase the risk of human-polar bear encounters.

Industry activities as attractants – Offshore oil and gas development during future incremental steps would lead to construction of permanent structures along the coast. Currently, developments in the nearshore environment account for a disproportionate number of the polar bear observations. To illustrate, Endicott, Liberty, Northstar, and Oooguruk in the Beaufort Sea accounted for 47% of the bear observations between 2005 and 2008 (182 of 390 sightings; 76 FR 47010). Because polar bears can be curious and permanent structures can provide habitat (e.g., for resting), oil and gas activities and structures could serve as attractants. In some cases, bears may benefit from the presence of infrastructure. For example, the two human-built causeways on the North Slope (the STP/West Dock Causeway and the Endicott Causeway) have been used by polar bears for resting, traveling, and other life functions (over approximately seven miles in length) since their construction in the 1980s. Such use of infrastructure by polar bears, however, could result in increased human – bear encounters that could, in turn, result in disturbance or the need to haze bears, which can occasionally cause injuries or vary rarely, death. Given that most human-polar bear interactions currently occur at nearshore infrastructure, activities occurring in future incremental steps along the coast could increase human-polar bear interactions above current levels. Stranding of polar bears on shore due to melting sea ice could increase this potential. Thus, we expect adverse effects on polar bears to occur during future incremental steps.

Authorized Discharges – A total of 459 production and service wells would be drilled from production platforms over the life of the Proposed Action. Treated well cuttings and mud wastes from platform and subsea wells could be reinjected in disposal wells or barged to an onshore treatment and disposal facility located at the shorebase (e.g., treated at a landfarm). We do not expect drilling wastes disposed of in well or on the seafloor to affect polar bears. Wastes at landfarms, however, could affect polar bears if polar bears could come in contact with them in the terrestrial environment.

Mitigation measures – Most human-polar bear interactions involve transient polar bears and do not result in harm to polar bears. LOAs issued under the MMPA require operators to develop human-polar bear interaction plans and participate in onsite polar bear training. This training would educate field personnel about dangers and how safety procedures, including deterrence actions that minimize risk of negative outcomes (76 FR 13454). Effects of deterrence actions are described in more detail in the *Interrelated and Interdependent Effects* section below. We also expect shorebase plans would include measures to secure wastes, such as those at landfarms, such that they are not available to polar bears.

Although we expect adverse effects to non-denning polar bears to occur during future incremental steps, given 1) polar bears occur relatively infrequently in the Action Area; and 2) mitigation measures should prevent most human-polar bear interactions from resulting in harm to polar bears, we anticipate adverse effects to impact only a small proportion of the worldwide population and thus not cause population-level effects.

5.4.3.2 Effects on Denning Polar Bears

Development and production activities have potential to impact denning polar bears in marine and terrestrial environments, and we describe effects relevant to polar bears denning in either environment.

Industry infrastructure as attractants – Permanent structures could provide features attractive to polar bears. For example, the Staging Pad, an isolated, abandoned gravel pad approximately 7 km northeast of the Milne Point Central Processing Facility, is the most consistent location of polar bear denning on the North Slope; eight females denned on this human-built pad over a nine-year period. Bears have also successfully denned on a decommissioned exploration gravel pad on Cross Island and on the runway ramp at the Bullen Point Long Range Radar Site. Human occupied facilities could also be used for denning; in 2015, a gravel pit adjacent to the landfill in Prudhoe Bay was used as a denning site.

Effect of noise disturbance on denning bears – Female polar bears entering dens and those in dens with cubs are more sensitive than other bears to industry activities. Noise from oil and gas activities (stationary or mobile and on ice or on land) could disturb bears at den sites, and depending on the timing in the denning cycle, could affect the female bear and/or cubs. During the early stages of denning when the pregnant female has limited investment at the site, disturbance could cause her to abandon the site in search of an alternate site. At emergence, cubs are acclimating to their new environment, and the female bear is vigilant to protect her offspring. As a result, females with cubs-of-the-year may be more sensitive than other bears, and visual, acoustic, and olfactory stimuli may disturb the female to the point of abandoning the den site before the cubs are physiologically ready to move. For example, in 2006, a female and two cubs emerged from a den 400 meters from an active river crossing construction site. Three days later, the female abandoned the den site within hours of the cub emergence. In 2009, a female and two cubs emerged from a den site within 100 meters of an active ice road with heavy traffic and abandoned the site within three days. Females with cubs generally remain near the den site for three days to three weeks (C. Perham 2011, MMM, *pers. comm.*) prior to abandoning a den site. Such early den abandonment occurrences, however, are infrequent and isolated.

Oil and gas personnel occasionally encounter a previously undiscovered den. From 2002 through 2010, six previously unknown dens were encountered by oil and gas personnel. Once a den site is identified, personnel must report its location to the Service, and mitigation measures to protect the den described in polar bear interaction and response plans are implemented. For example, in the spring of 2011, a female bear emerged from a maternal den she had constructed in the bagged island armor of ENI's Spy Island Development. The island was not in use by industry when she initiated denning, but the den was discovered after personnel returned in the spring. In coordination with the Service, personnel temporarily left the island until the female emerged naturally with a cub and abandoned the den site (i.e., did not abandon early due to human disturbance). Thus, this female and cubs tolerated oil and gas activities for some time prior to emergence; implementation of an interaction plan most likely also minimized effects on these denning bears.

The oil and gas industry develops interaction plans and receives training in association with LOAs, and known polar bear dens around oil and gas activities, discovered opportunistically or from planned surveys, are monitored by the Service. These sites are only a small percentage of the total active polar bear dens in any given year, and LOAs issued to the oil and gas industry and polar bear interaction plans specify procedures to be followed when a bear or a bear with cubs are encountered. At that time, mitigation, such as activity shutdowns near the den and 24-hour monitoring of the den site may be implemented limiting human-bear interactions, thereby allowing the female bear to naturally abandon the den and minimize impacts to the animals. We expect that by working closely with the Service, these interaction plans and training would minimize disturbance to denning bears. For example, in the spring of 2010, an active den site was observed approximately 60 meters from a heavily used ice road. A one-mile exclusion zone was established around the den, closing a two-mile portion of the road. Monitors were assigned to observe bear activity and monitor human activity to minimize any other impacts to the bear group. These mitigation efforts minimized disturbance to the bears and allowed them to naturally abandon the den site. We expect similar mitigation methods to be used during the future incremental steps, and expect these measures to have similar effectiveness at minimizing disturbance.

Impacts of mobile sources of disturbance on denning bears – Mobile sources include vessel and aircraft traffic, ice road construction and associated vehicle traffic, including tracked vehicles and snowmobiles. Additionally, if development were to occur in the Chukchi Sea, BOEM anticipates construction of a road and pipelines to connect with existing infrastructure. Because disturbance from traffic on the road would be frequent, continuous, and confined to the road corridor, we assume denning females will either avoid the area or become habituated (Smith et al. 2007) to this source of disturbance and not suffer adverse effects during denning. Although vehicles on ice or land could hypothetically travel over dens causing them to collapse, this is unlikely to occur because oil and gas personnel routinely coordinate with the Service to determine where their activities are relative to known dens and denning habitat. LOA provisions require oil and gas personnel to avoid known polar bear dens by one mile and often require personnel to search for potential denning habitat using den detection techniques, such as Forward-looking Infrared (FLIR) technology. Similar provisions would likely be enacted during the future incremental steps to minimize the chance that oil and gas activities cause the destruction of dens or early den abandonment.

Denning bears may also abandon or depart their dens early in response to repeated noise produced by extensive aircraft overflights. Mitigation measures, such as minimum flight elevations over polar bears or areas of concern and flight restrictions around known polar bear dens, will be likely be required in LOAs or other MMPA authorizations, as appropriate, to reduce the likelihood that bears are disturbed by aircraft.

Given that 1) polar bears den in low densities across the Action Area; and 2) mitigation measures should prevent most adverse effects to polar bears from occurring, we anticipate infrequent adverse effects to the worldwide population of polar bears that would not result in population-level effects.

5.4.3.3 Terrestrial Denning Habitat Loss

Some terrestrial denning habitat could occur through gravel mining and construction or expansion of infrastructure, including a pipeline landfall, shorebase, road, and possibly other infrastructure; denning habitat, however, does not limit population size (C. Perham, pers. comm. in USFWS 2008). Therefore, the amount of terrestrial denning habitat lost in the action area would likely have a small impact on denning polar bears.

5.4.3.4 Small Spills

As noted in the *Effects* section for the first incremental step, due to the temporary nature of impacts from spill response activities, the small scale of these impacts, the relatively low density of polar bears in the action area, and displacement of polar bears from spill sites due to localized disturbance from spill response activities, any effects to polar bears resulting from a small spill would likely be minor.

5.4.4 Interrelated and Interdependent Effects – All Species and Critical Habitat

Polar bear deterrence – As discussed in the *Effects* section for polar bears in the first incremental step, deterrence activities are not part of the proposed Action, but polar bears could ultimately be subject to hazing; thus, we consider hazing to be an interrelated action to the proposed Action. Hazing would most likely occur onshore, by ice management vessels, and on the ice. Polar bears could experience temporary disturbance and stress from some of these actions (e.g., from acoustical devices, moving vehicles, spotlights) and could walk, run or swim away. For healthy bears, any stress they experience from this activity would likely be short term; bears that have walked or swam long distances could experience longer periods of stress and could need to rest elsewhere prior to resuming normal activities such as feeding. Bears that are deterred using more aggressive methods (e.g., "contact rounds" such as bean bags and rubber bullets), would likely experience stress, pain and could be bruised. In August 2011, one polar bear was accidentally killed during a deterrence event due to mistaking a firecracker round with a bean bag round. Such outcomes are extremely rare (no bears were killed during oil and gas activities from 1993 until this event).

From 2006 through 2010, the oil and gas industry working in the Beaufort Sea and adjacent coastal areas reported sightings of 1,414 polar bears, of which 209 (15%) were intentionally harassed or deterred (C. Perham, *pers. comm.*, email, July 12, 2011). Annually, the percent of total bears sighted that were deterred ranged from ranged from 9% in 2010 to 43% in 2006, with an average of 15%. For the purposes of this BO, we expect that with increased development, the number of bears deterred annually during the EDS would increase. If polar bears become stranded in the nearshore/coastal environment due to melting sea ice from climate change, the number of deterrence events could increase further. In the majority of deterrence events, contact rounds will not be used, and we expect that most of these deterrence events would cause only minor, temporary behavioral changes (e.g., causing the bear to depart the area).

Increased community development – Increased oil and gas development near coastal villages may increase housing and other community infrastructure needs, which could lead to additional excavation and fill of tundra habitat and development of communication utilities such as powerlines. Excavation and fill of tundra could destroy breeding habitat, and powerlines could pose a collision risk for listed eiders. Associated with such development is a potential increase in human-caused disturbance and predator populations (e.g., ravens and foxes) that could negatively impact nesting efforts of listed eiders. Lost breeding and brood-rearing habitat due to increased development near Barrow could potentially cause population-level effects on Alaska-breeding Steller's eiders. Thus, oil and gas development could adversely affect listed eiders by increasing potential for further community development.

An increase in community infrastructure could result in increased human-polar bear interactions with community residents. Increased human-polar bear interactions in and around villages would pose safety concerns for humans and bears alike, and polar bears that approach these communities could potentially be subject to increased subsistence harvest. Given, however, existing polar bear detection and deterrence measures employed by community residents and the North Slope Borough Department of Wildlife Management, we expect the increased risk increase of polar bear interactions with community residents to be minimal.

Furthermore, the U.S. manages subsistence harvest of polar bears through international, bi-lateral, and user-to-user agreements. The signing of the *Multilateral Agreement on the Conservation of Polar Bears* in 1973 (Multilateral Agreement) pledged action to protect polar bear habitat and a commitment to manage polar bear populations in accordance with sound conservation practices based on the best available scientific data. Sustainable harvest levels are set by the Inuvialuit-Inupiat (I-I) Council (Canada-Alaska) and the U.S.-Russia Polar Bear Commission (Commission) for the Southern Beaufort Sea and Alaska-Chukotka polar bear populations, respectively. Additionally, reporting requirements under the MMPA's marking and tagging program require all harvested polar bears be tagged by a representative of the Service to monitor subsistence harvest and control illegal hunting, trade, and transport of marine mammal parts. Given (1) the low density of polar bears in the action area; (2) provisions included in the Multilateral Agreement; and (3) MMPA reporting requirements, we expect increased subsistence harvest of polar bears in the action area would be low, and population-level effects from increased harvest as a result increased human activity associated with future incremental steps are not anticipated.

Increased U.S. Coast Guard presence – We expect that U.S. Coast Guard (USCG) operations will increase with increasing industry vessel traffic in the Chukchi Sea. USCG vessels could encounter listed eiders and polar bears and could affect listed species in a manner similar to industry. The impact from a few USCG operations, however, would be relatively small compared to industry operations.

5.4.5 Summary: Future Incremental Steps

Actions occurring during future incremental steps and their associated interrelated and interdependent effects will likely adversely affect spectacled eiders and polar bears; but, given the current status and environmental baseline of these species and the relatively few individuals affected compared to the size of the listed spectacled eider and polar bear populations, we do not anticipate these adverse effects would cause population-level declines.

Actions occurring during future incremental steps and their associated interrelated and interdependent effects may adversely affect Alaska-breeding Steller's eiders. Given the current status and environmental baseline of this species (i.e., including anticipated community development projects) and what is proposed in future incremental steps, population-level declines could potentially result. Shorebase construction at Barrow could lead to a significant increase in habitat loss, disturbance, collisions, and accidental shootings in important habitat for Alaska-breeding Steller's eiders, possibly with population-level consequences.

Uncertainty from a variety of factors complicated this effects analysis. The range of possible effects on listed species is large because of uncertainty regarding what may actually occur during future incremental steps. Additionally, the status of species will likely change (e.g., from effects of other development projects and climate change habitat alterations) before all future incremental steps occur; if population sizes change or species alter when or how they use the Action Area, the potential effects of development and production could differ from the analysis above.

5.5 Large Oil Spills

BOEM and BSEE define large spills as those at least 1,000 barrels in volume and larger. The large oil spill scenario (BOEM 2015b) has many components aimed at assessing the likelihood and number of spills that could occur based on their sources and sizes (Table 5.1), and the likelihood that oil reaches important resources. Using this information, we assessed the likelihood of adverse and population-level effects to listed species and designated critical habitat. We begin by describing components of the spill scenario and the Oil-Spill Risk Analysis (OSRA; BOEM 2015b) considered relevant to analyzing potential effects to listed species:

- Sources of spills;
- Types of oils
- Likelihood of spills by size category;
- Median OCS spill sizes for platforms and pipelines;

- Conditional probabilities (i.e., the chance a large oil spill would reach resources important to listed species assuming a spill occurs); and
- Combined probabilities (i.e. the chance of one or more large spills occurring and contacting a particular resource over the life of the EDS).

An analysis of possible effects to listed species and designated critical habitat from large oil spills, including effects of disturbance during cleanup activities, follows. We then provide a summary of effects, including a discussion regarding uncertainty of the analysis.

Estimating large oil-spill occurrence or contact with resources important to listed species while they are present in the Action Area is an exercise in mathematical probability. Uncertainty exists regarding whether exploration or development will occur at all, and if it does, the location, number, and size of potential large oil spill(s) and the wind, ice, and current conditions at the time of a spill(s). Although some uncertainty reflects incomplete or imperfect data, a considerable amount of uncertainty exists simply because it is difficult to predict events 15-77 years into the future.

Table 5.1. Generalized size, type, and timing of spills. From BOEM (2015b).

Spill Size	Spill Type	Assumed Potential to Occur in Activity Phase
Small	Refined	Geological and Geophysical Surveys and Exploration Drilling; Exploration Ends: Year 28
Small	Refined	Development, Production and Decommissioning
Small	Crude or Condensate	Oil Development and Production; Oil Production Ends: Year 53
Large	Crude or Condensate	Oil Development and Production; Oil Production Ends Year 53
Large	Diesel	Oil and Gas Development and Production; Gas Production Ends: Year 74
	Gas Release	Gas Production Starts Year 31; Gas Production; Gas Production Ends: Year 74
Activity Phase Through Time		*Exploration (Years 1-5)*; *Exploration and Development (Years 6-9)*; *Exploration, Development and Production (Years 10-25)*; *Development and Production (Years 26-50)*; *Production Decommissioning (and Years 51-77)*

5.5.1 The Chance of a Large Spill from Exploration and Delineation Drilling Activities – First and Future Incremental Steps

Although diesel fuel spills are possible, large spills would most likely be in the form of crude or condensate oil whose sources are wells, storage tanks on platforms, and pipelines (Table 5.1). Because industry does not store large volumes of crude or condensate oil or construct pipelines during the first incremental step, large crude or condensate oil spills from storage tanks on drilling platforms and pipelines could occur only in future incremental steps (BOEM 2015b). No large crude or diesel oil spills are estimated from exploration and delineation drilling wells. This is based on BOEM's and BSEE's review of potential discharges, historical oil spill and modeling data, and the likelihood of oil spill occurrence. This estimate is based on:

- The low rate of OCS exploratory drilling well-control incidents spilling crude oil per well drilled;
- Since 1971, one OCS crude oil spill (large/very large) has occurred during temporary abandonment (converting an exploration well to a development well) while more than 15,000 exploratory wells were also drilled;
- The low number (40) of exploration wells being drilled as a result of this proposed action;
- No crude oil would be produced from the exploration wells, and the wells would be permanently plugged and abandoned;
- The history of exploration spills on the Arctic OCS, all of which have been small;
- No large spills occurred while drilling 35 exploration wells to depth in the Arctic OCS 1975-2003; and
- Pollution prevention and oil spill response regulations and methods, implemented by BOEM, BSEE, and operators and since the Deepwater Horizon spill have reduced the risk of spills and diminished their potential severity (BOEM 2011, Visser 2011).

The remote possibility exists, however, that a loss of well control (LOWC; as defined by 30 CFR 250.188(3)) followed by a long-duration flow could occur during exploration. Therefore, it is possible, although very unlikely, for this type of event to result in a large oil spill during first and future incremental steps. BOEM and BSEE analyzed the potential impacts of a very large oil spill (VLOS; a spill of ≥150,000 barrels) for the purposes of evaluating a low-probability, high-impact event in the Leased Area (BOEM 2015b). According to BOEM and BSEE, a large OCS oil spill from a LOWC followed by an uncontrolled flow event is extremely rare (10^{-4}- 10^{-5}/well), and such spills rarely reach large spill volumes. Thus, BOEM and BSEE estimate that a large spill, including one from a LOWC, is extremely unlikely to occur from exploration and delineation wells during first or future incremental steps because the spill frequency from LOWCs is extremely low (Bercha 2014a).

5.5.2 Fate of a Very Large Oil Spill from a Loss of Well Control

BOEM (2015b) estimated the fate of oil spilled from a long duration LOWC that caused a spill to cumulatively reach the VLOS volume. In the LOWC scenario, BOEM (2015b) used a discharge model that estimated the highest possible uncontrolled flow rate that could occur within known prospects in Lease Sale 193 area. Oil would flow from a well for 74 days, the estimated time required for a second drilling platform to arrive and drill a relief well. The initial oil discharge is projected to be more than 61,000 barrels/day during Day 1 and is projected to decrease to 20,479 barrels/day by Day 74. The total oil discharged by Day 74 would be

2,160,200 barrels. A cumulative volume of 2.2 million barrels was used for purposes of analysis, and oil removed through response efforts was not considered to estimate this volume. The fate of oil spilled is described below.

In the extremely unlikely event that a VLOS were to occur, BOEM estimates about 10-40% of oil would be recovered or reduced (burned, chemically dispersed, and skimmed), 25-40% would be naturally dispersed, evaporated, or dissolved, and about 20-65% would remain offshore until biodegraded or until it reached shore (Wolfe et al. 1994, Gundlach and Boehm 1981, Gundlach et al. 1983, Lubchenco et al. 2010 cited in BOEM 2015b). A VLOS would likely spread hundreds of square miles (BOEM 2015b). For planning purposes, USCG estimates 5–30% of oil will reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2 cited in BOEM (2015b)).

The probability that a LOWC would occur is extremely low and therefore not reasonably certain to occur. We therefore do not consider a LOWC or a resulting VLOS as an indirect effect of the proposed Action. If, however, such a rare event were to occur, impacts to listed species and critical habitat could be significant, with the severity of impacts depending on the location, timing, and volume of oil spilled.

5.5.3 The Chance of One or More Large Oil Spills Occurring from Platforms and Pipelines – Future Incremental Steps Only

Large spill rates are based on the estimated mean number of large spills per billion barrels of hydrocarbon produced (Table 5.2; BOEM 2015b). BOEM (2015b) assumes 4.3 billion barrels of oil would be produced and transported by pipelines and therefore estimates 0.9 pipeline spills and 0.5 platform/well spills would occur, for a total of 1.4 spills over the life of the Leased Area. Additionally, based on the mean spill number BOEM estimates the percent chance of one or more large platform/well and pipeline spills as 39% and 59%, respectively, and estimates the chance of one or more large spills occurring from these combined sources as 75% over the estimated 51 years of development and production (BOEM 2015b, Figure 5.1).

Table 5.2. Mean spill rate for platforms/wells, pipelines, and the total with 95% confidence interval (in parentheses) as calculated by Bercha Group, Inc. (2014b). From BOEM 2015b).

Type	Mean spills/billion barrels produced
Platforms/wells	0.11
Pipelines	0.21
Total	**0.32 (0.12-0.56)**

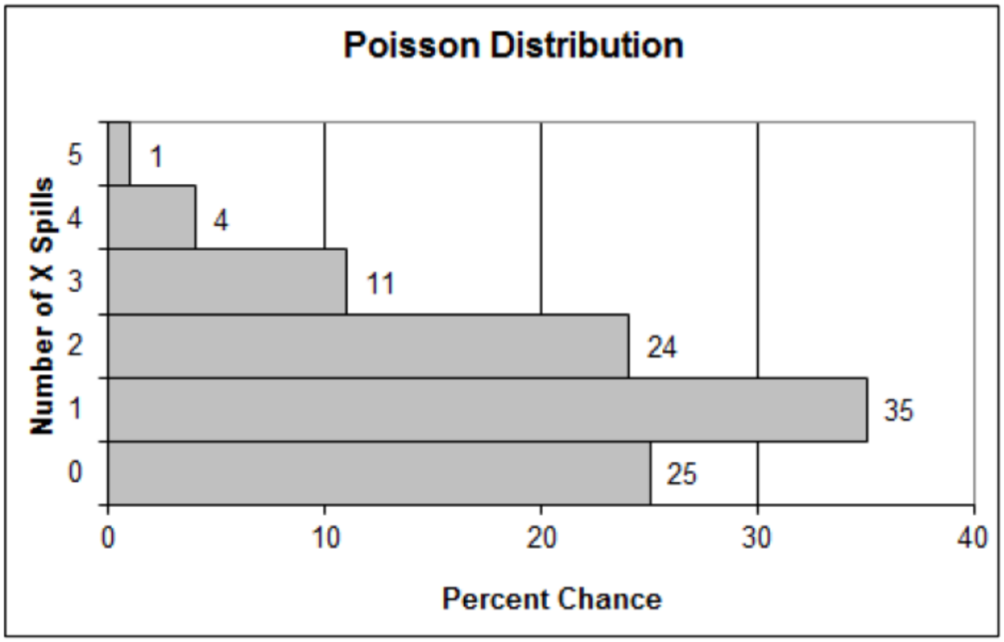

Figure 5.1. Poisson distribution for the percent chance of one or more large spills occurring from pipelines and platforms over the EDS life. From BOEM (2015b).

5.5.4 BOEM's Estimated Marine Crude Oil Spill Volumes, Future Incremental Steps

The large spill-size assumptions BOEM and BSEE used are based on reported spills in the Gulf of Mexico and Pacific OCS because no large spills have occurred in the Alaska OCS from oil and gas activities (BOEM 2015b). The median size of a large crude oil spill from a pipeline on the OCS over the last 15 years is 1,720 barrels, and the average is 2,771 barrels (Anderson et al. 2012 cited in BOEM 2015b). The median large crude oil spill size from a platform on the OCS over the entire record from 1964-2010 is 5,066 barrels, and the average is 395,500 barrels (Anderson et al. 2012 cited in BOEM 2015b). Median volumes, rounded to the nearest hundred, were used by BOEM and BSEE to determine the size of large spills analyzed in oil spill weathering (fate) models. The potential types of oil spilled from platform s are assumed to be crude oil, natural gas liquid condensate, or diesel oil.

5.5.4.1 Fate of a Large Platform Crude Spill

If a 5,100-barrel crude oil platform spill were to occur in summer for a given set of environmental conditions, after 30 days 44% would remain (after weathering [dispersion and evaporation]) in the environment (BOEM 2015b). The spill would cover approximately 1,063 km^2 of discontinuous area, oiling an estimated 44 km of coastline (BOEM 2015b). Thirty days after meltout, the remaining 53% (after weathering) of a 5,100-barrel winter crude oil spill from a platform would cover 351 km^2 of discontinuous area, oiling an estimated 54 km of coastline (BOEM 2015b).

5.5.4.2 Fate of a Large Pipeline Crude Spill

If a 1,700-barrel pipeline spill were to occur in summer, after 30 days 44% would remain (after weathering) in the environment (BOEM 2015b). The spill would cover approximately 615 km^2 of discontinuous area, oiling an estimated 26 km of coastline (BOEM 2015b). Thirty days after meltout, the remaining (after weathering) 53% of a 1,700-barrel winter crude oil spill from a pipeline would cover 200 km^2 of discontinuous area, oiling an estimated 32 km of coastline (BOEM 2015b).

5.5.5 Conditional Probabilities

The chance that a large oil spill will contact a specific environmental resource area (ERA) within a given time of travel from a launch area (LA) or pipeline segment (PL) is termed a conditional probability, where the condition is that a large spill occurs (

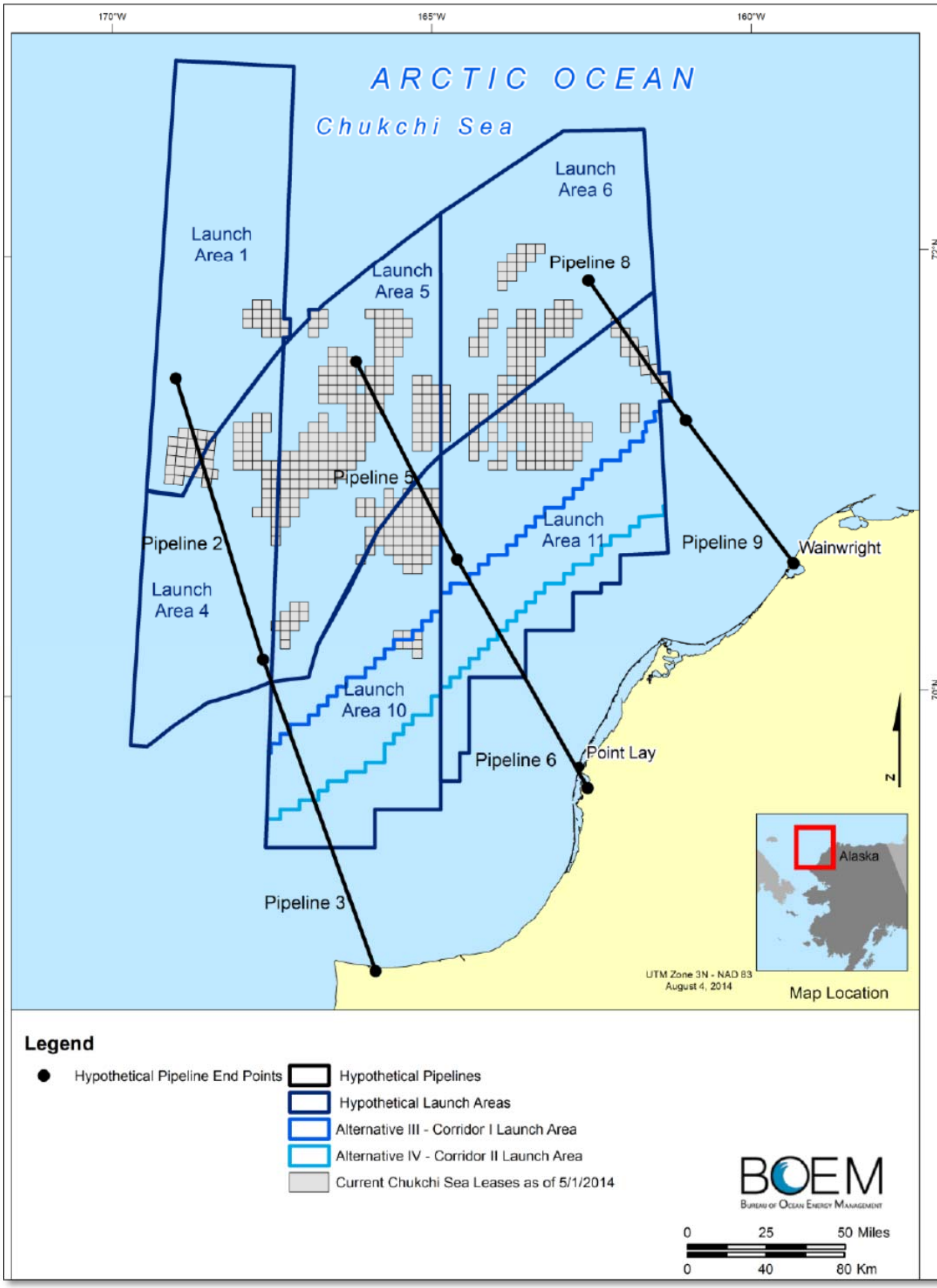

Figure 5.2. Hypothetical launch areas (LAs) and pipeline segments (PLs) used in the oil spill trajectory analysis. From BOEM (2015b).Figure 5.2). Conditional probabilities, expressed as a

percent chance, are reported for three seasons (annual, summer, and winter) and six time periods (3, 10, 30, 60, 180, and 360 days). This portion the OSRA assumes no clean up response and no containment.

ERAs of greatest interest to this consultation are those representing areas important to listed eiders (Figure 5.3). Most telemetered spectacled eiders (Sexson et al. 2014, Sexson 2015) were observed within areas represented by ERAs 2, 10, 19, and 65 during spring and autumn migration during the months specified for these ERAs (May through October; Figure 5.3). While ERAs 1 and 64 (May through October; Figure 5.3) represent habitats used by Alaska-breeding Steller's eiders, we assume Alaska-breeding Steller's eiders can also use ERAs 10 and 19 from May through October.

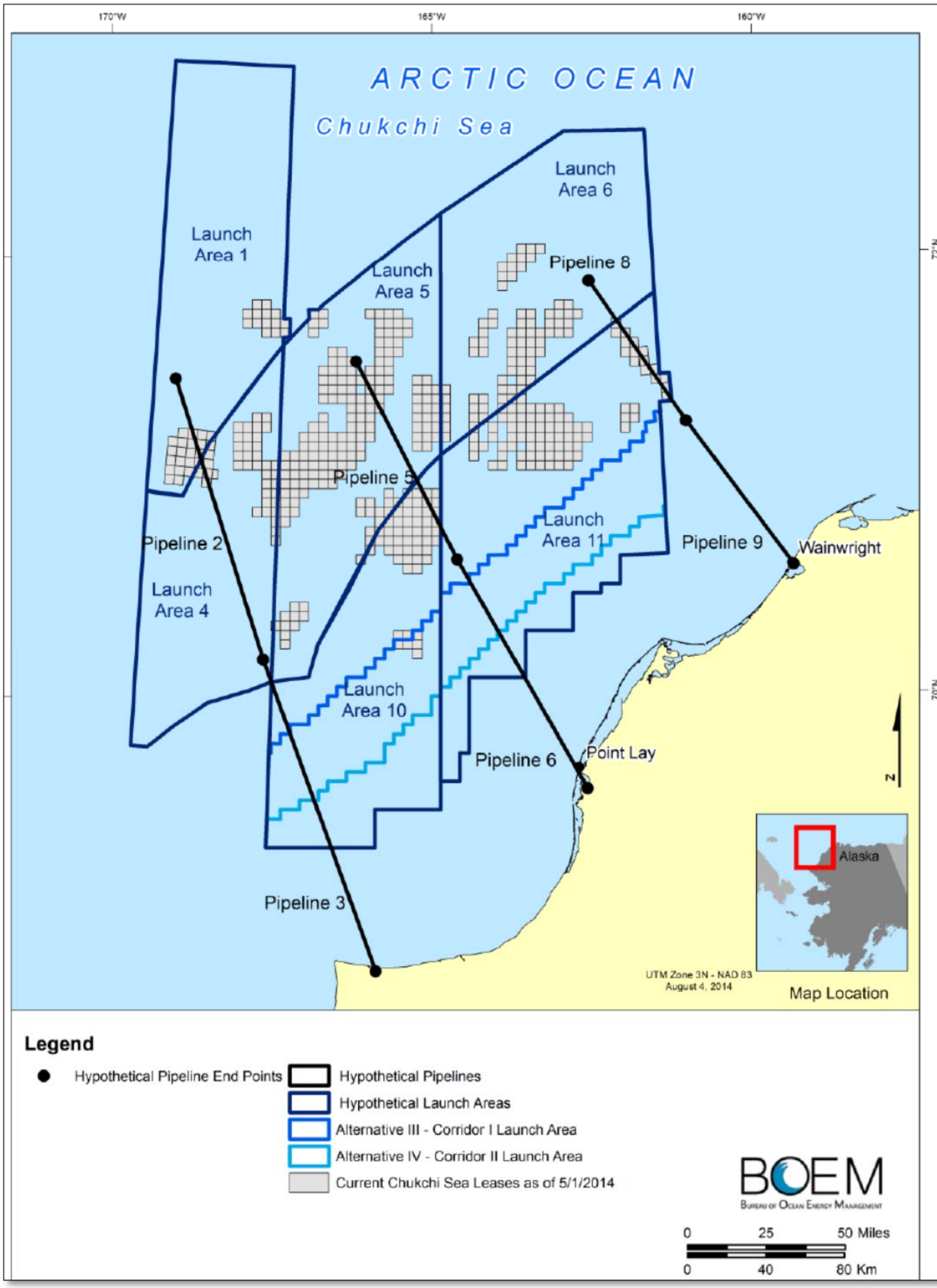

Figure 5.2. Hypothetical launch areas (LAs) and pipeline segments (PLs) used in the oil spill trajectory analysis. From BOEM (2015b).

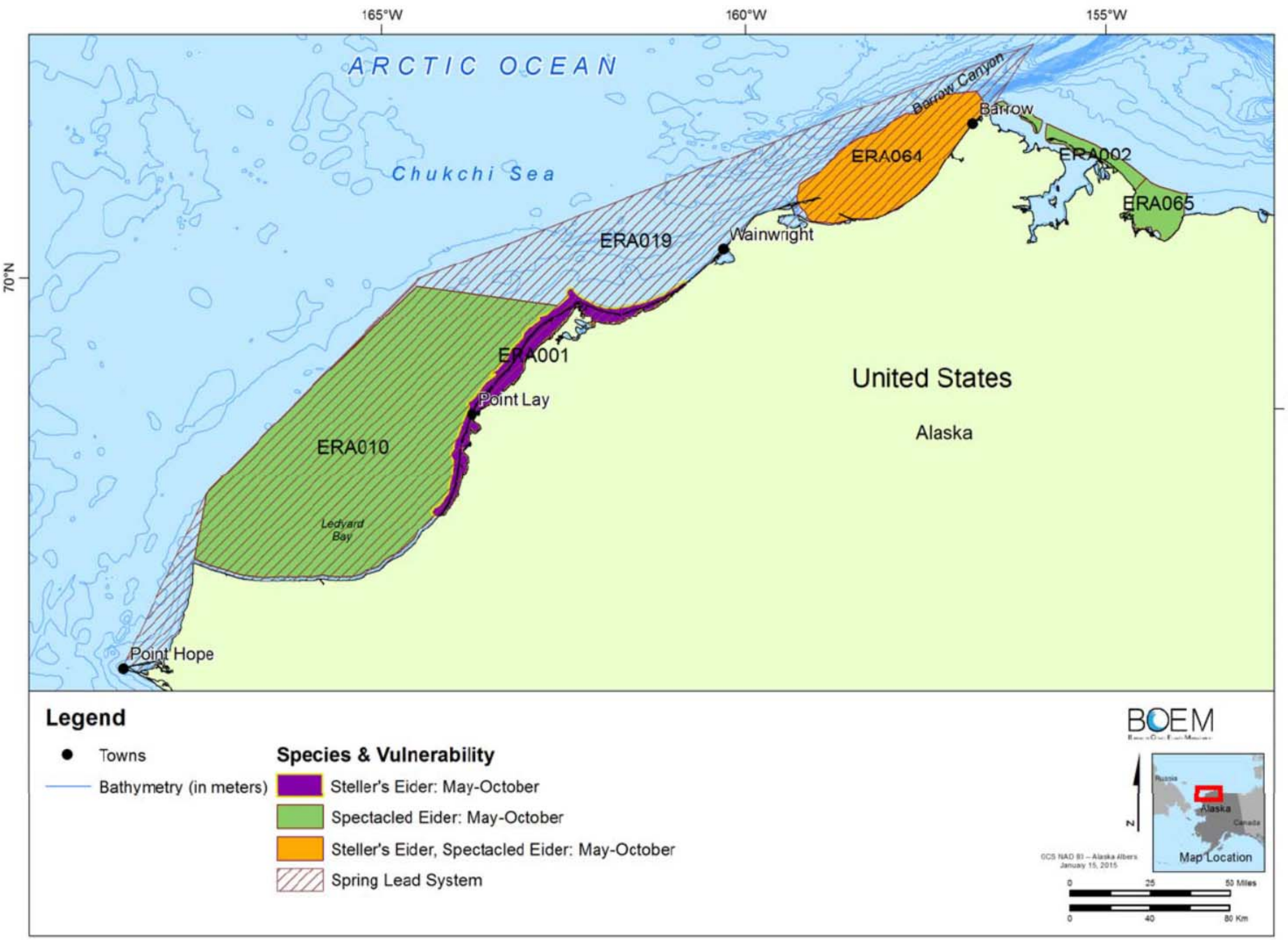

Figure 5.3. ERAs important to listed eiders. From BOEM (2015b).

Polar bears can occur in many areas represented by offshore ERAs and shoreline segments in the OSRA. Because polar bears can occur over a very broad area, we do not focus our discussion on specific ERAs or shoreline segments and do not present information for them in this BO; we instead discuss possible adverse and population-level effects given oil spill size, timing, and location.

5.5.6 Combined Probabilities

Combined probabilities are the chance of one or more large spills occurring and contacting a particular environmental resource area over the life of the EDS. They are estimated using matrix multiplication of the variables: large oil-spill rates, conditional probabilities, and resource estimates (e.g., estimated billions of barrels of oil produced), and transportation scenarios (e.g., hypothetical pipeline lengths). Combined probabilities are expressed as a percent chance of one or more large spills occurring and contacting a resource and the estimated mean number of spills occurring over the assumed life of the EDS. The ERAs of interest for the combined analysis are presented in Figure 5.2, and we do not present ERA information for polar bears.

5.5.6.1 Cleanup Activities – First and Future Incremental Steps

Cleanup activities would likely take place if a large spill occurred. Activities could include vessel and aircraft operations, in-situ burning, animal rescue, use of dispersants, booming, beach cleaning, drilling of a relief well, and bioremediation (BOEM 2015b). It is difficult to say how effective cleanup efforts would be at removing oil from the environment. Based on clean-up activities with the Exxon Valdez Oil Spill where only about 14% was recovered or disposed (Wolf et al. 1994), spill response may be largely unsuccessful in remote open water conditions, and spill response drills have had various levels of success in the cleanup of oil in broken-ice conditions (Dickens 2011). The duration of cleanup activities for a large spill would depend on the timing and amount of oil spilled, but would likely last months or years.

5.5.7 Effects of Large Oil Spills -– First and Future Incremental Steps

Based on the OSRA (BOEM 2015b), a large spill is extremely unlikely to occur during the first incremental step because the only source of a large spill would be a LOWC from an exploration or delineation well followed by an uncontrolled flow event. Thus, we conclude that effects to listed species and designated critical habitat from a large spill, including a VLOS, are not reasonably expected to occur during the first incremental step and are thus discountable.

If a large spill were to occur from an exploration or delineation well, however, it could adversely affect listed species, and in rare circumstances could cause population-level effects. Critical habitat in the Action Area could also be adversely affected. The severity of these impacts would likely increase with spill volume. We previously described the general potential effects of oil on individuals in the *Small Spills* section of the first incremental step. Thus, our effects analysis below focuses on the potential for large spills, including a VLOS, to cause population-level impacts and incorporates conditional and combined probabilities from the OSRA regarding the chance that oil would reach areas important to listed species and designated critical habitat. We also describe effects of disturbance from cleanup activities on listed species and designated critical habitat.

5.5.7.1 Listed Eiders

A large oil spill has the potential to contact individuals of listed eiders and impact their habitat. Certain areas are of particular concern because of their importance to large numbers of these species. Marine waters along the Alaska Arctic coast support large numbers of listed eiders at specific times of the year, primarily May through October, with some individuals remaining into November (Sexson et al. 2014, Sexson 2015). Openings within the sea ice in spring (spring leads), including within Ledyard, Peard, and Smith bays, provide habitat for listed eiders as they migrate to breeding areas. These same water bodies provide molting or staging habitat as listed eiders migrate back to wintering areas in autumn. ERAs representing areas important to Alaska-breeding Steller's eiders are 1, 64, and 65; ERAs 10 and 19 are important to both listed eider species.

Although BOEM (2015b) presented information for other seasons, we focused our analysis on summer conditional probabilities because the timing represented by this analysis overlapped more with the timing of use of the Action Area by listed eiders. Depending on the origination of the spill and the number of days after a spill, summer conditional probabilities ranged from <0.5% to 59% (Table 5.3). In all cases, the highest percent chance that oil reached a given ERA originated from a nearshore pipeline segment (PL). For ERAs 1, 10, and 19, this was PL 6, which transects these ERAs. For ERAs 2 and 64, these were nearby PLs 8 and 9; oil spilled from PLs 8 and 9 both resulted in a 2% chance that oil reached ERA 2 and a 1% chance that oil reached ERA 65. These values are a mean of thousands of trajectories from several points along the hypothetical pipeline segment; values likely ranged from <0.5 to >99.5%, depending on whether the launch point was within, adjacent to, or far from an ERA. The likelihood that oil reached a given ERA increased little after about 30 days post spill (Table 5.3).

We provided a description of how oil could affect listed eiders in the *Effects* section of the first incremental step. The number of birds oiled, and thus the potential for population-level effects, would depend on many factors, including season of the spill, its distance from congregations of birds, oil type, and oil spill volume. For example, telemetered spectacled eiders were not evenly distributed throughout the LBCHU but instead tended to form clusters (e.g., Figure 4.2; Sexson 2015). Thus, impacts of a large spill could range from zero to large numbers of listed eiders affected. Spectacled eiders are vulnerable because large congregations spend about a month flightless while molting in Ledyard Bay. The Alaska-breeding population of Steller's eiders is vulnerable because of its low abundance; population-level impacts could result from the loss of as few as tens of breeding females.

Table 5.3. Range of summer conditional probabilities (expressed as percent chance) that a large oil spill, starting at Launch Areas or Pipeline Segments (Figure 5.2), would contact environmental resource areas (ERAs; numbers in parentheses) representing important listed eider habitat (Figure 5.3) within the stated number of days after a spill. From BOEM (2015b).

Environmental Resource Area	3 days	10 days	30 days	60 days	180 days	360 days
Kasegaluk Lagoon (1)	<0.5-11%	1-16%	1-19%	1-19%	1-19%	1-19%
Pt. Barrow, Plover Is. (2)	<0.5%	<0.5%	<0.5-2%	<0.5-2%	<0.5-2%	<0.5-2%
Ledyard Bay (10)	<0.5-54%	<0.5-57%	1-59%	2-59%	2-59%	2-59%
Spring Leads (19)	<0.5-12%	<0.5-14%	<0.5-15%	<0.5-15%	<0.5-15%	<0.5-15%
Peard Bay (64)	<0.5-18%	1-28%	5-34%	6-35%	6-35%	6-35%
Smith Bay (65)	<0.5%	<0.5%	<0.5%	<0.5-1%	<0.5-1%	<0.5-1%

Table 5.4. Combined probabilities (expressed as percent chance), over the assumed life of the Leased Area of one or more spills ≥1,000 barrels, and the estimated number of spills (mean), occurring and contacting a given ERA.

Environmental Resource Area	3 days	10 days	30 days	60 days	180 days	360 days
Kasegaluk Lagoon (1)	2% (0.2)	3% (03)	4% (0.05)	5% (0.05)	5% (0.05)	5% (0.05)
Pt. Barrow, Plover Is. (2)	<0.5%	<0.5%	<0.5%	1% (0.01)	1% (0.01)	1% (0.01)
Ledyard Bay (10)	11% (0.11)	13% (0.14)	14% (0.15)	15% (0.16)	15% (0.16)	15% (0.16)
Spring Leads (19)	6% (0.07)	9% (0.09)	11% (0.11)	11% (0.12)	12% (0.12)	12% (0.12)
Peard Bay (64)	1% (0.01)	4% (0.05)	8% (0.09)	9% (0.09)	9% (0.10)	9% (0.10)
Smith Bay (65)	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%	<0.5%

The spill scenario presented by BOEM estimated two large spills, which could occur from a platform or pipeline. The OSRA suggests that a large spill some distance away from ERAs important to listed eiders (i.e., from some LAs representing portions of the current Leased Area where platform spills could originate) is unlikely to reach these areas. Additionally, the chance of oil reaching these ERAs does not increase after about 30 days after the spill. If, however, oil reached these ERAs when significant numbers of listed eiders were present (e.g., if a leak occurred from a nearshore segment of pipeline during spring or autumn), numerous birds could be poisoned or killed from contact with oil. Based on the median spill size for pipelines (1,700 barrels) and combined probabilities (Table 5.4) presented by BOEM (2015b), adverse effects from oil spills are possible; but, we do not anticipate population-level declines to occur for listed eiders.

5.5.7.1.1 Cleanup Activities – Listed Eiders

Disturbance associated with cleanup activities, including capturing oiled birds, could further stress birds already compromised from contact with oil. Hazing birds away from oiled areas, however, may reduce the number of individuals contacting spilled oil. We expect that the potential effects from cleanup activities on listed eiders would increase with increasing spill volume and oil persistence. While a few individuals could experience disturbance, we would not expect population-level effects to occur from oil spill response efforts.

5.5.8 Spectacled Eider Critical Habitat: Ledyard Bay Unit

If a large spill occurred within or near the LBCHU, the spill could affect PCEs and the ability of spectacled eiders to use this area for the reasons it was designated. Spilled oil could contaminate or kill the flora and fauna that comprise PCEs important to molting spectacled eiders. ERA 10 (Table 5.3, Table 5.4) represents LBCHU. As described for listed eiders above, spills from nearshore pipeline segments have the greatest potential for affecting ERA 10. The scale and severity of effects would depend on the location, timing, and volume of the spill and could range from virtually no effects to significant effects if a large volume of oil reached the LBCHU during fall molt. Additionally, impacts from an oil spill may affect PCEs for multiple years. Therefore, the effects of a large oil spill could range from minor to those that severely affect the function and conservation role of PCEs intended for molting spectacled eiders.

The spill scenario presented by BOEM estimated two spills, which could occur from a platform or pipeline. The OSRA suggests that a large spill some distance away from ERA 10 (i.e., from some LAs representing portions of the current Leased Area where platform spills could originate) would likely not reach this ERA. If, however, oil did reach this ERA, spilled oil could adversely affect PCEs even when spectacled eiders are absent. It is possible that a large spill proximal to LBCHU could result in adverse effects to spectacled eider food resources. Based on the median spill sizes and combined probabilities (Table 5.4) presented by BOEM (2015b), oil spills could reach ERA 10; but, we do not anticipate long-term effects to PCEs. Although these effects could last more than one year, the affected PCEs would eventually recover and be capable of supporting spectacled eiders.

5.5.8.1 Cleanup Activities – LBCHU

Cleanup activities could reduce use of the LBCHU by causing disturbance and displacement of spectacled eiders from spill response vessels and aircraft. We would expect that the extent and severity of potential effects to the LBCHU from cleanup activities would increase with increasing spill volume, depending on location and timing of the spill. The effects of such disturbance and displacement would end once vessels and aircraft left the area. Thus, although oil spill response efforts could conceivably last one or more years, these efforts would likely be temporary and therefore would not significantly impact the PCEs and their ability to serve their conservation role.

5.5.9 Polar Bears

A large oil spill as modeled by BOEM and BSEE has the potential to contact polar bear habitat in the marine environment and along the coast and landfast ice in all seasons, and could result in persistent toxic subsurface oil and chronic exposure of bears to oil, even at sub-lethal levels. We previously presented how oil could affect polar bears exposed to oil in the *Effects* section of the first incremental step. Chronic exposure to oil could have long-term effects on individuals (Peterson et al. 2003). Long-term oil effects could be substantial to individuals affected through interactions between natural environmental stressors and compromised health of exposed animals, and through chronic, toxic exposure as a result of bioaccumulation. Polar bears are biological sinks for pollutants because they are the apical predator of the Arctic ecosystem and are also opportunistic scavengers of other marine mammals. Additionally, their diet is composed mostly of high-fat sealskin and blubber (Norstrom et al. 1988). Polar bears would therefore be susceptible to the effects of bioaccumulation of contaminants associated with spilled oil, which could affect the bears' reproduction, survival, and immune systems.

Polar bears are always present in the Action Area and therefore can be affected by platform and pipeline oil spills at any time. Mobile, non-denning (transient) bears would have a higher probability of encountering oil than non-mobile, denning females. The most significant impacts could occur if oil reached the coast and/or barrier islands during open-water and broken-ice periods (summer and autumn) because transient polar bears are most mobile (and are more likely to contact spilled oil) and can be concentrated in the nearshore environment (i.e., on barrier islands) during this period. Hence, if a spill occurred in autumn and oil reached the nearshore environment, bears concentrated on shore would likely be the most susceptible to oiling and thus injury or death; swimming bears and those on ice floes in the oil spill trajectory could also be affected. Transient polar bears can also contact oil during the ice-covered season because polar bears would have access to a larger proportion of the Action Area during this time. Transient bears, however, occur at very low densities across the Action Area; and, regardless of the season, few are likely to be impacted.

Population-level effects would likely increase with increasing spill volume and oil persistence in the environment. Location and timing of spills would also influence the extent of effects. Estimating the number of polar bears possibly oiled the Action Area is difficult because we do not have reliable population estimates for the Chukchi Sea portion of the Action Area; but, there is no data to indicate large aggregations of polar bears occur in the Chukchi Sea or along its coast.

Based on the OSRA and the sparse distribution of polar bears (low density over a large area, with only a few tens of bears congregating even in the highest density areas), we anticipate that if a large spill occurred, it is likely that few polar bears would be adversely affected. If a large spill were to reach an area where polar bears were congregated, it is possible that tens of polar bears could be killed; but, even the loss of tens of polar bears would not significantly affect polar bears at the global or species scale.

Cleanup Activities— Polar Bears
Cleanup activities could displace polar bears via vessels and aircraft, and could include capturing oiled polar bears. These types of disturbances and capturing efforts could further stress bears already compromised from contact with oil. Although polar bears may be injured or killed from oil contamination, it is possible mitigation measures such as deterring bears away from an oiled area could reduce the number of bears contacting oil. We expect the effects to polar bears from cleanup activities to increase with increasing spill volume, depending on the location and timing of the spill. While a few individuals could experience disturbance, we would not expect population-level effects to occur from oil spill response efforts.

5.5.10 Summary – Large Oil Spills

We analyzed a scenario which estimated two large spills, which could occur from a platform or a pipeline, as presented by BOEM (2015b). The analysis of two large spills allowed a conservative estimate of effects because the chance of two spills occurring is 24%, which is about the same chance as no spills (25%) occurring (Figure 5.1). Large spills from launch areas (LAs) (i.e., from platforms) generally are less likely to reach environmental resource areas (ERAs) representing areas important to listed eiders than from pipeline segments (PLs) which are directly adjacent to or underlying these areas. Pipelines will almost certainly pass through nearshore Chukchi Sea environment; thus, the potential impacts of oil spills on listed eiders will mostly depend on pipeline location relative to listed eider congregations. The general conclusion for listed eiders, therefore, is that large oil spills could cause adverse effects to listed eiders, but severe population-level impacts are not reasonably expected to occur. The general conclusion for polar bears is that up to tens of polar bears could be adversely affected by large oil spills, but population-level effects are not anticipated.

While the ORSA model provided useful information to aid in the assessment of possible effects to listed species, like all models, the ORSA model has limitations such as the following:

- BOEM (2015b) presented large spill mean rates and median volumes from platforms and pipelines in the Gulf of Mexico and the Pacific Ocean. Large spill rates and volumes in the Chukchi Sea may be influenced by environmental factors not present in these other areas.
- Platform and pipeline design, operation, and maintenance may influence the actual spill rate and volumes for the Proposed Action.
- Environmental data in the coupled ice ocean model used for the trajectory analysis is from 1986-2004 (BOEM 2015b), whereas potential oil spills would occur at least five years from the present (the year 2015). Due to climatic changes, ice conditions and environmental factors specific oil spill trajectories could differ from those calculated in the ORSA.
- ERAs important to listed eiders were based on current use of the Action Area. The chance that oil may reach an area important to listed species may differ from the OSRA ERAs because use patterns by listed eiders may change with the changing climate.

6 Cumulative Effects

Regulations implementing the ESA (50 CFR §402.02) define "cumulative effects" as the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Within the Action Area, oil and gas development, scientific research, and community growth will likely occur. However, these activities would require Federal permits (e.g., from the BLM and USACE) and separate consultation and therefore are not considered cumulative impacts under the ESA.

The gas pipeline road and possibly other roads constructed during onshore development may improve access to areas used by subsistence hunters. New roads may increase access to areas used by waterfowl during the waterfowl subsistence hunting season. Although spectacled and Steller's eiders are closed to hunting, they are occasionally taken by hunters. New roads and ice roads may also increase access for subsistence hunters to harvest polar bears. Promulgation of regulations that govern the subsistence harvest of migratory birds is a Federal action, as is the management of subsistence harvest of polar bears. These actions require separate consultation under the ESA and therefore are not considered cumulative impacts under the ESA.

7 Conclusion

Section 7(a)(2) of the ESA requires that each "Federal agency shall, in consultation with...the Secretary, insure that any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of designated critical habitat. This BO evaluates the potential impacts of the proposed Action on listed species and designated critical habitat, and was conducted as an incremental step consultation. As an incremental step consultation, this BO must address whether:

1. Activities within the first incremental step violate section 7(a)(2) of the ESA; and
2. There is a reasonable likelihood the entire Action will violate section 7(a)(2) of the ESA.

To reach conclusions, impacts of the incremental steps of the proposed Action are not considered in isolation, but are placed in the context of the current status of the species and critical habitat, the environmental baseline, and cumulative effects (as defined by the ESA).

It is important to note that throughout our analysis of effects of the Action, presented earlier, and our overall conclusions, presented here, our consideration of the potential effects to listed species and critical habitat from exposure to spilled oil relies upon and defers to analyses provided by BOEM and BSEE in the Second SEIS (BOEM 2015b) and BA (BOEM 2015a). The Second SEIS and BA estimate the number and volume of spills that may take place, based on previous mean spill rates and median spill sizes elsewhere in the OCS, and sophisticated spill trajectory models that evaluate the chances that spilled oil will contact important resource areas such as the LBCHU or spring lead system. We have critically evaluated their analyses to ensure our understanding of their models and analyses, and to search for possible misinterpretation of relevant species distribution or important biological considerations. We have found none, so defer to BOEM and BSEE as managers of oil and gas exploration and development in the OCS and their analyses of potential impacts of oil spills in the marine environment.

7.1 Conclusion for the First Incremental Step

This portion of the BO considers impacts to listed spectacled and Alaska-breeding Steller's eiders, polar bears, and designated critical habitat that may result from the first incremental step of the proposed Action. In evaluating the impacts of exploration of the anchor field on listed species, the Service identified a number of adverse effects that may occur. These are discussed more fully in the *Effects of the Action* and are summarized below.

7.1.1 Spectacled and Alaska-breeding Steller's Eiders

It is important to note that this conclusion does not reflect potential effects to listed eiders of habitat loss in the terrestrial environment from construction of shorebases to support exploration. As described in the *Effects of the Action*, the range in possible effects to listed eiders is considerable depending on the number, location, and size of shorebases (which includes area excavated to provide fill). Due to uncertainty in the BA in these important factors, our evaluation of the impacts of the first increment is confined to the effects of exploration and delineation of the anchor field in the marine environment. Consideration of potential effects of habitat loss in the terrestrial environment is contained within our conclusion for the entire action, found below. Additionally, authorization of incidental take of listed eiders resulting from habitat loss in the terrestrial environment is not provided in this BO.

Collisions - Activities taking place during the first incremental step may result in collisions between MODUs and vessels and spectacled and Alaska-breeding Steller's eiders. Collisions between birds and human-built structures are episodic, and it is difficult to estimate collision risk for listed eiders from MODUs and vessels using the short-term datasets currently available. Based on recent exploratory activities in the Chukchi Sea, however, we estimate that 7 spectacled eiders and < 1 Alaska-breeding Steller's eider will be killed from collisions with MODUs and vessels associated with seismic surveys and exploratory activities in the first increment. These estimates are approximate and based on king and common eider collision rates, but they are based on the best information available at this time and we believe it is unlikely that we have significantly underestimated potential effects. In addition, BOEM's requirements regarding lighting protocols for vessels operating in the Chukchi Sea will likely reduce collision risk. The ultimate effectiveness of this mitigation is unknown, however, so these collision estimates have not been adjusted to reflect the benefits these mitigation measures may confer.

Oil Spills - Although small spills would be reasonably foreseeable in the first incremental step, it is highly unlikely that listed eiders will be significantly affected because small spills are by definition of such low volume that oil or other spilled substances would likely evaporate, weather, or be mostly recovered. Moreover, the density of listed eiders in most of the Leased Area where most small spills would occur is very low, so only very few are likely to encounter small spills, and disturbance from spill response activities would likely displace individuals away from spill sites before they come into contact with oil or other spilled substances. Spills of greater volume would not be likely to occur during the first increment. According to analysis by BOEM/BSEE, large and very large oil spills would be so unlikely during the first incremental step as to be considered not reasonably foreseeable. Thus, they are not considered to be direct or indirect effects of the first increment within the meaning of the ESA.

7.1.1.1 Conclusion for Spectacled Eiders

In evaluating impacts of the first incremental step to spectacled eiders, the Service identified potential adverse effects from collisions and from exposure to oil spills. The Service estimates loss of approximately 7 spectacled eiders (including adults and/or fledged juveniles) from collisions with MODUs and vessels during 5 years of exploration and delineation activities (average 1.4 per year). The risk of impacts of oil spills during the first increment is very low because spectacled eiders are unlikely to encounter small spills, and large spills are not reasonably expected to occur during the first increment. After considering the aggregate effects, it is the Service's biological opinion that effects of the activities that may occur during the first incremental step, considered in the context of the status of the species, environmental baseline, and cumulative effects, *are not likely to jeopardize the continued existence of spectacled eiders by reducing appreciably their likelihood of survival and recovery in the wild by reducing their reproduction, numbers, and distribution.*

7.1.1.2 Conclusion for Alaska-breeding Steller's Eiders

In evaluating impacts of the proposed project to Alaska-breeding Steller's eiders, the Service identified potential adverse effects from collisions and hypothetically from exposure to oil spills. The Service estimates loss of approximately 1 Alaska-breeding Steller's eider (adult or fledged juvenile) from collisions with MODUs and vessels during 5 years of exploration and delineation activities (average 0.2 per year). The risk of impacts of oil spills during the first increment is very low because Alaska-breeding Steller's eiders are unlikely to encounter small spills, and large spills are not reasonably expected to occur during the first increment. After considering the aggregate effects, it is the Service's biological opinion that effects of the activities that may occur during the first incremental step, considered in the context of the status of the species, environmental baseline, and cumulative effects, *are not likely to jeopardize the continued existence of Alaska-breeding Steller's eiders by reducing appreciably their likelihood of survival and recovery in the wild by reducing their reproduction, numbers, and distribution.*

7.1.2 Ledyard Bay Critical Habitat Unit

In our analyses of impacts to designated critical habitat, we do not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.2, but instead have relied upon the statutory provisions of the ESA.

No exploration wells or other permanent structures are anticipated within the LBCHU because no leases occur there. Impacts to the LBCHU from activities authorized in the first incremental step of the proposed Action are anticipated to have at most only minor, short-term impacts to the PCEs, and therefore are not likely to diminish the function and conservation value to spectacled eiders for which it was designated. In addition, due to minimization measure designed to avoid disturbance within the critical habitat unit during molt (e.g., Lease Stipulation No. 7), human presence and disturbance is not expected to prevent spectacled eiders from accessing or utilizing the LBCHU or associated PCEs.

Oil spills – Although small spills would be reasonably foreseeable in the first incremental step, they are by definition so limited in size that oil or other spilled substances would likely evaporate, weather, or be mostly recovered. By virtue of their size, they are also likely to cover a limited areal extent, and are unlikely to persist long enough to reach the LBCHU if spilled elsewhere. Moreover, given the limited volumes of small spills, effects on the biological and physical features of the critical habitat would be short term and localized, and therefore would not diminish the function and conservation value of the LBCHU for spectacled eiders.

Spills of greater volume would not be likely to occur during the first increment. According to analysis by BOEM/BSEE, large and very large oil spills would be so unlikely during the first incremental step as to be considered not reasonably foreseeable. Thus, they are not considered to be direct or indirect effects of the first increment within the meaning of the ESA.

7.1.2.1 Conclusion for Ledyard Bay Critical Habitat Unit

We identified potential impacts to the LBCHU from disturbance and small spills, but due to minimization measures to avoid disturbance of molting eiders, and the low likelihood that small spills would impact the critical habitat unit, these effects would be expected to have at most only minor, short-term impacts to the PCEs and disturbance is not expected to prevent spectacled eiders from accessing or utilizing the LBCHU or associated PCEs. After considering the aggregate effects, it is the Service's biological opinion that effects of the activities that may occur during the first incremental step, considered in the context of the status of the designated critical habitat, environmental baseline, and cumulative effects, *are not likely to destroy or adversely modify spectacled eider critical habitat such that it fails to retain the intended function and conservation role for which it was designated.*

7.1.3 Polar Bears

Disturbance – Transient (non-denning) polar bears may be affected by human presence and activities such that they change their behavior and movements, either moving away from the source of disturbance, or in rare cases they may be attracted, which could occasionally result in the need to haze the individual(s) involved. Based on successful management of human-bear interactions in recent decades, we anticipate that most interactions would result in only minor, temporary changes in behavior that would not adversely affect the individual polar bears involved. Although intentional deterrence actions would occasionally be employed, they would be designed and closely managed to de-escalate encounters and protect polar bears and humans alike, and would therefore be expected to avoid, rather than cause, injuries or death of polar bears. Therefore, we expect interactions resulting in injury or death of polar bears would be unlikely during the first increment, and expect at most sublethal effects to at most a few individual polar bears.

Oil Spills – As noted above, small spills would be expected to occur in the first incremental step. However, it is highly unlikely that polar bears would be significantly affected because small volumes of spilled oil would likely evaporate, weather, or be almost entirely recovered. Moreover, the density of polar bears is low in most of the Action Area so it is unlikely that polar bears would encounter oil or other substances from a small spill. Further, spill response activities would cause significant local disturbance which would likely displace polar bears from the spill site, further decreasing chances of contact with spilled substances.

Spills of greater volume would not be likely to occur during the first incremental step. According to analysis by BOEM/BSEE, large and very large oil spills would be so unlikely during the first incremental step as to be considered not reasonably foreseeable. Thus, they are not considered to be direct or indirect effects of the first increment within the meaning of the ESA.

7.1.3.1 Conclusion for Polar Bears

Activities that may result from the first incremental step that could affect polar bears include habitat loss, disturbance and increased human-polar bear interactions, and exposure to oil spills. Given that 1) habitat loss would be minor; 2) disturbance and human-polar bear interactions would be unlikely to result in the injury or death of a bear, 3) due to small volumes and spill prevention and response measures, small spills would be expected to at most, affect very few individuals; and 4) large or very large oil spills would be extremely unlikely to occur, we do not expect population-level impact to occur as a result of activities proposed during the first incremental step. After considering the aggregate effects, it is the Service's biological opinion that effects of the activities that may occur during the first incremental step, considered in the context of the status of the species, environmental baseline, and cumulative effects, *are not likely to jeopardize the continued existence of polar bears by reducing appreciably their likelihood of survival and recovery in the wild by reducing their reproduction, numbers, and distribution.*

7.2 Conclusion for the Entire Proposed Action

In addition to considering the effects of activities proposed in the first incremental step, we analyzed effects of the entire proposed Action, including terrestrial shorebases associated with exploration of the anchor field and satellite field, and development, production, and decommissioning of both fields, as described in the BA and EDS, to determine if there is a reasonable likelihood that the entire proposed Action would violate section 7(a)(2) of the ESA. We first discuss some of the relevant uncertainties, followed by a discussion of the legal framework within which our conclusion must be made, and then provide our conclusions.

7.2.1 Key Uncertainties

Evaluating the potential effects of the proposed Action, which entails oil and gas activities projected to take place over 77 years, is complicated by uncertainty in several respects. First, there is some uncertainty inherent in the proposed action provided by BOEM/BSEE that formed the basis for impact evaluation. For example, the number of shorebases to be constructed to support exploration is expressed as a range (up to three), as is their location (from Icy Cape to Barrow), and impacts for eider breeding habitat loss would depend upon these factors. Second, the EDS provided is an updated and detailed hypothetical scenario based upon the best available information. It projects reasonably foreseeable activities and locations, and thereby provides a reasonable and suitable basis for impact evaluation. Nonetheless, actual development proposals and the ensuing projects are likely to differ, possibly substantially, from this EDS, and potential impacts would thereby vary correspondingly. Third, probably the most important factor in determining ultimate impacts to listed species and designated critical habitat will be the number, volume, timing, and location of possible oil spills. The Second SEIS and BA estimate the number and volume of spills that may take place, based on mean spill rates derived from a fault tree model and median spill sizes elsewhere in the OCS, and sophisticated spill trajectory models that evaluate the chances that spilled oil will contact important resource areas. Nonetheless, actual events would be unlikely to exactly match estimates and projections provided. Elaboration on some of these important uncertainties follows.

The scale of future development – BOEM and BSEE have provided a EDS for the leased area that projects one large prospect containing potential oil and condensate resources of 4.3 Bbbl, developed from one anchor field and a smaller satellite field entailing 8 offshore platforms and 589 total wells, with subsea pipelines transporting product to a shorebase at an unknown location, and two terrestrial pipelines moving oil and gas to the TAPS and gas line (yet to be constructed). The actual scale of development could vary from this projection, likely considerably, based on future resource estimates, market forces, changes in societal environmental risk tolerance, advances in technology, and other factors.

The location of future development **–** The siting of facilities and other infrastructure could significantly affect potential impacts, particularly for listed eiders, because the species' densities are highly variable spatially. For example, our estimates of the impacts of habitat loss from construction of shorebases suggest that the number of nests of spectacled or Alaska-breeding Steller's eiders potentially affected could vary by an order of magnitude or more depending on the siting of infrastructure.

The number of large marine oil spills – The greatest identified population-level risk to listed species and designated critical habitat from development and production is from a large marine oil spill. BOEM (2015b) stated that large (≥ 1,000 barrel) spills could originate from three sources: wells, production platforms, and production pipelines. Based on information on spill occurrence in the OCS to date and a fault tree model, BOEM (2015b) estimates 0.9 pipeline spills and 0.5 platform (and well) spills would occur over the life of the Leased Area, for an estimated total of 1.4 large spills. Using the median volume of spills occurring on the OCS to date, BOEM (2015b) estimated spill sizes of 1,700 bbl and 5,100 bbl for pipeline and platform spills, respectively. While providing a reasonable basis for environmental impact assessment, it must be appreciated that actual events resulting from Lease Sale 193 are extremely unlikely to perfectly match these estimates that were necessarily calculated well in advance of any development that may occur.

Effectiveness of oil spill response and cleanup efforts – In the event that an oil spill occurs, a response effort would be implemented and cleanup efforts would begin. Because there have been no large marine oil spills in the Chukchi Sea, the effectiveness of response efforts there is unknown. However, efficacy would likely be affected by timing (i.e., presence of ice, broken ice, or open water), location (i.e., proximity to infrastructure, spill response equipment, and ease of logistics), weather and current conditions, and volume of oil spilled. Given these variables, it is impossible to reliably predict the benefit to listed species or critical habitat that spill response efforts would provide.

Whether a spill would encounter listed species or designated critical habitat **–** In the event that oil is spilled in the marine environment, a number of factors would influence the extent to which listed species or designated critical habitat would be affected. First, effects would depend in part on the amount of oil spilled, which would be influenced by the technology used to transport oil, the length of pipelines, and numerous other factors. Further, the location of a spill would have great bearing on the likelihood that listed species would be exposed. For example, the probability of spills reaching important habitats for listed eiders such as Ledyard Bay or the spring lead system varies considerably depending on spill location and source. Finally, the seasonal timing of spills would influence the occurrence and location of listed species in the region, affecting the chances of contact, and the likelihood that oil would cause lasting impacts to the primary constituent elements of critical habitat.

7.2.2 Legal Framework

Although a wide range of effects of the entire proposed Action is possible, the applicable legal standards do not require the Service to base conclusions on what is possible, but rather what is reasonably likely or reasonably certain to occur. In particular, the following requirements and definitions from the ESA and its implementing regulations (at 50 CFR. 402) provide the foundation for our conclusion:

- Section 7(a)(2) of the ESA requires that each "Federal agency shall, in consultation...the Secretary, insure that any action authorized, funded, or carried out by such agency...is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of designated critical habitat.

- When consulting on the first increment in an incremental step consultation, regulations (50 CFR. 402.14(k)) require that we look forward to completion of the entire action and conclude that "there is a *reasonable likelihood* that the entire action will not violate 7(a)(2) of the [ESA]." (italics added)

- To "jeopardize the continued existence of" means "to engage in an action that *reasonably would be expected*, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." (italics added) (50 CFR. 402.02)

These definitions make clear that in reaching a conclusion on the final action, we must consider and base our conclusions upon what is "reasonably likely" (50 CFR. 402.14(k)) and "reasonably expected to occur" (50 CFR. 402.02), not what is merely possible.

7.3 Conclusion – Entire Action

7.3.1 Spectacled and Alaska-breeding Steller's Eiders

Collisions, predation, subsistence hunting, toxic contamination and small spills – We conclude that collisions with structures (in marine and terrestrial environments), increased predation as a result of anthropogenic influences on predator population size or distribution, increased subsistence hunting as a result of new roads, toxics contamination, and small oil spills may adversely affect listed eiders at the individual level. In all cases, however, we also conclude that these potential effects would be very unlikely to cause population-level impacts based on the best information available at this time.

Habitat loss and disturbance or displacement – The impact of potential habitat loss and disturbance/displacement to listed eiders will be proportional to the spatial overlap between significant oil and gas infrastructure and eider concentration areas. Listed eiders occur at low or very low density throughout the majority of the action area, including both marine and terrestrial environments. To have population-level impacts, there would need to be substantial development or repeated disturbance in areas where listed eiders concentrate, such as the LBCHU, spring leads, or Steller's eider nesting habitat in the Barrow triangle.

We expect that repetitive disturbance of birds is unlikely in the LBCHU because disturbance can be avoided by routing vessels and aircraft around identified molting habitat and concentrations of spectacled eiders. The vast majority of the spring lead system is outside the leased area; only rarely do leads open up in the leased area (Mahoney 2012, in BOEM/BSEE 2015). Thus, exploratory or production wells would not be placed where spring leads normally occur. Vessels transiting through the LBCHU or spring leads may cause short-term minor disturbance but the effects are likely to be limited to the brief duration of the vessel's transit and by the small number of vessels expected to transit the area (i.e., BOEM and BSEE estimate up to two drill ships with up to 19 support vessels and one ancillary activity annually, citing Shell Gulf of Mexico, Inc., 2014). Pipelines connecting offshore platforms with the shoreline could be proposed for the LBCHU or areas with spring leads, but considering the considerable size of the LBCHU and spring leads, the proportion of the area subject to habitat alteration or construction-related disturbance would likely be extremely limited. Further, the benthic community and its use by eiders would be expected to recover quickly.

In the terrestrial environment, significant impacts to listed eiders could occur if shorebases, pipeline landfall, storage pads, pipelines through terrestrial habitat, pump stations, and roads were to be placed in important nesting habitat. Spectacled and Alaska-breeding Steller's eiders have highly variable density in the region, and possible impacts from facilities sited within nesting habitat would be proportional to the density of eiders nesting there. The siting of infrastructure would be particularly important for Steller's eiders, as they occur at extremely low density in the southern portions of the action area but at considerably higher density within the Barrow triangle. Additionally, Alaska-breeding Steller's eiders, which number only in the hundreds, have comparatively low abundance, so impacts to a small number of individuals or pairs would have disproportionately higher potential for population-level effects. The BA states that "significant construction in the Barrow area is not expected to occur" and "placement of a new pipeline corridor, including the access road, is not anticipated to be in the Barrow Triangle," indicating that these potential impacts are not reasonably expected to occur at this time. However, the current description of exploration shorebases and EDS, with accompanying minimization measures, do not commit to avoiding development with the Barrow triangle. Proposals, including those that support exploration, will require reintitiation of consultation if habitat loss is likely to adversely affect spectacled or Alaska-breeding Steller's eiders. This likelihood is higher where Steller's eiders concentrate, such as within the Barrow triangle.

Oil spills – For the purposes of analysis under the EDS, BOEM and BSEE estimate that 777 small spills (<1,000 bbl) will occur over the life of the scenario (20 during the first incremental step and 757 during future incremental steps). Their analysis concludes that small spills would be contained or evaporate and dissipate quickly, and travel limited distances, which reduces the chances for contacting listed eiders. They conclude that small spills would be reasonably foreseeable events, but based on their limited size and other ameliorating factors, would have minimal effects to listed eiders.

In addition to small spills, development activities carry the additional risk of large (≥1,000 bbl) spills and very large (≥150,000 bbl) spills. We refer to the reader to the EIS, BA, and Effects of the Action section above for more detail, however particularly salient points derived from our understanding of species distribution and the analyses of oil spill risk provided by BOEM and BSEE include:

- With the exception of the spring lead system prior to June 10, and the LBCHU from August – October, listed eiders occur in the marine environment at low or very low densities in the Action Area. Therefore, outside of the spring leads and LBCHU, for large numbers of individuals to come in contact with oil, a large volume of oil would need to be spilled such that it affected a significant proportion of the Action Area.

- During spring migration, large numbers of Steller's and spectacled eiders are present in the spring lead system, and during the molting season, large numbers of spectacled eiders are present in the LBCHU. Oil reaching these areas during these high use periods has the potential to contact and kill a significant number of either species. Particularly for Alaska-breeding Steller's eiders, which are less abundant, the potential for population-level impacts from spill-caused mortality certainly exists.

- Based on information on spill occurrence in the OCS to date and the EDS for this lease sale, BOEM estimates 0.9 pipeline spills and 0.5 platform (and well) spills would occur over the life of the Leased Area, for an estimated total of 1.4 large spills. Using these mean spill numbers, the chance of no large pipeline spills is 41% and the chance of one or more large pipeline spills is 59%. The chance of no large platform (well and platform) spills is 61% and the chance of one or more large platform spills is 39%. Using the total mean spill number, the chance of no large pipeline or platform spills occurring is 25%, while the chance of one or more large spills is 75% for the EDS.

- BOEM modeled spills originating from hypothetical launch points distributed throughout the Leased Area and along hypothetical pipeline routes to shore to evaluate the likelihood of spilled oil reaching specific areas of interest, assuming that a large spill occurs. According to the OSRA model from BOEM, depending upon the geographic origin of the spill, the chance of a large oil spill contacting the LBCHU (ERA 10) within 180 days ranges from 2% to 59%. For the Chukchi Sea Spring Lead System (ERA 19), the chance of contact within 180 days ranges from < 0.5% to 15%.

- Combining the probability of one or more large spills occurring over the assumed life of the leased area, with that of oil from a large spill reaching areas of interest within 180 days, and within the time period that spectacled or Steller's eiders occupy the area, there is an estimated 15% chance that one or more large spills will occur and contact the

LBCHU and an estimated 12% chance that one or more large spills will occur and contact the Chukchi Sea Spring Lead System.

Based on these conclusions, population-level impacts from oil spills, although possible, are not reasonably expected to occur. For population-level impacts to occur, all of the following would have to take place: 1) one or more large oil spills would have to occur (the estimated likelihood of one or more large spills is 75%); 2) spilled oil would have to reach an area used by large congregations of spectacled or Steller's eiders (i.e., Ledyard Bay or the spring lead system), although these areas comprise only a small subset of the Action Area ; 3) the spill would have to reach these areas when concentrations of spectacled or Steller's eiders are present, or persist until they return; and 4) the oil would have to actually contact a significant proportion of the population. While *any* of these events is possible, we conclude that it is not reasonably likely/reasonably expected that *all* of these events would occur, based on the best information currently available.

Therefore, the Service concludes the effects of all incremental steps, in light of the uncertainty regarding the scale of potential development and oil spills, and in the context of the status of the species, environmental baseline, and cumulative effects, *are not reasonably likely to jeopardize the continued existence of spectacled or Alaska-breeding Steller's eiders by reducing appreciably the likelihood of survival and recovery of these species in the wild by reducing their reproduction, numbers, and distribution*.

7.3.2 Ledyard Bay Critical Habitat Unit

The direct loss of habitat caused by placing infrastructure in areas of the LBCHU would be limited to a very small portion of the designated critical habitat. No production platforms or wells would occur within the LBCHU because no leases occur there. Burying one or more pipelines through the LBCHU would disturb the benthos and the PCE of the marine benthic community, but would affect only a very small proportion of the LBCHU, and would likely pose a short-term effect, as the benthos would likely recolonize the area. Drilling muds and cuttings from exploration or production facilities on leases outside the LBCHU would leave footprints around well sites and would impact the surrounding benthos. These discharges could result in drifting sediments that affect the flora and fauna in the water column and underlying benthic community through toxicity or organic enrichment. However, these effects would be unlikely to reach the LBCHU or affect it only insignificantly, as the nearest leased blocks where these actions could take place are at least 20 miles from the LBCHU. While development, production, and other activities may adversely affect the LBCHU, effects on the PCEs would be localized and would not diminish the function and conservation value of the LBCHU for molting spectacled eiders.

Oil spills –Small spills are by definition of low volume and would be largely recoverable. Small spills would also have to occur directly adjacent to or within the LBCHU for effects to occur, and, because no leases occur within the LBCHU, very few activities would be likely to occur there. Additionally, effects of such contamination would be minimized through oil evaporation, weathering, and recovery efforts. While it is possible that small spills may occur in the LBCHU, their effects on the PCEs would be short-term and localized and would not diminish the function and conservation value of the LBCHU for molting spectacled eiders.

Large oil spills during future incremental steps could originate from platforms (and wells) and pipelines or from a loss of control incident followed by a long-duration flow. According to the OSRA model used by BOEM and BSEE, depending upon the geographic origin of the spill, the chance of a large oil spill contacting the LBCHU (ERA 10) within 180 days ranges from 1% to 59%. Thus, assuming that a spill occurs, there would be an appreciable chance that oil would reach the LBCHU. Combining the probability of one or more large spills occurring over the assumed life of the Leased Area, with that of oil from a large spill reaching the LBCHU within 180 days, BOEM and BSEE estimate a 15% chance that one or more large spills will occur and contact the LBCHU. They conclude: "this could potentially affect PCEs and the ability of spectacled eiders to use this area for the purposes for which the critical habitat was designated." However, because the analyses conclude there is only a 15% chance that one or more spills will occur and reach the LBCHU when molting eiders are present, this is not reasonably expected to occur. Further, should these events occur, the actual effects to the LBCHU and its ability to support spectacled eiders would depend on a variety of factors, including the amount of oil to reach the LBCHU and efficacy of clean-up efforts.

In conclusion, the LBCHU is likely to provide the conservation function for which it was designated, namely to provide a rich source of benthic invertebrates and aquatic flora and fauna in waters of an appropriate depth to support molting spectacled eiders. Therefore, the Service concludes the effects of all incremental steps, considered together with uncertainty regarding the scale of potential development and oil spills, and in the context of the status of the critical habitat, environmental baseline, and cumulative effects, are *not reasonably likely to destroy or adversely modify spectacled eider critical habitat, and the critical habitat would retain the intended function and conservation role for which it was designated.*

7.3.3 Polar Bears

Polar bears may be adversely affected through disturbance and human-polar bear interactions, and exposure to oil spills. Based on successful management of disturbance and human-polar bear interactions in the oil fields in Alaska to date, we expect the number of individual bears to suffer injury or death to be very few, resulting in only individual-level impacts. Given the sparse distribution of polar bears (low density over a large area, with only a few tens of bears congregating even in the highest density areas), we anticipate that even under the worst circumstances, a very large spill could potentially contact and kill at most tens of polar bears. This level of impact is not likely to cause population-level declines. Therefore, the Service concludes the effects of all incremental steps, considered in the context of the status of the species, environmental baseline, and cumulative effects, *are not reasonably likely to jeopardize the continued existence of polar bears by reducing appreciably the likelihood of survival and recovery of these species in the wild by reducing their reproduction, numbers, and distribution.*

7.3.4 Summary – Entire Action

In the discussions presented above, we concluded that based on the information provided by BOEM and BSEE, which includes descriptions of potential exploration activities, an EDS, and the legal standards that we are to apply in reaching conclusions, that the proposed action, *is not reasonably expected* to jeopardize listed species or destroy or adversely modify designated critical habitat. We note, however, that the potential impacts of exploration, development, production, and decommissioning on listed species and designated critical habitat would range from (1) none, if no exploration or development occurs, to (2) negligible, if activities occur in areas or are managed in ways that minimize oil spill risk and the siting of infrastructure and activities in important habitats, to (3) potentially problematic if exploration or development is proposed in areas that would compromise the ability of the marine or terrestrial environment to support listed species, to (4) potentially catastrophic in the event that one or more oil spills contact a large number or large proportion of North Slope breeding spectacled or Steller's eiders, or results in long-term impacts to the LBCHU. Thus, the **possible** effects of development and production range from zero to potentially catastrophic.

7.4 Future Consultation

Consultation prior to future incremental steps in this phased oil and gas process is required to fully evaluate proposals for shorebase construction and actions beyond exploration and delineation of the anchor field. As stated previously, considerable uncertainty regarding specific activities of the entire action exists. Therefore, when future incremental steps are proposed with specific information about the nature and extent of proposed activities, including the scale and location of activities and description of specific technology to be employed to reduce oil spill risk, more precise estimation of the actual risk of impacts to listed species and critical habitat will be possible. As a result, section 7 consultation to evaluate specific proposals in future incremental steps will be crucial to ensuring that shorebase construction, development, and production do not jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. It is also possible that the status of one or more listed species or critical habitat, environmental baseline, or cumulative effects may change in the future, which would alter the context in which the effects of future proposed actions would be evaluated.

7.5 Avoiding Jeopardy and Destruction/Adverse Modification in Future Incremental Steps

Under the incremental step consultation approach, BOEM and BSEE have continuing obligations to:

- Avoid irreversible or irretrievable commitment of resources that would prevent implementation of reasonable and prudent alternatives to the Action at a later date; and
- Obtain sufficient data upon which to base the final BO(s) for future incremental steps.

We hereby provide notification and emphasize that some potential development proposals could conceivably jeopardize listed species or cause destruction or adverse modification of critical habitat. If actual development is within, or proximal to, areas used by large numbers of listed eiders (e.g., nesting habitat near Barrow, portions of the LBCHU and spring lead system), or poses significant risk of spills that could reach concentrations of listed species or destroy food resources or other important habitat components, the impacts could be significant and could result in jeopardy or destroy or adversely modify critical habitat. It is incumbent upon BOEM and BSEE and lessees proposing to develop oil and gas resources associated with Lease Sale 193 to design future proposed production projects that are not likely to result in jeopardy or destruction or adverse modification of critical habitat.

Therefore, BOEM/BSEE and the oil and gas industry must remain fully aware of the need to consult on shorebase construction, other future increments, and the potential for jeopardy or destruction/adverse modification conclusions to be reached in future consultation. Further, we believe that BOEM/BSEE and the oil and gas industry should recognize the need to incorporate effective mitigation measures into their proposed Actions to avoid jeopardy or destruction or adverse modification of critical habitat from development/production and the impacts of potential oil spills.

To reduce the likelihood of jeopardy or destruction/adverse modification conclusions, we recommend that BOEM/BSEE and industry:

- Avoid proposing infrastructure in important eider habitats, including the LBCHU and spring leads;
- Avoid proposing significant infrastructure or fill extraction that results in habitat loss within the Barrow triangle (an area north of 70 degrees 50 minutes North and between the shorelines of the Chukchi Sea and Admiralty Bay);
- Avoid proposing development or pipelines in areas where spilled oil has a high risk of reaching the LBCHU or spring leads; and
- Improve and use technology to reduce oil spill risk, including reducing the likelihood for spills to occur, and minimizing the amount of oil that can be released in the event that spills occur.

8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. “Harm” is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. “Harass” is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, but not the purpose of, carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS).

The measures described below are non-discretionary, and must be undertaken by BOEM and BSEE so they become binding terms and conditions in leases, permits, or other authorizations for the exemption in section 7(o)(2) to apply. These Terms and Conditions (T&Cs) apply to all seismic, geohazard, geotechnical, and vertical seismic profile surveys, and exploratory and delineation drilling activities. BOEM and BSEE have a continuing duty to regulate activities covered by this ITS. If the BOEM or BSEE (1) fail to implement the T&Cs, or (2) fail to require any lessee, permittee or the agents of their permittees and lessees to comply with the T&Cs of the ITS through enforceable terms/stipulations of the permit/lease, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, BOEM and BSEE must report the progress of the proposed Action and its impact on listed species to the Service as specified in the ITS. This ITS first discusses listed eiders and then polar bears.

8.1 Spectacled and Alaska-breeding Steller's Eiders

This ITS provides exemption for incidental take only for offshore activities in the first incremental step of the Action. BOEM and BSEE must continue consultation for future incremental steps, and should reinitiate consultation in the event that thresholds for reinitiation (as described in Section 11, below) are exceeded, including if terrestrial shorebase construction that is likely to adversely affect spectacled or Alaska-breeding Steller's eiders is proposed in the first incremental step. Incidental take exemptions for future incremental steps and for actions for which consultation is reinitiated may be provided when the proposed projects are evaluated. As described in the *Effects of the Action*, activities during the first incremental step may adversely affect spectacled and Alaska-breeding Steller's eiders through collisions with structures.

8.1.1 Collisions

During exploratory operations, equipment and vessels would be present in the marine environment posing a collision risk for listed eiders. Collision risk is a function of proximity of structures to habitats used by these species, including migratory routes. Estimating the number of collisions is complicated by: 1) a lack of information on listed eider migration routes, behavior, and vulnerability to collisions with these types of structures; 2) uncertainty over locations of activities in the Action Area; and 3) the extent to which lease stipulations/permit requirements governing lighting and operations will reduce collision risk.

Because spectacled and Alaska-breeding Steller's eiders are believed to stage, molt, and winter in the Chukchi and Bering seas to the west of their North Slope nesting range, in the absence of information about vessel location, the Service assumes the entire North Slope population of each species could conceivably pass by exploratory drillsites in the Chukchi Sea during fall migration and therefore would potentially be at risk of colliding with structures.

Using methods explained in detail in the Effects of the Action above, **we estimate and provide lethal incidental take exemption for 7 spectacled eiders and 1 Alaska-breeding Steller's eider from collisions with MODUs and support vessels during exploration and delineation of the anchor field in the first incremental step.**

8.1.2 Habitat Loss

As explained in the *Conclusion* for the first incremental step above, we believe that construction of one or more shorebases to support exploration could result in adverse effects to listed eiders through habitat loss and disturbance/displacement. Potential impacts would depend on the number, location, and size of shorebases and the associated material sites excavated to provide fill. Given the lack of specificity regarding these factors in the EDS, at this time we are unable to accurately estimate or enumerate impacts to listed eiders from development or expansion of onshore infrastructure during the first incremental step. Thus, no incidental take exemption for spectacled or Steller's eiders associated with habitat loss in the first incremental step is provided in this ITS. Exploration proposals that include construction of shorebases that are likely to adversely affect listed eiders will require reinitiation of consultation, therefore, to ensure that impacts are adequately evaluated and appropriate incidental take exemptions, RPMs and T&Cs are provided.

8.2 Reasonable and Prudent Measures for Spectacled and Alaska-breeding Stellers' Eiders

These Reasonable and Prudent Measures (RPMs) and their implementing Terms and Conditions aim to minimize the incidental take anticipated for the first incremental step (marine deep-penetration surveys, high-resolution activities, and exploratory and delineation drilling) of the proposed Action. Additional RPMs will be developed and implemented during consultation on future incremental steps in this project.

Activities authorized by BOEM and BSEE under the first incremental step may lead to incidental take of spectacled and Alaska-breeding Steller's eiders through collision mortality. As described in the *Conclusion,* crude or refined oil or toxic substance spills that results in incidental take of listed eiders are also possible, and an RPM is included to require monitoring and reporting of spills and potential effects to avifauna. However, because spills are not an otherwise legal activity, no incidental take exemption is provided for adverse effects in connection with oil spills.

As part of the proposed Action BOEM/BSEE will require their lessees, permittees, and the agents of their lessees and permittees to implement mitigation measures, including lighting protocols aimed at reducing collisions between vessels and exploratory drilling structures and listed eiders. These stipulations/typical permit conditions are provided as Appendix A of this BO.

To ensure the best available information is used in developing mitigation measures for listed species and critical habitat, BOEM and BSEE are required to:

RPM 1 – Work jointly with the Service to develop and implement strategies to avoid and minimize bird collisions.

RPM 2 – Work jointly with the Service to avoid and minimize impacts of disturbance from aircraft, vessels, and drilling operations on listed eiders.

RPM 3 – Monitor and report oil spills to improve understanding of risk and impacts.

8.3 Terms and Conditions for Spectacled and Alaska-breeding Steller's Eiders

To be exempt from the prohibitions of Section 9 of the ESA, BOEM and BSEE will require their lessees, permittees, or agents of their lessees and permittees to comply with the following non-discretionary T&Cs, which implement the RPMs described above.

To monitor the effectiveness of these RPMs and T&Cs, an annual reporting requirement is required (see *Reporting Requirements* below).

RPM 1 – Work jointly with the Service to develop and implement strategies to avoid and minimize bird collisions.

T&C 1a. BOEM and BSEE will require lessees and their contractors to implement lighting protocols on MODUs aimed at minimizing outward radiation of light. These requirements establish a coordinated process for a performance-based objective rather than pre-determined prescriptive requirements. The performance-based objective is to minimize the radiation of light outward from exploration structures while operating on a lease or if staged within nearshore Federal waters pending lease deployment. Lessees must provide BOEM with a written statement of measures that will be or have been taken to meet the lighting objective, and must submit this information with an exploration plan when it is submitted for regulatory review and approval pursuant to 30 CFR 550.203.

T&C 1b. BOEM and BSEE will require their lessees, permittees or agents of their lessees and permittees to minimize the use of high-intensity work lights on vessels, especially inside the 20-m bathymetric contour. Exterior lights will only be used as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather; otherwise they will be turned off. Interior and navigation lights should remain on as needed for safety.

T&C 1c. BOEM and BSEE will require their lessees, permittees, and agents of their lessees and permittees, to report avian encounters with vessels or drilling structures within three days to BSEE who will then provide these avian encounter reports to the Endangered Species Branch Chief, USFWS, Fairbanks Fish & Wildlife Field Office (FFWFO) within 7 days. Minimum information for encounter reporting will include species, date/time, location, weather, identification of the vessel or drilling structure involved and its operational status when the encounter occurred, and one or more photographs (or a statement explaining why obtaining a photograph of any particular bird was not possible). The FFWFO should be contacted regarding the recovery or transport of dead birds.

RPM 2 – Work jointly with the Service to avoid and minimize impacts of disturbance from aircraft, vessels, and drilling operations on listed eiders.

T&C 2a. To prevent impacts to molting spectacled eiders that are likely less mobile and energetically stressed during this flightless period, BOEM and BSEE will require their lessees, permittees, and agents of their lessees and permittees to implement mitigation measures requiring that aircraft not fly below 1,500 feet over the spring lead system between April 1 and

June 10 and over the LBCHU between July 1 and November 15. If weather prevents attaining this altitude, aircraft will use pre-designated flight routes. Predesignated flight routes will be established by the lessee/permittee and BOEM, in collaboration with the Service, during review of the exploration and delineation of the anchor field. This requirement applies during the performance of marine deep penetration surveys, high-resolution survey activities, and exploration and delineation well drilling activities. Exceptions for using the pre-designated flight routes when weather prevents attaining 1,500 feet altitude include medical or other emergencies. Low-level flights associated with a medical or other emergency must be reported within 24 hours to BSEE, who will then provide these reports to the Endangered Species Branch Chief, USFWS FFWFO within 7 days. Any lessee, permittee or agent of a lessee or permittee that does not report a low-level flight ($\leq$1500 ft) over the spring lead system between April 1 and June 10 and over the LBCHU between July 1 and November 15, within 24 hours to BSEE, will be considered out of compliance with this condition.

T&C 2b. To prevent impacts to molting spectacled eiders that are likely less mobile and more energetically stressed during this flightless period, BOEM and BSEE will impose mitigation measures on their lessees, permittees, and agents of their lessees and permittees requiring that no seismic survey vessels geophysical or geotechnical vessels, or MODUs (and any vessels supporting, accompanying, or otherwise assisting them) operate in the LBCHU[12] after July 1 of each year. The only exceptions for such vessels to enter the LBCHU after July 1 are for reportable marine casualties as defined in 46 CFR 4.05-1 or hazardous conditions as defined by 33 CFR 160.204. Entries into the LBCHU after July 1 due to marine casualties or hazardous conditions will be reported to BSEE within 24 hours, and BSEE will report the activity to the Endangered Species Branch Chief, USFWS FFWFO, within 7 days. Any lessee, permittee, or agent of a lessee or permittee that does not report an entry into the LBCHU after July 1 of each year, within 24 hours to BSEE will be considered out of compliance with this condition.

T&C 2c. To prevent impacts to migrating listed eiders in the spring lead system, BOEM and BSEE will require their lessees, permittee, and agents of their lessees or permittees to impose and implement mitigation measures requiring that no seismic survey vessels geophysical or geotechnical vessels, or MODUs (and any vessels supporting, accompanying, or otherwise assisting them) may operate in the spring lead system[3] between April 1 and June 10 of each year. The only exceptions for such vessels to enter the spring lead system between April 1 and June 10 are to support exploratory wells that could be drilled on a lease block in the spring lead system or for reportable marine casualties as defined in 46 CFR 4.05-1 or hazardous conditions as defined by 33 CFR 160.204. Entries into the spring lead system between April 1 and June 10 due to marine casualties or hazardous conditions will be reported to BSEE within 24 hours, and BSEE will report the activity to the Endangered Species Branch Chief, USFWS FFWFO, within 7 days. Any lessee, permittee or agent of a lessee or permittee that does not report vessel entries into the spring lead system between April 1 and June 10 within 24 hours to BSEE will be considered out of compliance with this condition.

[12] If the final 2012-2017 OCS Oil and Gas Leasing Program or subsequent sales excludes LBCHU, there would be no expressed need for lessees or their agents to enter the LBCHU for exploration drilling purposes.

T&C 2d. MODUs and supporting, assisting, or accompanying vessels are required to enter and exit the LBCHU in a manner that minimizes travel within the LBCHU. Supporting, assisting, or accompanying vessels are required to remain in close association with the drill ship, for reportable marine casualties as defined in 46 CFR 4.05-1 or hazardous conditions as defined by 33 CFR 160.204. BOEM and BSEE will require their lessees, permittees, and agents of their lessees and permittees to regularly report any eiders observed within the LBCHU during drilling and other support operations to the BSEE. BSEE will provide these reports to the Endangered Species Branch Chief, USFWS FFWFO on a monthly basis.

For the purposes of **T&C 2a** (minimizing disturbance by aircraft) and **T&C 2c** (minimizing disturbance by drilling activities within the spring lead system), the spring lead system is defined as the area landward of a line drawn from Point Hope to the corner of the LBCHU at 69º12’00”N x 163º13’00”W, to the corner of the LBCHU at 70º20’00”N x 164º00’00”W to 71º39’35”N x 156º00’00”W (Figure 8.1).

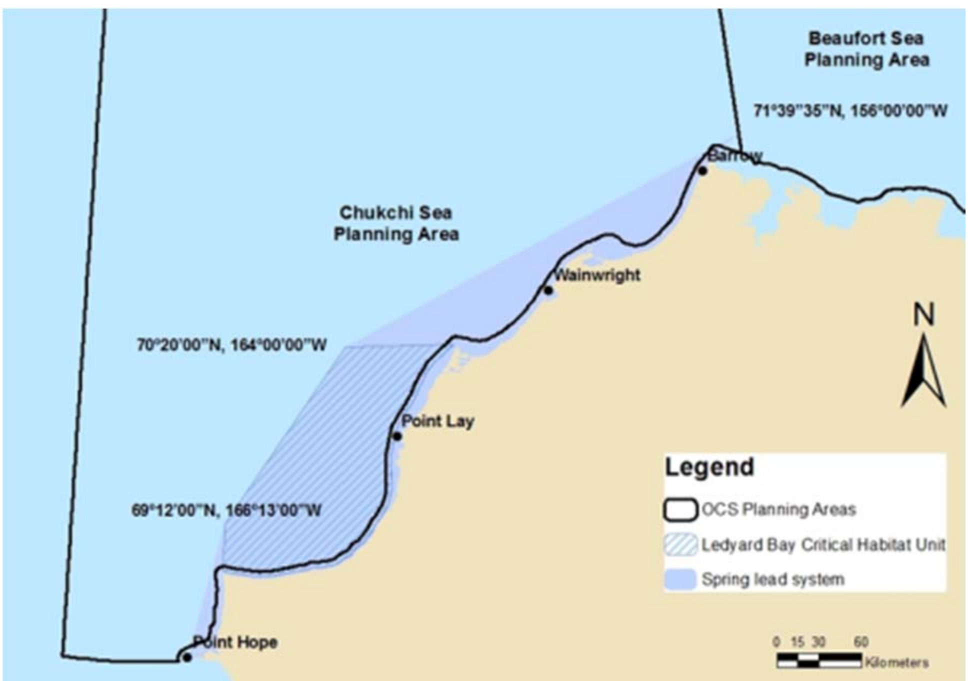

Figure 8.1. Spring lead system for the purposes for the Terms and Conditions section.

RPM 3 – Monitor and report oil spills to improve understanding of risk and impacts.

T&C 3. BSEE shall report oil spills $\geq$ 1 barrel as defined by 30 CFR 254.46, if the spill contacted water or ice, to the Endangered Species Branch Chief, USFWS FFWFO within 7 days. A follow-up report by BSEE is required within 30 days after the first report if the oil contacted any birds in the area, including information on number and species of birds contacted, their behavioral response and fate, and other circumstances relevant to the impact of contact.

8.4 Conclusion for RPMs and T&Cs

The RPMs, with their implementing T&Cs, are designed to minimize the impact of incidental take that might otherwise result from the proposed Action. The Service believes that no more than **7 spectacled eiders or one Steller's eider will be incidentally taken**. If, during the course of the action, this level of incidental take is exceeded, BOEM must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs. Additionally, re-initiation of consultation will be required.

8.5 Polar Bears

Consistent with the ESA and regulations at 50 CFR 402.14(i), incidental take authorization for marine mammals is not included in formal consultations until regulations, authorizations, or permits under the MMPA 101(a)(5) are in effect. Thus, the Service is not authorizing incidental take for polar bears within this BO, but instead will authorize take under the ESA through the process used to authorize incidental take for polar bears under the MMPA. The evaluations in this BO are predicated on the assumption that authorization under the MMPA will be provided. Once a lessee or permittee (or agent of a lessee or permittee) receives an LOA (or Incidental Harassment Authorization) for incidental take pursuant to section 101(a)(5) or intentional take pursuant to sections 101(a)4(A), 1019(h), and 112(c) of polar bears, the LOA will contain measures to reduce impacts to bears that will also serve as RPMs, pursuant to section 7(b)(4) of the ESA.

It is important to note, however, that BOEM/BSEE cannot require that a lessee or permittee (or agent of a lessee or permittee) request incidental take authorization under the MMPA. Should the lessee or permittee (or agent of a lessee or permittee), decline to apply for incidental take authorization under the MMPA, or not qualify for authorization, BOEM/BSEE would need to consult separately under the ESA if the proposed activity may affect the polar bear. This will ensure that the action does not violate section 7(a)(2) of the ESA, and will provide an alternate mechanism for measures to reduce impacts.

9 Reporting Requirements

The BSEE, Alaska OCS Region, must submit an Annual Monitoring Report for each year, by March 30th of the following year, to the Endangered Species Branch Chief, USFWS, FFWFO, and the Regional Supervisor – Environment, BOEM, Alaska OCS Region. The purpose of this report is to monitor the effectiveness of RPMs/T&Cs and effects of the first incremental step on listed species and critical habitat. The Annual Monitoring Report will include the following information:

- A summary of avian collisions reported during the previous calendar year (RPM 1).
- A summary of low-level flights over LBCHU and spring lead system reported by the lessees, permittees of BOEM or BSEE or the agents of lessees or permittees for medical or other emergency (RPM 2/LBCHU);
- A summary of vessel entries into LBCHU after July 1 (RPM 2/LBCHU);

- A summary of vessel entries into spring lead system from April 1 to June 10 (RPM 2/LBCHU);
- A summary of the location and number of OCS wells drilled in the preceding calendar year (RPM 2/LBCHU);
- A summary of all reported spills $\geq$ 1 barrel for the preceding calendar year (RPM 3);
- A summary of any incidences of non-compliance issued to the lessees and permittees of BOEM or BSEE and the agents of their lessees and permittees for activities conducted in the preceding year. If new incidents of non-compliance from previous years emerge, report these incidents in the next annual report; and
- A summary of efforts by BOEM and BSEE to implement conservation recommendations (see below).

10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

As described in the *Conclusion* section under incremental consultation regulations (50 CFR 402.14(k)), BOEM/BSEE is required to fulfill its continuing obligation to obtain sufficient data upon which to base the final BO on the entire proposed Action. In addition to management-specific research needs, BOEM/BSEE is encouraged to support research that may provide information to strengthen our understanding of Steller's and spectacled eiders and polar bears and their status, distribution, and ecology in the Chukchi Sea, and assist in implementing recovery efforts. Specific research needs include:

- Characterizing the distribution and use of marine habitats of spectacled and Steller's eiders in the Chukchi Sea;
- Ecosystem research in the spring lead system, the LBCHU (especially changes to benthic communities), and other marine habitats used by spectacled and Steller's eiders, and evaluation of current and potential future impacts of environmental change on these habitats;
- Developing technologies for reducing migratory bird collisions with offshore and onshore oil and gas development infrastructure, particularly for listed eiders;
- Monitoring abundance, trends, habitat use, and productivity of listed species to assist with understanding potential effects of human activities on populations, including in the terrestrial environment; and
- As suggested by Gall and Day (2010), fund efforts to synthesize data in reports authored by Gall and Day (2010), Blanchard et al. (2010), and Hopcroft et al. (2010), to elucidate the ecosystem differences between the Burger (possibly benthic dominated) and Klondike Study Areas (possibly pelagic-dominated).

Further, BOEM/BSEE and the oil and gas industry can reduce potential impacts to listed species and critical habitat by:

- Avoiding proposing infrastructure in important eider habitats, including the LBCHU, spring leads, nesting habitat near Barrow, and on or adjacent to areas where large number of polar bears are known to congregate;
- Avoiding proposing development in areas where spilled oil has a high risk of reaching the LBCHU or spring leads;
- Improving technology to reduce the maximum amount of oil that can be spilled in marine areas, which has great bearing on potential risk to wildlife in marine areas; and
- Working with the Service and other species experts to develop strategies that could be implemented to prevent oil contacting listed species in the event of a large marine spill.

11 Re-initiation Notice

This concludes formal consultation on the Action described. This BO considered activities associated with offshore activities associated with the first incremental step and the entire action as required under 50 CFR 402.14(k). As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and:

1) If the amount or extent of incidental take is exceeded;
2) If new information reveals effects of the action agency that may affect listed species or designated critical habitat in a manner or to an extent not considered during offshore activities during the first incremental step of this opinion;
3) If the agency action is subsequently modified in a manner that causes an effect to listed or critical habitat not considered in this opinion (see below);
4) If a new species is listed or critical habitat designated that may be affected by the action;
5) If an action is conducted under the authority of Lease Sale 193 that may adversely affect polar bears, and the lessee or permittee (or agent of a lessee or permittee) declines to apply for an LOA or does not qualify for an LOA; and
6) Finally, additional consultation will be required before future incremental steps of the proposed Action may be authorized.

It should be noted that construction of one or more shorebases to support exploration could result in adverse effects to spectacled and Alaska-breeding Steller's eiders through habitat loss and the potential that activity on the shorebases could affect eider nesting in adjacent habitat through disturbance/displacement. The likelihood and magnitude of these effects will vary, possibly considerably, with the location and size of shorebases and associated habitat impacts, such as borrow pits needed to provide gravel fill. Given the lack of specificity in the BA regarding the number, size, and location of shorebases, we have not fully evaluated the potential effects of shorebases, nor have we enumerated or provided incidental take exemptions for spectacled and Alaska-breeding Steller's eiders due to habitat impacts in the terrestrial environment from the first incremental step. In the event that exploration entails construction of onshore support facilities that are likely to adversely affect spectacled or Alaska-breeding Steller's eiders through habitat impacts in the terrestrial environment, consultation should be reinitiated to ensure that impacts are appropriately evaluated, enumerated, and exempted from incidental take prohibitions. Evaluation should also include thoughtful consideration of the potential for shorebases constructed to support exploration to later be adapted or expanded to support development and production.

Thank you for your cooperation in the development of this BO. If you have any comments or require additional information, please contact Ted Swem, Endangered Species Branch Chief, Fairbanks Fish and Wildlife Field Office, 101 12th Ave., Fairbanks, Alaska, 99701.

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13 Appendix A: Mitigation Measures as Presented by BOEM (2015a)

2.3. Mitigation Measures

The following sections describe a variety of mitigation measures typically required for the types of activities comprising the Proposed Action. As described below, at the lease sale stage these mitigations typically take the form of lease stipulations; post-lease activities may have mitigation imposed through conditions of approval of plans, permit conditions, or other mechanisms. we note, however, that while the Proposed Action represents a reasonably foreseeable suite of exploration, development, production, and decommissioning activities that could potentially occur, considerable uncertainty exists as to what activities will actually be proposed in the future. As specific projects are proposed in this multi-stage oil and gas program, more precise information about the nature and extent of the activities – including the scale and location of the activities and a description of the particular technologies to be employed – will be considered and evaluated in additional ESA consultations and other analyses (such as NEPA) as appropriate. Through this multi-stage process, a dynamic analysis of the potential effects of oil and gas activities is ensured, and additional mitigation measures and protections may be developed and at any stage based on the specific details of the particular projects.

There are a variety of typical design features and operational procedures used to mitigate the potential impacts of petroleum activities. Leaseholders and other permittees routinely request, and are expected to obtain, authorizations, including Incidental Harassment Authorizations (IHAs) and Letters of Authorization (LOAs) for activities that could result in the “take” marine mammals under the MMPA. These authorizations contain mitigation measures to ensure the authorized activities would result in the take of no more than small numbers of marine mammals and have no more than a negligible impact on marine mammal stocks. This standard represents a lower threshold for impacts than the jeopardy standard under the ESA. Mitigation measures typically required for activities in the Chukchi Sea are described below and analyzed in Section 5. As such measures are continually being revised or updated, and can be site-specific, the list below is not intended as a commitment for any particular activity. The final design features and operational procedures used for mitigation are identified in each LOA or IHA prior to commencement of activities in the Alaska OCS.

In the following sections, BOEM and BSEE discuss the kinds of mitigation measures that are typically applied to the types of activities comprising the first incremental step and then those specific to future incremental step activities. The final section addresses two new technologies with potential for ameliorating the effects of airguns, as well as several new technologies with potential for replacing airguns as a means of reducing potential adverse effects on marine mammals. BOEM did not identify any additional mitigation measures specific to the natural gas development and production scenario evaluated in the Lease Sale 193 Exploration and Development Scenario in the 2014 second SEIS (USDOI, BOEM, 2014)

2.3.1. Lease Sale 193 Stipulations

Mitigation measures are associated with each lease sale in the form of lease stipulations. Stipulations are requirements added to the lease that become contractual obligations that the lessee must follow. The seven stipulations that apply to the leases issued pursuant to Chukchi Sea OCS Oil and Gas Lease Sale 193 are set forth in Appendix D of the Second SEIS (USDOI, BOEM, 2014). The list of lease stipulations below remains comprehensive:

1. Protection of Biological Resources
2. Orientation Program
3. Transportation of Hydrocarbons
4. Industry Site-Specific Monitoring for Marine Mammal Subsistence Resources
5. Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence-Harvest Activities
6. Pre-Booming Requirements for Fuel Transfers
7. Measures to Minimize Effects on Spectacled And Steller's Eiders from Exploration Drilling

Of particular relevance to this BA are lease stipulations 1, 4, 5, and 7. Lease stipulation 1 gives BOEM and BSEE additional authority when a previously unidentified biological population or habitat is discovered in the lease area, including the authority to require that the lessee conduct biological surveys to determine the presence, extent, and composition of the biological population(s) or habitat(s), and relocate and/or modify the types and timing of operations to minimize impacts to the biological population(s) and/or habitat(s). Stipulation 4 requires that lessees who are proposing to conduct exploration operations on lease blocks that were identified during Lease Sale 193 as important areas for subsistence (see Appendix A) conduct a Regional Supervisor, Field Operations (RS/FO)-approved site-specific monitoring program unless the RS/FO, in consultation with appropriate agencies (i.e., NMFS, USFWS) and co-management organizations (e.g., Alaska Nanuuq Commission, Eskimo Walrus Commission (EWC)), determines that a monitoring program is not necessary. Stipulation 5 requires that all exploration, development, and production operations (and support activities associated with such operations) within lease blocks that were identified during Lease Sale 193 as important areas for subsistence (see Appendix A) and in all federal waters landward of the Lease Sale 193 area be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities. Lease stipulation 7 outlines actions that lessees are required to take that will minimize the likelihood that Spectacled and Steller's eiders will strike drilling structures or vessels. Lease stipulation 7 also provides additional protection to eiders within the blocks listed below and Federal waters landward of the sale area, including the Ledyard Bay Critical Habitat Area (LBCHA), during times when eiders are present.

In addition to stipulations, lease sales may also have ITLs (Information to Lessees) and NTLs (Notices to Lessees) associated with them. Certain ITLs and NTLs provide additional information to the lessees on best practices or ways to further mitigate the potential for impacts. For a full list of mitigation measures associated with existing leases in the Chukchi Sea, see Appendix A.

2.3.2. Mitigation Measures Associated with First and Future Incremental Step Activities

Mitigation measures are specific to the different types of activities in each phase of oil and gas development. Below, with respect to exploration, mitigation measures and typical monitoring protocols for seismic operations are addressed first, and then mitigation measures associated with exploratory and delineation drilling are presented. Mitigation measures for vessel, aircraft, and terrestrial vehicle operations and onshore development activities, are also presented.

If first incremental step activities delineate oil and gas reserves of sufficient size, and companies choose to move into production, additional consultation would take place when BOEM receives a DPP. The DPP describes development and production activities proposed by an operator for a lease or group of leases. The description includes the timing of these activities, information concerning drilling vessels, the location of each proposed well or production platform or other structure, and an analysis of both offshore and onshore impacts that may occur as a result of the plan's implementation. The DPP would identify the precise location of the production well and associated facilities such as pipelines to shore and onshore processing facilities, providing BOEM, BSEE, and USFWS with project-specific details of future incremental step activities that enable the agencies to evaluate impacts on listed species at a more detailed level and to identify potential mitigations of such impacts.

2.3.2.1. Seismic Operations

Seismic operations include deep penetration (primarily marine streamer 2D and 3D surveys; see Section 2.2.1.1.1) and ancillary activities (high-resolution surveys; see Sections 2.2.1.1.2 and 2.2.1.1.3). Monitoring is conducted by on-board Protected Species Observers (PSOs) to activate appropriate mitigation measures to protect ESA-listed species during completion of specific activities. Therefore, monitoring protocols are discussed first, followed by mitigation measures in four categories of seismic survey.

2.3.2.2. Seismic Survey Mitigation

The monitoring protocols below are important for ensuring that the following mitigation measures are implemented as appropriate. Mitigation measures vary with the specific category of seismic survey being utilized. Four categories are discussed below.

2.3.2.2.1. Vessel-based Seismic Surveys

BOEM and BSEE’s G&G permit stipulations for vessel-based surveys include:

- Timing and location: Timing and locating survey activities to avoid interference with the marine mammal hunts.
- Minimized energy: Selecting and configuring the energy source array in such a way that it minimizes the amount of energy introduced into the marine environment by using the lowest sound levels feasible to accomplish data collection needs.
- Established safety zones: Early season field assessment to establish and refine (as necessary) the appropriate 180-dB and 190-dB safety zones, and other radii relevant to behavioral disturbance.

The potential disturbance of marine mammals during seismic survey operations is minimized further through the typical implementation of several ship-based mitigation measures, which include establishing and monitoring safety and disturbance zones, speed and course alterations, ramp-up (or soft start), power-down, and shutdown procedures, and provisions for poor visibility conditions.

- Safety and disturbance zones: Operators are required to use NMFS-approved observers onboard the survey vessel to monitor the 190-, 180-, and 160-dB (rms) safety radii for pinnipeds, cetaceans, and polar bears, and to implement other appropriate mitigation measures.

Safety radii for marine mammals around airgun arrays are customarily defined as the distances within which received pulse levels are greater than or equal to 180 dB re 1 μPa (rms) for walrus, and 190 dB re 1 μPa (rms) for polar bears.

- Ramp-up: A ramp-up (or "soft start") of a sound source array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns until the desired operating level of the full array is attained. The purpose of a ramp-up is to alert marine mammals in the vicinity to the presence of the sound source and to provide them time to leave the area and thus avoid any potential injury or impairment of their hearing abilities. During a survey program, the operator is required to ramp up sound sources slowly (if the sound source being utilized generates sound energy within the frequency spectrum of pinnipeds hearing). Full ramp-ups (i.e., from a cold start after a shutdown, when no airguns have been firing) will begin by firing one small airgun. Ramp-ups are required at any time electrical power to the airgun array has been discontinued for a period of 10 min or more and the observer watch has been and the observer watch has been suspended. The entire safety zone must be visible and monitored by observers during the 30 min lead-in to a full ramp-up, and clear of marine mammals for 15 min prior to beginning the ramp-up from a cold start, to ensure that no marine mammals enter the safety zone. Lead-in to a full ramp-up from a cold- start to ensure that no marine mammals have entered the safety zone.
- Power-downs and Shutdowns: A power-down is the immediate reduction in the number of operating energy sources from all firing to some smaller number. A shutdown is the immediate cessation of firing of all energy sources. The arrays will be immediately powered down whenever a marine mammal is sighted approaching near or close to the applicable safety zone of the full arrays but is outside the applicable safety zone of the single source. If a marine mammal(s) is sighted within the applicable safety zone of the single energy source, the entire array will be shut down (i.e., no sources firing).
- Following a power-down or shutdown, operation of the airgun array will not resume until the marine mammal has cleared the applicable safety zone. If a marine mammal(s) is sighted within the safety zone during the 30 min watch prior to ramp-up, ramp-up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15 min for pinnipeds and 30 min for baleen whales. The vessel operator and observers will maintain records of the times when ramp-ups start and when the airgun arrays reach full power. During periods of transit between survey transects and turns, one airgun (or sound source) will remain operational. The ramp-up procedure still must be followed when increasing the source levels from one gun to the full array. Keeping an air gun firing avoids the prohibition of a cold start during darkness or other periods of poor visibility. Survey operations can resume upon entry to a new transect without a full ramp-up and the associated 30 min lead-in observations as long as the exclusion zones are free of marine mammals.

- Operations at Night and in Poor Visibility: Most operators conduct seismic operations 24 hr/day. When operating under conditions of reduced visibility attributable to darkness or to adverse weather conditions, infrared or night-vision binoculars will be available for use. It is recognized, however, that their effectiveness is limited. For that reason, observers will not routinely be on watch at night, except in periods before and during ramp-ups. As stated earlier, if the entire safety zone is not visible for at least 30 min prior to ramp-up from a cold start, then ramp-up may not proceed. It should be noted that if one small airgun has remained firing, the rest of the array can be ramped up during darkness or in periods of low visibility. Survey operations may continue under conditions of darkness or reduced visibility.

Note: An exception to this is when in-ice surveys are conducted. For in-ice surveys only, vessel-based observers would typically be required to monitor for marine mammals near the seismic source vessel during all periods of airgun survey operations and prior to any ramp up of the airgun array. Observers would not be required to monitor for marine mammals during turns and during transit between seismic survey lines when a mitigation airgun is operating.

- Speed and Course Alterations: If a marine mammal (in water) is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course will be changed in a manner that does not compromise safety requirements. The animal's activities and movements relative to the source vessel will be closely monitored to ensure that the individual does not approach within the safety radius. If the mammal is sighted approaching near or close to the applicable safety radius, further mitigative actions must be taken, i.e., either further course alterations or power-down or shutdown of the airgun(s).
- In the event that an injured or dead marine mammal is sighted within an area where the operator deployed and utilized airguns within the past 24 hr, the airguns must be shut down immediately and the Marine Mammal Stranding Network/USFWS notified. If an assessment (certified by the lead PSO onboard) indicates the marine mammal was not a casualty of project-related vessel/seismic operations, the ramp-up may be initiated and the survey continued.

2.3.2.2.2. In-Ice Seismic Surveys

A recent proposal for an in-ice seismic survey incorporated design features and operational procedures for minimizing the potential for impacts to marine mammals (NMFS, 2013a). The survey was designed to proceed as follows:

- The survey was scheduled to occur in late September–December to avoid higher local marine mammal abundance.
- The seismic survey would have begun in the deep water area of the northeastern U.S. Beaufort Sea where marine mammals would be least abundant.
- PSOs were required to be on duty whenever airguns were firing during daylight and during the 30-min periods prior to ramp up. PSOs were on standby for monitoring during periods of darkness. The PSOs could be called to duty when marine mammals were sighted and/or during ramp up of the powered-down array when the mitigation gun was firing during low visibility.
- The survey would have proceeded along a course designed in part to avoid interference with marine mammal migrations.

Authorization of an in-ice seismic survey is anticipated to require the same basic mitigation measures as required for open-water vessel-based seismic surveys, with additional measures to account for longer periods of darkness:

- Safety zones: As with other seismic surveys, a 180-dB (for cetaceans)/190-dB (for pinnipeds and polar bears) isopleth zone around the seismic-survey-sound source must remain free of marine mammals before the survey can begin and must remain free of marine mammals during the survey.
- Observers: Trained observers would watch for and identify marine mammals; recording their numbers, distances, and reactions to the survey operations. The observers have the authority to initiate a power-down or shutdown.
- Equipment: The observers would have 7×50 reticle binoculars, +20× binoculars, a GPS unit, laptop computers, and night vision binoculars available. The observers may use night vision binoculars or floodlights to aid monitoring during periods of darkness. A forward looking infrared thermal imaging (FLIR) camera system mounted on a high point in front of the icebreaker would also be available to assist with detecting the presence of seals on ice and in water ahead of the airgun array.
- Ramp up: If the airgun array is shut down for any reason, it will not be ramped up again until no marine mammals are detected within the 180/190-dB exclusion zone for 30 min.
- Exclusion zone: While ice would be more prevalent during the post-September period, observations of a seal on ice would not trigger a shutdown unless the seal entered the water within the exclusion zone.

BOEM requires detailed weekly operations reports, which includes observer reports during operations, and a comprehensive completion report due 30 days after operations cease. Any harm or mortality to a marine mammal must be reported to BOEM, BSEE, and USFWS immediately. Review of the observer reports, vessel track, and activity reports can be used as a management tool to monitor disturbance events during the survey and to modify survey plans, if necessary.

2.3.2.2.3. Protected Species Monitoring

Monitoring for protected species during seismic surveys will be conducted throughout the period of survey operations by PSOs. The observers are stationed aboard the survey source vessel. Duties of the observers include watching for and identifying polar bears and pinnipeds; recording their numbers, distances, and reactions to the survey operations; initiating mitigation measures; and reporting the results.

The observers must be on watch during all daylight periods when the energy sources are in operation and when energy source operations are to start up at night. A shift does not exceed four consecutive hours, and no observer works more than three shifts in a 24-hr period (i.e., 12 hr total per day) in order to avoid fatigue. Observers are biologists/local experts who have previous marine mammal observation experience and field crew leaders are highly experienced with previous vessel-based monitoring projects. Qualifications for these individuals are typically provided to NMFS for review and acceptance. All observers complete a training session on marine mammal monitoring shortly before the start of their season.

Monitoring Methods

The following are the standard monitoring methods utilized to ensure that appropriate mitigation measures are initiated at the appropriate times.

- Vantage point: The observer(s) will watch for marine mammals from the best available vantage point on the operating source vessel, which is usually the bridge or flying bridge. Personnel on the bridge will assist the PSOs in watching for marine mammals.
- Observer equipment: The observer(s) will scan systematically with the naked eye and 7 x 50 reticle binoculars, supplemented with 20 x 50 image stabilized binoculars, and night-vision equipment when needed.
- Safety zones: The observer(s) will give particular attention to the areas within the "safety zone" around the source vessel. These zones are the maximum distances within which received levels may exceed 180 dB re 1 μPa (rms) for cetaceans or 190 dB re 1 μPa (rms) for pinnipeds. The observers will also monitor the 160 dB re 1 μPa (rms) radius for Level B harassment takes. When a marine mammal is seen within the applicable safety radius, the geophysical crew will be notified immediately so that the required mitigation measures can be implemented. It is expected that the airgun arrays will be shut down or powered down within several seconds-often before the next shot would be fired, and almost always before more than one additional shot is fired. The observer will then maintain a watch to determine when the mammal(s) is outside the safety zone such that airgun operations can resume.
- Sighting information: When a marine mammal sighting is made, the following information about the sighting is recorded: (1) species, group size, age/size/sex categories (if determinable), behavior when first sighted and after initial sighting, heading (if consistent), bearing and distance from the source vessel, apparent reaction to the source vessel (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace; (2) time, location, heading, speed, activity of the vessel, and operational state (e.g., operating airguns, ramp-up, etc.), sea state, ice cover, visibility, and sun glare; and (3) the positions of other vessel(s) in the vicinity of the source vessel. This information will be recorded by the observers at times of marine mammal sightings.
- General information: The ship's position, heading, and speed; the operational state (e.g., number and size of operating energy sources); and the water temperature (if available), water depth, sea state, ice cover, visibility, and sun glare will also be recorded at the start and end of each observation watch, every 30 min during a watch, and whenever there is a substantial change in one or more of those variables.
- Estimated distances: Distances to nearby marine mammals (e.g., those within or near the 190-dB (or other) safety zone applicable to pinnipeds) will be estimated with binoculars (7 x 50) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers will use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.
- Observation equipment: Prior to mid-August, there will be no hours of total darkness in the Chukchi Sea Program Area. Onboard observers will scan systematically with the naked eye, and the operators will also provide or arrange for the following specialized field equipment for use by the observers: reticule binoculars, 20 x 50 image stabilized binoculars, Big Eye binoculars, laser rangefinders, inclinometer, and laptop computers. Night vision equipment will be available for use when needed.

Acoustic Sound Source Verification Measurements

The operator or leaseholder is typically required by NMFS to conduct acoustic measurements of their equipment (including source arrays) at the source. These sound source verification (SSV) tests will be utilized to determine safety radii for the airgun array. A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190-, 180-, and 160-dB re
1 μPa (rms) radii of the airgun sources, will be submitted within 5 days after collection and analysis
of those measurements. This report will specify the distances of the safety zones that were adopted for the survey. The measurements are made at the start of the field season so that the measured radii can be used for the remainder of the survey period.

Field Data-recording and Verification

The following procedures for data recording and verification allow initial summaries of data to be prepared during and shortly after the field season and will facilitate transfer of the data to statistical, graphical, or other programs for further processing. Quality control of the data will be facilitated by the start-of-season training session, subsequent supervision by the onboard field crew leader, and ongoing data checks during the field season.

- Recording: The observers will record their observations onto datasheets or directly into handheld computers.

- Database: During periods between watches and periods when operations are suspended, data will be entered into a laptop computer running a custom computer database.
- Verification: The accuracy of the data entry will be verified in the field by computerized validity checks as the data are entered and by subsequent manual checking of the database printouts.

Use of Passive Acoustic Arrays

Although not required, industry has jointly funded an extensive acoustic monitoring program. This program incorporates the use of dozens of recorders distributed broadly across survey area and the nearshore environment. The broad area arrays are designed to capture both general background soundscape data and marine mammal call data. From these recordings, it is anticipated that industry/government may be able to gain insights into large-scale distribution of marine mammals, identification of marine mammal species present, movement and migration patterns, and general abundance data. The intense area arrays are designed to support localization of marine mammal calls on and around the survey areas.

Reporting

All walrus and polar bear sightings must be reported and include the details specified in and any relevant IHA issued pursuant to the MMPA. A report that summarizes the monitoring results and operations as specified in the LOA must be received no later than 90 days after completion of the project. The reports include:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through study period versus operational state, sea state, and other factors affecting visibility and detectability of marine mammals).
- Summaries of the occurrence of power-downs, shutdowns, ramp-ups, and ramp-up delays.
- Analyses of the effects of various factors, influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare).
- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover.
- Sighting rates of marine mammals versus operational state (and other variables that could affect detectability).
- Initial sighting distances versus operational state.
- Closest point of approach versus operational state.
- Observed behaviors and types of movements versus operational state.
- Numbers of sightings/individuals seen versus operational state.
- Distribution around the acoustic source vessel versus operational state.
- Estimates of take by harassment.

The take estimates are calculated using two different methods to provide both minimal and maximal estimates. The minimum estimate is based on the numbers of marine mammals directly seen within the relevant radii (160, 180, and 190 dB (rms)) by observers on the source vessel during survey activities. The maximal estimate is calculated using densities of marine mammals determined for non- acoustic areas and times. These density estimates are calculated from data collected during (a) vessel based surveys in non-operational areas, or (b) observations from the source vessel or supply boats during non-operational periods. The estimated densities in areas without data acquisition activity are applied to the amount of area exposed to the relevant levels of sound to calculate the maximal number of animals potentially exposed or deflected. These reports are due 90 days after termination of the survey season.

2.3.2.3. Exploration and Delineation Drilling

Under the Proposed Action, exploration and delineation drilling operations are expected to use MODUs with icebreaker support vessels. Drilling operations are expected to range between 30 and 90 days per well site, depending on the depth of the well, delays during drilling, and time needed for well logging and testing operations. Considering the relatively short open-water season in the Chukchi Sea OCS (June–November), BOEM and BSEE estimate that two wells per drilling rig could be drilled, tested, and abandoned during a single open-water season. Drilling operations would be supported by resupply vessels and, most likely, ice management vessels.

Drilling activities generate continuous non-pulse sounds during operations. The continuous nature of these sounds allows polar bears and pinnipeds approaching the activity to be exposed to increasing levels of noise and to have an opportunity to avoid the location well before there is any chance of injury.

Mitigation measures are unique depending on the specific circumstances of the drilling operations, as described below.

Shell Gulf of Mexico, Inc. measured the sounds produced by the Discoverer while drilling on the Burger Prospect (within the Leased Area) in 2012. A broadband (10 Hz – 32 kHz) source level of 182 dB was calculated for the Discoverer based on the measurements recorded when drilling the 26-in hole interval (Bisson et al., 2013). These estimates are considered representative of a typical industry- standard, ice-reinforced drillship that would be used for exploration drilling in the Arctic OCS.

Shell's measurements showed source levels from drilling would fall below 160 dB (rms) within 10 m from the drillship. The 2012 measurement of the distance to the 120 dB (rms) threshold for normal drilling activity by the Discoverer was 0.93 mi (1.5 km) while the distance of the ≥120 dB (rms) radius during mudline cellar (MLC) construction was 5.1 mi (8.2 km) (Bisson et al. 2013). These near-continuous, non-pulse source sound levels were expected to cause some temporary avoidance of the immediate area by marine mammals but no physical damage to marine mammal hearing.

Drilling activities could cease in certain areas in deference to subsistence whaling when operations are close enough to impact the hunt(s). While MODUs could be moved to another area during this period of inactivity, moving a drilling rig in the middle of the season increases the chance of a spill and poses associated safety and logistical concerns. The non-operation of MODU would avoid drilling-related effects to listed species at the drill site, however as this measure is highly location- and season-specific this type of mitigation measure cannot be considered to apply to all MODU operations. The mitigation of subsistence marine mammal harvests is a requirement of the MMPA, and is not a direct consideration of the ESA.

Previously submitted exploration plans have included the use of observers onboard the drillship and various support vessels to monitor marine mammals and marine mammal responses to industry activities. While not specifically required for inclusion in exploration plans, these monitoring efforts will help industry/government agencies evaluate the effectiveness of mitigation measures and evaluate adverse effects of the activity on marine mammals. The observers would initiate mitigation measures should in-field measurements of the operations indicate conditions represented a threat to the health and well-being of marine mammals.

Mitigation measures for authorized discharges are described according to relevant requirements of the EPA NPDES permit (see Section 2.2.1.1.4).

2.3.2.4. Vessel Operations

There are a wide variety of vessels of different types and sizes that operate in support of exploration activities. These vessels typically conform to the following operational procedures with respect to whales, as stipulated in IHAs and LOAs:

- Maximum distance. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from groups of walruses, and must maintain a minimum 800 m (½ mi) buffer zone from walruses and polar bears.
- Changes in direction. Vessel operators should avoid multiple changes in direction when within ½ mi (800 m) of walruses; however, those vessels capable of steering around such groups should do so.
- Changes in speed. Vessels should avoid multiple speed changes; however, vessels should slow down when near groups of walruses, especially during poor visibility, to reduce the potential for collisions.
- Groups of walruses. Vessels may not be operated in such a way as to separate members of a group of walruses.

Some oil and gas exploration activity includes the use of an icebreaker. Icebreakers contribute greater sound levels during ice-breaking activities than ships of similar size during normal operation in open water (Greene and Moore, 1995). As the icebreakers would not generate noise above 160 dB re 1μPa (rms), and because the icebreaker activity would most likely be needed to protect the safety of fleet/drilling platform, there are no associated mitigation measures or provisions for shutdowns, power-downs, or ramp-ups. The icebreakers could be required to have on-board PSOs whose duties will include watching for and identifying marine mammals, recording their numbers, recording distances, and recording their reactions to the drilling operations.

2.3.2.5. Aircraft Operations

Aircraft are typically required to operate within specific height and distance parameters with respect to marine mammals. These include the following:

- Helicopters: Helicopters may not hover or circle above marine mammals or pass within ½ mi (800 m) lateral distance of groups of walruses or polar bears.
- Inclement weather: When weather conditions do not allow a 1,500 ft flying altitude, such as during storms or when cloud cover is low, aircraft may be operated below 1,500 ft, but the operator should avoid known walrus concentration areas and take precautions to avoid flying directly over or within ½ mi (800 m) of walruses.
- Support aircraft: Support aircraft must avoid extended flights over the coastline to minimize effects on marine mammals in nearshore waters or the coastline.

Aerial marine mammal surveys have not been required in the Chukchi Sea because of a lack of adequate landing facilities and the prevalence of fog and other inclement weather in that area, potentially resulting in an inability to return to the airport of origin, and thereby resulting in safety concerns.

2.3.2.6. Onshore Operations

Onshore activities associated with the Proposed Action would be subject to permits, authorizations, stipulations, required operating procedures (ROPs), and best management practices (BMPs) as recommended or required by the appropriate land-based resource and management agencies. The U.S. Bureau of Land Management's 2013 Record of Decision (ROD) for the National Petroleum Reserve – Alaska Integrated Activities Plan (USDOI, BLM, 2013) presents stipulations and BMPs that are typical of the types of mitigation BOEM anticipates for onshore oil and gas activities described in the Proposed Action if located on Federal lands. These mitigation measures provide operators with guidance in minimizing impacts to wildlife, vegetation, and subsistence resources, including requirements for water and mineral withdrawals, waste disposal, construction footprints, and contaminant and spill handling. Of particular applicability to ESA-listed species are the following BMPs:

A–8: Objective: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.

Requirement/Standard: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans.

C–1: Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.

Requirement/Standard:
a. Cross-country use of heavy equipment and seismic activities is prohibited within ½ mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game.
b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with USFWS and/or NOAA-Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.

E–4: Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.

Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections.

E–5: Objective: Minimize impacts of the development footprint.

Requirement/Standard: Facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include:
a. Use of maximum extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads;
b. sharing facilities with existing development;
c. collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads;
d. integration of airstrips with roads;
e. use of gravel-reduction technologies, e.g., insulated or pile-supported pads; and,
f. coordination of facilities with infrastructure in support of offshore development.
Note: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.

E–8: Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.

Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider:
a. Locations outside the active flood plain.
b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.
d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.

E–10: Objective: Prevention of migrating waterfowl, including species listed under the Endangered
Species Act, from striking oil and gas and related facilities during low light conditions.

Requirement/Standard: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration.

E–11: Objective: Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.

Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller's Eiders Habitats:

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol. Information gained from these surveys shall be used to make infrastructure siting decisions as discussed in subparagraph b, below.

b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall work with USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.

c. To reduce the possibility of spectacled and/or Steller's eiders or other birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to USFWS when exceptions are authorized.

1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.

d. To reduce the likelihood of spectacled and/or Steller's eiders or other birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low flying birds. Such markings shall be developed through consultation with USFWS.

E–18: Objective: Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests.

Requirement/Standard: Ground-level activity (by vehicle or on foot) within 200 m of occupied Steller's and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 m of occupied Steller's and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data will be used to evaluate whether the action could occur based on employment of a 200-m buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. Also, in cases in which oil spill response training is proposed to be conducted within 200 m of shore in riverine, marine, or intertidal areas, the BLM will work with USFWS to schedule the training at a time that is not a sensitive nesting/brood-rearing period or require that nest surveys be conducted in the training area prior to the rendering a decision on approving the training. The protocol and timing of nest surveys for Steller's and/or spectacled eiders will be determined in cooperation with USFWS, and must be approved by USFWS. Surveys should be supervised by biologists who have previous experience with Steller's and/or spectacled eider nest surveys.

F–1 (i): Objective: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.

Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):
Subsection (i): Aircraft used as part of a BLM-authorized activity along the coast and shorefast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.

K–3: Objective: Protect fish and wildlife habitat (including, but not limited to, that for waterfowl and shorebirds, caribou insect-relief, and marine mammals), preserve air and water quality, and minimize impacts to subsistence activities and historic travel routes on the major coastal waterbodies.

Requirement/Standard (Development): With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within ¾ mile seaward of the shoreline (as measured from mean high tide) of the major coastal waterbodies or the natural coastal islands (to the extent that the seaward subsurface is within NPR-A). These areas include: Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon, and their associated Islands. Elsewhere, permanent facilities within the major coastal waterbodies will only be permitted on or under the water if they can meet all the following criteria:

a. Design and construction of facilities shall minimize impacts to subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.

b. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.

c. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through the major coastal waterbodies as identified by the North Slope Borough.

d. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.

e. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses.

f. Before conducting open water activities, the permittee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

K–6: Objective: Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.

Requirement/Standard:

a. Exploratory well drill pads, production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the Reserve and the mainland, or in inland areas within one mile of the coast. (Note: This would include the entirety of the Kasegaluk Lagoon and Peard Bay Special Areas.) Other facilities necessary for oil and gas production within NPR-A that necessarily must be within this area (e.g., barge landing, seawater treatment plant, or spill response staging and storage areas) would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. Lessees/permittees shall consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the North Slope Borough, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.

b. Marine vessels used as part of a BLM-authorized activity shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.

c. Marine vessels used as part of a BLM-authorized activity shall maintain a ½-mile buffer from shore when transiting past an aggregation of walrus using a terrestrial haulout.

2.3.3. Mitigation Measures Considered for Alternative Exploration Technologies and Decreasing Airgun Noise

The impulsive airgun has been under scrutiny and criticism as a sound source for seismic exploration due to the belief that the propagated sound waves may harm marine life during operations. BOEM frequently receives comments from stakeholders who suggest that airguns should be replaced by more "environmentally-friendly" alternative technologies and other techniques to mitigate current technologies used in oil and gas exploration. The 2011 BE for Oil and Gas Leasing and Exploration Activities in the Beaufort Sea and Chukchi Sea Planning Areas (USDOI, BOEMRE, 2011b) provides detailed clarification on the status of these proposed technologies, including hydraulic and electric marine vibrators, Low-level Acoustic Combustion Sources (patented, LACS), Deep-towed Acoustics/Geophysics Systems (DTAGS), low frequency passive seismic methods (e.g., natural seismicity, ocean waves, microseism surface waves), and fiber optic receivers, and why they are not currently practicable. Technologies supplemental to seismic operations such as gravity/gradiometry and controlled source electromagnetics are commercially available and discussed in BOEM's 2011 BE (USDOI, BOEMRE 2011b).

2.3.3.1. Mitigation by Decreasing Airgun Impacts

In addition to alternative methods for seismic data collection, industry and the public sector have actively investigated the use of the technology-based mitigation measure to lessen the impacts of airguns in water.

2.3.3.2. Air Gun Silencer

One new technology-based measure to lessen the impacts of the airguns currently in use is an airgun silencer, which has acoustically absorptive foam rubber on metal plates mounted radially around the airgun. This technology has demonstrated 0–6 dB reductions at frequencies above 700 Hz, and 0–3 dB reductions at frequencies below 700 Hz. This system has been tested only on low pressure airguns and is not a practicable mitigation tool because it needs to be replaced after 100 shots (Spence et al., 2007).

2.3.3.3. Bubble Curtain

Bubble curtains are another technology for reducing the impacts of airguns. Bubble curtains generally consist of a rubber hose or metal pipe with holes to allow air passage and a connector hose attached to an air compressor. They have successfully been tested and used in conjunction with pile driving and at construction sites to frighten away fish and decrease the noise level emitted into the surrounding water (Würsig et al., 2000; Sexton, 2007; Reyff, 2009). They have also been used as stand-alone units or with light and sound to deflect fish away from dams or keep them out of specific areas (Weiser, 2010; Pegg, 2005).

The use of bubbles as a mitigation measure for seismic noise has also been pursued. During an initial test of the concept, the sound source was flanked by two bubble screens; it demonstrated that bubble curtains were capable of attenuating seismic energy up to 28 dB at 80 Hz while stationary in a lake. This two-bubble curtain configuration was field tested from a moving vessel in Venezuela and Aruba where a 12 dB suppression of low frequency sound and a decrease in the level of laterally projecting sound was documented (Sixma, 1996; Sixma and Stubbs, 1998). A different study in the Gulf of Mexico tested an "acoustic blanket" of bubbles as a method to suppress multiple reflections in the seismic data. The results of the acoustic blanket study determined that suppression of multiple reflections was not practical using the current technology. However, the acoustic blanket measurably suppressed tube waves in boreholes and has the capability of blocking out thruster noises from a laying vessel during an ocean-based cable (OBC) survey, which would allow closer proximity of the shooting vessel and increase productivity (Ross et al., 2004, 2005).

A recent study "Methods to Reduce Lateral Noise Propagation from Seismic Exploration Vessels" was conducted by Stress Engineering Services Inc. under the BOEM Technology Assessment & Research (TA&R) Program. The first phase of the project was spent researching, developing concepts for noise reduction, and evaluating the following three concepts: (1) an air bubble curtain; (2) focusing arrays to create a narrower footprint; and (3) decreasing noise by redesigning airguns. The air bubble curtain was selected as the most promising alternative, which led to more refined studies the second year (Ayers, Hannay, and Jones, 2009). A rigorous 3D acoustic analysis of the preferred bubble curtain design, including shallow-water seafloor effects and sound attenuation within the bubble curtain, was conducted during the second phase of the study. Results of the model indicated that the bubble curtains performed poorly at reducing sound levels and are not viable for mitigation of lateral noise propagation during seismic operations from a moving vessel (Ayers, Hannay, and Jones, 2010).