ENDANGERED SPECIES ACT – SECTION 7 CONSULTATION

BIOLOGICAL OPINION

AGENCY: National Marine Fisheries Service, Office of Protected Resources

ACTIVITY: Issuance of Incidental Harassment Authorization under section 101(a)(5)(a) of the Marine Mammal Protection Act to Shell Offshore, Inc. for exploratory drilling in the Alaskan Chukchi Sea in 2012.

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Alaska Region

APPROVED BY: Robert D. Mecum

DATE ISSUED: 4/23/12

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Presentation of the Analysis in this Opinion

Biological opinions are constructed around several basic sections that represent specific requirements placed on the analysis by the ESA and implementing regulations. These sections contain different portions of the overall analytical approach described here. This section is intended as a basic guide to the reader of the other sections of this opinion and the analyses that can be found in each section. Every step of the analytical approach described above will be presented in this opinion in either detail or summary form.

Description of the Proposed Action – This section contains a basic summary of the proposed Federal action and any interrelated and interdependent actions. This description forms the basis of the first step in the analysis where we consider the various elements of the action and determine the stressors expected to result from those elements. The nature, timing, duration, and location of those stressors define the action area and provide the basis for our exposure analyses.

Status of the Species – This section provides the reference condition for the species and critical habitat at the listing and designation scale. These reference conditions form the basis for the determinations of whether the proposed action is not likely to jeopardize the species or result in the destruction or adverse modification of critical habitat. Other key analyses presented in this section include critical information on the biological and ecological requirements of the species and critical habitat and the impacts to species and critical habitat from existing stressors.

Environmental Baseline – This section provides the reference condition for the species and critical habitat within the action area. The baseline includes the impacts of past and on-going actions (except the effects of the proposed action) on the species and critical habitat. This section also contains summaries of the impacts from stressors that will be ongoing in the same areas and times as the effects of the proposed action (future baseline). This information forms part of the foundation of our exposure, response, and risk analyses.

Effects of the Proposed Action – This section details the results of the exposure, response, and risk analyses NMFS conducted for listed species and elements, functions, and areas of critical habitat.

Cumulative Effects – This section summarizes the impacts of future non-Federal actions reasonably certain to occur within the action area. Similar to the rest of the analysis, if cumulative effects are expected, NMFS determines the exposure, response, and risk posed to individuals of the species and features of critical habitat.

Synthesis and Integration – In this section of the opinion, NMFS presents the summary of the effects identified in the preceding sections and then details the consequences of the risks posed to individuals and features of critical habitat to the species or Distinct Population Segment at issue. Finally, this section concludes whether the proposed action may result in jeopardy to the continued existence of a species or the destruction or adverse modification of designated critical habitat.

Legal and Policy Framework

The purposes of the ESA, "*…are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section*." To help achieve these purposes, the ESA requires that, "*Each Federal agency shall, in consultation with and with the assistance of 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 dedicated critical habitat…*"

Jeopardy Standard

The "jeopardy" standard has been further interpreted in regulation (50 CFR 402.02) as a requirement that Federal agencies insure that their actions are not reasonably expected to reduce appreciably *the likelihood of both the survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution*. It is important to note that the purpose of the analysis is to determine whether or not appreciable reductions are reasonably expected, but not to precisely quantify the amount of those reductions. As a result, our assessment often focuses on whether a reduction is expected or not, but not on detailed analyses designed to quantify the absolute amount of reduction or the resulting population characteristics (abundance, for example) that could occur as a result of proposed action implementation.

For the purposes of this analysis, NMFS equates a listed species' probability or risk of extinction with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. A designation of a high risk of extinction indicates that the species faces significant risks from internal and external processes that can drive a species to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

The parameters of productivity, abundance, and population spatial structure are important to consider because they are predictors of extinction risk, the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed species, and these parameters are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02).

Destruction or Adverse Modification Standard

The Ninth Circuit Court of Appeals rendered a decision in Gifford Pinchot v. U.S. Fish and Wildlife (No. 03-35279) finding that NMFS's regulatory definition of "destruction or adverse modification" of critical habitat was contrary to law. Pending the adoption of new regulatory definition, we now rely upon the statutory provisions of the ESA to complete the analysis with respect to critical habitat. NMFS will evaluate "destruction or adverse modification" of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species.

Additional requirements on the analysis of the effects of an action are described in regulation (50 CFR 402) and our conclusions related to "jeopardy" generally require an expansive evaluation of the direct and indirect consequences of the proposed action, related actions, and the overall context of the impacts to the species and habitat from past, present, and future actions as well as the condition of the affected species [for example, see the definitions of "cumulative effects," "effects of the action," and the requirements of 50 CFR 402.14(g)]. Recent court cases have reinforced the requirements provided in section 7 regulations that NMFS must evaluate the effects of a proposed action within the context of the current condition of the species and critical habitat, including other factors affecting the survival and recovery of the species and the functions and value of critical habitat.

Consultations designed to allow federal agencies to fulfill these purposes and requirements are concluded with the issuance of a biological opinion or a concurrence letter. Section 7 of the ESA and the implementing regulations (50 CFR 402), and associated guidance documents (*e.g.,* USFWS and NMFS 1998) require biological opinions to present: (1) a description of the proposed Federal action; (2) a summary of the status of the affected species and its critical habitat; (3) a summary of the environmental baseline within the action area; (4) a detailed analysis of the effects of the proposed action on the affected species and critical habitat; (5) a description of cumulative effects; and (6) a conclusion as to whether it is reasonable to expect the proposed action is not likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild by reducing its numbers, reproduction, or distribution or result in the destruction or adverse modification of the species' designated critical habitat.

Consultation History

NMFS's Office of Protected Resources requested formal consultation on this action by letter dated January 10, 2012.

I. DESCRIPTION OF THE PROPOSED ACTION

This opinion will address authorization by NMFS of the incidental and unintentional taking of bowhead, fin, and humpback whales and ringed and bearded seals due to exploratory oil drilling to Shell Offshore Inc. and Shell Gulf of Mexico Inc. (collectively "Shell") on the Outer Continental Shelf (OCS) waters of the Chukchi Sea. Section 101 (a)(5) of the Marine Mammal Protection Act (MMPA), directs the Secretary of Commerce to allow, upon request by U.S. citizens engaged in a specific activity (other than commercial fishing) in a specified geographical region, the incidental but not intentional taking of small numbers of marine mammals if certain findings are made. Such authorization may be accomplished through regulations and issuance of letters of authorization under those regulations, or through issuance of an incidental harassment authorization (IHA). These authorizations may be granted only if an activity would have no more than a negligible effect on the species (or stock) in question, if the activity would not have an unmitigable adverse impact on the availability of the marine mammal for subsistence uses, and if the permissible method of taking and requirements pertaining to the monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. These authorizations are often requested for oil and gas activities which produce underwater noise capable of harassing or harming marine mammals. Harassment is a form of taking otherwise prohibited by the MMPA and ESA.

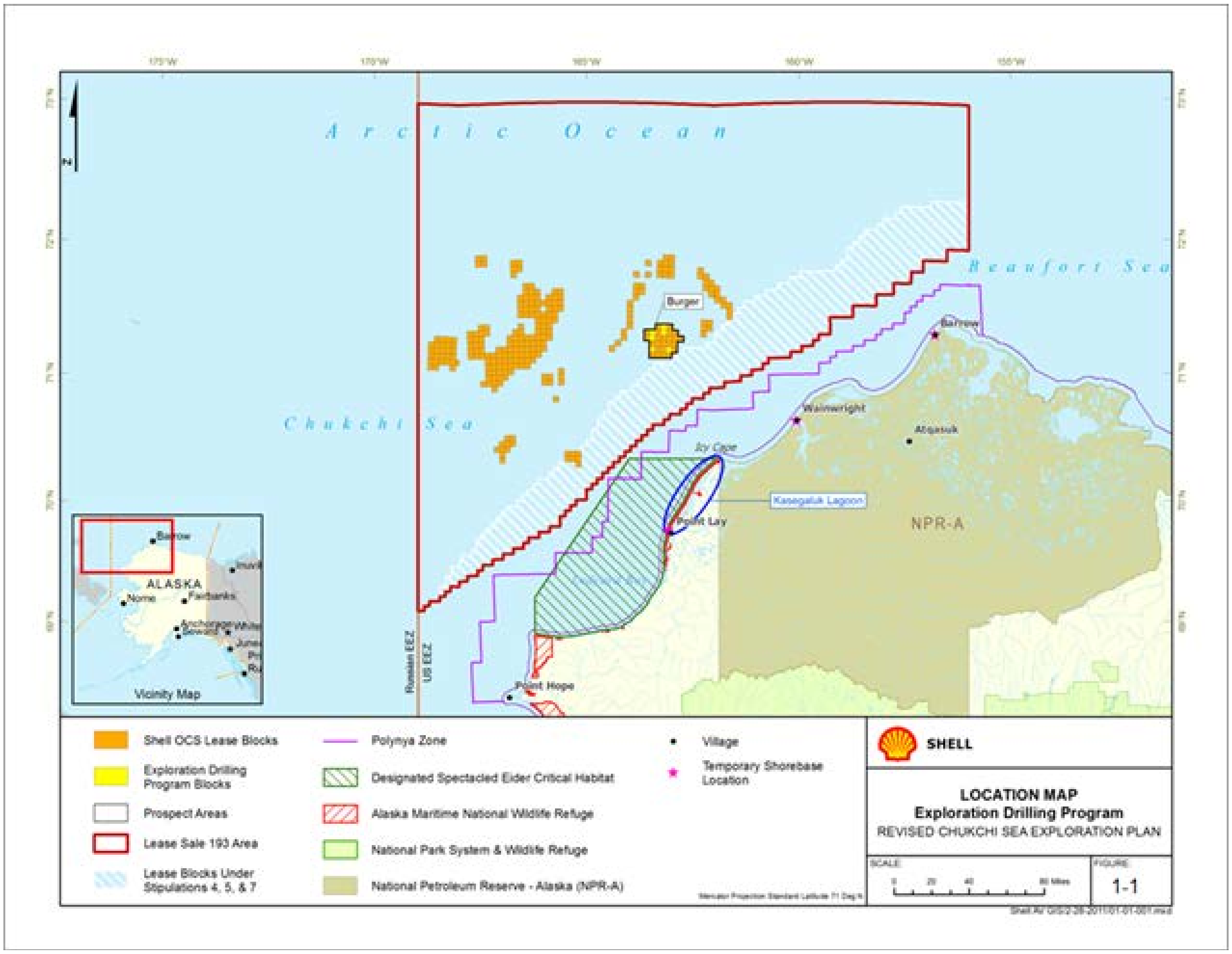

Figure 1 – Shell Chukchi Sea Drilling - 2012

On June 30, 2011, NMFS received an application from Shell requesting an authorization for the harassment of marine mammals incidental to conducting an offshore exploratory drilling program in the Chukchi Sea, Alaska. The proposed activities that have the potential to take marine mammals include operation of the drillship, ice management/icebreaking activities, and zero-offset vertical seismic profile (ZVSP) surveys. The marine mammal species that have the potential to be impacted by Shell's Chukchi Sea exploratory drilling program include: beluga whale; bowhead whale; gray whale; killer whale (*Orcinus orca*); minke whale (*Balaenoptera acutorostrata*); fin whale (*Balaenoptera physalus*); humpback whale (*Megaptera novaeangliae*); harbor porpoise; bearded seal; ringed seal; spotted seal; and ribbon seal. NMFS' proposed action is to issue an IHA to Shell for the take of these marine mammal species, by harassment, incidental to conducting the Chukchi Sea exploratory drilling program during the 2012 open-water season (i.e., July through October). NMFS published a Notice of Proposed IHA and request for comments in the *Federal Register* on November 9, 2011 (76 FR 69958).

This Biological Opinion incorporates much of the information presented within the NMFS's Notice of Proposed IHA and environmental assessment, as well as pertinent research on matters related to oil exploration. Traditional knowledge and the observations of Inupiat hunters are presented in this analysis. This knowledge contributes, along with western science, to a more complete understanding of these issues. Consideration of both these systems of knowledge strengthens our assessment of potential effects.

While the primary action considered in this opinion is the authorization of incidental take under the MMPA as described above, the specifics associated with Shell's drilling program in the Chukchi Sea represent indirect or associated activities that are broadly considered to be part of the action. We present an overview of these actions below. Detailed discussions of the Shell drilling program may be found in the applications for the IHA here: http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_chukchi_iha_application2012.pdf

Chukchi Sea Exploration Drilling

Shell plans to conduct an offshore exploration drilling program on Alaska Outer Continental Shelf leases located greater than 64 mi (103 km) from the Chukchi Sea coast during the 2012 open-water season. The leases were acquired during the Chukchi Sea Oil and Gas Lease Sale 193 held in February 2008. During the 2012 drilling program, Shell plans to drill up to three exploration wells at three drill sites and potentially a partial well at a fourth drill site at the prospect known as Burger. Shell has identified a total of six lease blocks on this prospect where drilling could potentially occur. Figure 1 depicts the lease block and drill site locations. All drilling is planned to be vertical. Wainwright is the closest Native Alaskan community to the Burger prospect proposed drill sites.

(1) Drilling Vessels

Shell proposes to use the ice strengthened drillship *Discoverer* to drill the wells. The *Discoverer* is a true drillship and is a largely self-contained drillship that offers full accommodations for a crew of up to 140 persons. Additional information about the *Discoverer* is provided in Attachment A of Shell's Chukchi Sea IHA Application and is not repeated here.

(2) Support Vessels

During the 2012 drilling season, the *Discoverer* will be attended by eight vessels that will be used for ice management, anchor handling, OSR, refueling, resupply, and servicing of the exploration drilling operations. The ice management vessels will consist of an icebreaker and an anchor handler. The OSR vessels supporting the exploration drilling program include a dedicated OSR barge and an OSR vessel, both of which have associated smaller workboats, an oil spill tanker, and a containment barge.

(3) Aircraft

Offshore operations will be serviced by helicopters operated out of onshore support base locations. A helicopter capable of transporting 10 to 12 persons will be used to transport crews between the onshore support base and the drillship. The helicopters will also be used to haul small amounts of food, materials, equipment, and waste between vessels and the shorebase. The helicopter will be housed at facilities at the Barrow airport. Shell will have a second helicopter for SAR operations. This aircraft will stay grounded at the Barrow shorebase location except during training drills, emergencies, and other non-routine events.

A fixed wing propeller or turboprop aircraft will be used to routinely transport crews, materials, and equipment between the shorebase and hub airports such as Barrow or Fairbanks. A fixed wing aircraft will be used for marine mammal monitoring flights.

Zero-offset Vertical Seismic Profile

At the end of each drill hole, Shell may conduct a geophysical survey referred to as ZVSP at each drill site where a well is drilled in 2012. During ZVSP surveys, an airgun array is deployed at a location near or adjacent to the drilling vessel, while receivers are placed (temporarily anchored) in the wellbore. The sound source (airgun array) is fired repeatedly, and the reflected sonic waves are recorded by receivers (geophones) located in the wellbore. The geophones, typically in a string, are then raised up to the next interval in the wellbore, and the process is repeated until the entire wellbore has been surveyed. The purpose of the ZVSP is to gather geophysical information at various depths, which can then be used to tie-in or ground-truth geophysical information from the previous seismic surveys with geological data collected within the wellbore.

Timeframe of Activities

Shell’s base plan is for the drillship and associated support vessels to travel north from Dutch Harbor through the Bering Strait on or about July 1, 2012, then into the Chukchi Sea before arriving on location approximately July 4. Exploration drilling is expected to be complete by October 31, 2012. At the completion of the drilling season, one or two ice-management vessels, along with various support vessels, such as the OSR fleet, will accompany the drillship as it travels south out of the Chukchi Sea and through the Bering Strait to Dutch Harbor. Subject to ice conditions, alternate exit routes may be considered.

Shell anticipates that the exploration drilling program will require approximately 32 days per well, including mudline cellar construction. Therefore, if Shell is able to drill three exploration wells during the 2012 open-water season, it would require a total of 96 days. If Shell is able to drill part of a fourth well, it would add an additional 1-32 days to the season but would not extend beyond October 31, 2012. These estimates do not include any downtime for weather or other operational delays. Time to conduct the ZVSP surveys for each well is included in the 32 drilling days for each well. Shell also assumes approximately 10 additional days will be needed for transit, drillship mobilization and mooring, drillship moves between locations, and drillship demobilization.

Exploratory Drilling Program Sound Characteristics

Potential impacts to marine mammals could occur from the noise produced by the drillship and its support vessels (including the icebreakers), aircraft, and the airgun array during ZVSP surveys. The drillship produces continuous noise into the marine environment. NMFS currently recognizes a threshold of 120 dB re 1 µPa (rms) for the onset of Level B harassment from continuous sound sources for its determinations under the MMPA. This 120 dB threshold is also applicable for the icebreakers when actively managing or breaking ice. The airgun array proposed to be used by Shell for the ZVSP surveys produces pulsed noise into the marine environment. NMFS currently uses a threshold of 160 dB re 1 µPa (rms) for the onset of Level B harassment from pulsed sound sources for its determinations under the MMPA. These thresholds are one way that the concept of "take" can be determined and assessed. Our assessment of impacts in this opinion will be guided, but not limited by these MMPA thresholds. ESA-listed species may be impacted by non-acoustic stressors, as well as noise above or below these levels. We also aknowledge (and later discuss) the importance of context in the use of acoustic thresholds.

Drilling Sounds

Exploratory drilling will be conducted from the *Discoverer*. Underwater sound propagation results from the use of generators, drilling machinery, and the rig itself. Received sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene, 1987b), and underwater sound levels appeared to be lower at the bow and stern aspects than at the beam (Greene, 1987a).

Most drilling sounds generated from vessel-based operations occur at relatively low frequencies below 600 Hz although tones up to 1,850 Hz were recorded by Greene (1987a) during drilling operations in the Beaufort Sea. At a range of 558 ft (170 m) the 20-1000 Hz band level was 122-125 dB for the drillship *Explorer I*. Underwater sound levels were slightly higher (134 dB) during drilling activity from the *Northern Explorer II* at a range of 656 ft (200 m), although tones were only recorded below 600 Hz. The modeled 120 dB isopleth for the *Discoverer* is 0.81 mi (1.31 km).

Vessel Sounds

In addition to the drillship, various types of vessels will be used in support of the operations, including ice management vessels, anchor handlers, offshore supply vessels, barges and tugs, and OSR vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore, 1995; Blackwell and Greene, 2002, 2005, 2006). Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross, 1976). Icebreakers contribute greater sound levels during icebreaking activities than ships of similar size during normal operation in open water (Richardson *et al.*, 1995a). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice. Measurements of the icebreaking supply ship *Robert Lemeur* pushing and breaking ice during exploration drilling operations in the Beaufort Sea in 1986 resulted in an estimated broadband source level of 193 dB re 1 µPa at 1 m (Greene, 1987a; Richardson *et al.,* 1995a).

Sound levels during ice management activities would not be as intense as during icebreaking, and the resulting effects to marine species would be less significant in comparison. During ice management, the vessel's propeller is rotating at approximately 15-20 percent of the vessel's propeller rotation capacity. Instead of actually breaking ice, during ice management the vessel redirects and repositions the ice by pushing it away from the direction of the drillship at slow speeds so that the ice floe does not slip past the vessel bow. Basically, ice management occurs at slower speed, lower power, and slower propeller rotation speed (i.e., lower cavitation), allowing for fewer repositions of the vessel, thereby reducing cavitation effects in the water compared to those that would occur during icebreaking

Aircraft Sound

Helicopters may be used for personnel and equipment transport to and from the drillship. Under calm conditions, rotor and engine sounds are coupled into the water within a 26º cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26º area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in the shallow water.

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore, 1995). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present.

Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Helicopters flying to and from the drillship will generally maintain straight-line routes at altitudes of at least 1,500 ft (457 m) above sea level, thereby limiting the received levels at and below the surface.

Vertical Seismic Profile Sound

A typical eight airgun array (760 in^3) would be used to perform ZVSP surveys, if conducted after the completion of each exploratory well. Typically, a single ZVSP survey will be performed when the well has reached proposed total depth or final depth; although, in some instances, a prior ZVSP will have been performed at a shallower depth. A typical survey will last 10–14 hours, depending on the depth of the well and the number of anchoring points, and include firings of the full array, plus additional firing of a single 40-in^3 airgun to be used as a "mitigation airgun" while the geophones are relocated within the wellbore. The source level for the airgun array proposed for use by Shell will differ based on source depth. At a depth of 9.8 ft (3 m), the SPL is 238 dB re 1 µPa at 1 m, and at a depth of 16.4 ft (5 m), the SPL is 241 dB re 1 µPa at 1 m, with most energy between 20 and 140 Hz. However, the pulses contain significant energy up to 500–1,000 Hz and some energy at higher frequencies (Goold and Fish, 1998; Potter *et al*., 2007).

Mitigation

Shell's plans and the NMFS' IHA will include a comprehensive list of mitigative measures which must be implemented by Shell and will substantially reduce many impacts associated with the proposed drilling activity. These measures are as follows:

(1) General
(a) All vessels shall reduce speed to at least 9 knots when within 300 yards (274 m) of whales. The reduction in speed will vary based on the situation but must be sufficient to avoid interfering with the whales. Those vessels capable of steering around such groups should do so. Vessels

may not be operated in such a way as to separate members of a group of whales from other members of the group;

(b) Avoid multiple changes in direction and speed when within 300 yards (274 m) of whales;

(c) When weather conditions require, such as when visibility drops, support vessels must reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injury to whales;

(d) All vessels shall maintain cruising speed not to exceed 9 knots while transiting the Beaufort Sea in order to reduce the risk of ship-whale collisions;

(e) Aircraft shall not fly within 1,000 ft (305 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs, landings, or in emergency situations) while over land or sea;

(f) Utilize two, NMFS-qualified, vessel-based Protected Species Observers (PSOs) (except during meal times and restroom breaks, when at least one PSO shall be on watch) to visually watch for and monitor marine mammals near the drillship or support vessel during active drilling or airgun operations (from nautical twilight-dawn to nautical twilight-dusk) and before and during start-ups of airguns day or night. The vessels' crew shall also assist in detecting marine mammals, when practicable. PSOs shall have access to reticle binoculars (7x50 Fujinon), big-eye binoculars (25x150), and night vision devices. PSO shifts shall last no longer than 4 hours at a time and shall not be on watch more than 12 hours in a 24-hour period. PSOs shall also make observations during daytime periods when active operations are not being conducted for comparison of animal abundance and behavior, when feasible;

(g) When a mammal sighting is made, the following information about the sighting will be recorded:

(i) 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 MMO, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace;

(ii) Time, location, speed, activity of the vessel, sea state, ice cover, visibility, and sun glare; and

(iii) The positions of other vessel(s) in the vicinity of the MMO location.

(iv) The ship's position, speed of support vessels, and water temperature, 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 minutes during a watch, and whenever there is a change in any of those variables.

(h) PSO teams shall consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the PSO team onboard the survey vessel. New observers shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations;

(i) PSOs will complete a two or three-day training session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2012 open-water season. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs. A marine mammal observers' handbook, adapted for the specifics of the planned program will be reviewed as part of the training;

(j) If there are Alaska Native PSOs, the PSO training that is conducted prior to the start of the survey activities shall be conducted with both Alaska Native PSOs and biologist PSOs being trained at the same time in the same room. There shall not be separate training courses for the different PSOs; and

(k) PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

(2) ZVSP Mitigation and Monitoring Measures: Shell is required to implement the following mitigation and monitoring requirements when conducting the specified activities to achieve the least practicable impact on affected marine mammal species or stocks:

(a) PSOs shall conduct monitoring while the airgun array is being deployed or recovered from the water;

(b) PSOs shall visually observe the entire extent of the exclusion zone (EZ) (180 dB re 1 μPa [rms] for cetaceans and 190 dB re 1 μPa [rms] for pinnipeds) using NMFS-qualified PSOs, for at least 30 minutes (min) prior to starting the airgun array (day or night). If the PSO finds a marine mammal within the EZ, Shell must delay the seismic survey until the marine mammal(s) has left the area. If the PSO sees a marine mammal that surfaces then dives below the surface, the PSO shall continue the watch for 30 min. If the PSO sees no marine mammals during that time, they should assume that the animal has moved beyond the EZ. If for any reason the entire radius cannot be seen for the entire 30 min period (i.e., rough seas, fog, darkness), or if marine mammals are near, approaching, or in the EZ, the airguns may not be ramped-up. If one airgun is already running at a source level of at least 180 dB re 1 μPa (rms), the Holder of this Authorization may start the second airgun without observing the entire EZ for 30 min prior, provided no marine mammals are known to be near the EZ;

(c) Establish and monitor a 180 dB re 1 μPa (rms) and a 190 dB re 1 μPa (rms) EZ for marine mammals before the 8-airgun array (760 in^3) is in operation; and a 180 dB re 1 μPa (rms) and a 190 dB re 1 μPa (rms) EZ before a single airgun (40 in^3) is in operation, respectively. For purposes of the field verification tests, described in condition 10(c)(i) below, the 180 dB radius is predicted to be 0.77 mi (1.24 km) and the 190 dB radius is predicted to be 0.33 mi (524 m);

(d) Implement a “ramp-up” procedure when starting up at the beginning of seismic operations, which means start the smallest gun first and add airguns in a sequence such that the source level of the array shall increase in steps not exceeding approximately 6 dB per 5-min period. During ramp-up, the PSOs shall monitor the EZ, and if marine mammals are sighted, a power-down, or shut-down shall be implemented as though the full array were operational. Therefore, initiation of ramp-up procedures from shut-down requires that the PSOs be able to view the full EZ;

(e) Power-down or shutdown the airgun(s) if a marine mammal is detected within, approaches, or enters the relevant EZ. A shutdown means all operating airguns are shutdown (i.e., turned off). A power-down means reducing the number of operating airguns to a single operating 40 in^3 airgun, which reduces the EZ to the degree that the animal(s) is no longer in or about to enter it;

(f) Following a power-down, if the marine mammal approaches the smaller designated EZ, the airguns must then be completely shutdown. Airgun activity shall not resume until the PSO has visually observed the marine mammal(s) exiting the EZ and is not likely to return, or has not been seen within the EZ for 15 min for species with shorter dive durations (small odontocetes and pinnipeds) or 30 min for species with longer dive durations (mysticetes);

(g) Following a power-down or shut-down and subsequent animal departure, airgun operations may resume following ramp-up procedures described in Condition 8(d) above;

(h) ZVSP surveys may continue into night and low-light hours if such segment(s) of the survey is initiated when the entire relevant EZs are visible and can be effectively monitored; and

(i) No initiation of airgun array operations is permitted from a shutdown position at night or during low-light hours (such as in dense fog or heavy rain) when the entire relevant EZ cannot be effectively monitored by the PSO(s) on duty.

Additionally, BOEM has conditioned their approval of Shell's exploration plan on additional mitigation to reduce the possibility of an oil spill occurring late in the season; a time when ice formation would reduce any response efficiency. These conditions include a measure requiring Shell to leave sufficient time to implement cap and containment operations as well as significant clean-up before the onset of sea ice, in the event of a loss of well control. Given current technology and weather forecasting capabilities, Shell must cease drilling into zones capable of flowing liquid hydrocarbons 38 days before the anticipated first date of ice encroachment over the drill site. Based on a 5-year analysis of historic weather patterns, BOEM anticipates November 1 as the earliest anticipated date of ice encroachment. The 38 day period would also provide a window for drilling a relief well, should one be required.

Approval is also conditioned on a series of other measures to increase safety and confirm the availability of response equipment, including a well capping and containment system.

Term of this Opinion

This opinion will be valid upon issuance and remain in force until December 31, 2012.

Action Area

Federal regulations implementing the ESA (50 C.F.R. §402.02) define the action area as follows:

"Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. "

In order to define the action area for the proposed action, we must have some basic understanding of the zone over which direct and indirect effects of this action might occur. Based on literature on effects from drillships and other activities conducted in the Arctic, the bowhead whale is the most sensitive of the species considered in this opinion. . Bowheads may react to noise as low as 120 dB (Richardson, 1999). Based on this metric, we can define an action area as including the area ensonified to at least this level in identifying the action area.

The action area would not include the routes of these vessels to and from the Beaufort Sea, as such actions are not a direct or indirect part of the issuance of the IHA by NMFS.

Ice breakers actively engaged in icebreaking would be the loudest noise source associated with the proposed drilling program, and may produce noise capable of detection out to 50 km (Richardson et al. 1995a). Therefore, the action area for purposes of this Biological Opinion is defined as waters within 50 kilometers of the described activities in the Chukchi Sea. The direct and indirect effects of this action on the endangered bowhead, humpback, and fin whale and proposed ringed and bearded seal are expected to be confined to the action area.

II. STATUS OF THE SPECIES

Rangewide Status of the Species and Critical Habitat

NMFS has determined that the endangered bowhead, humpback, and fin whale and two species of ice seals currently proposed for listing under the ESA (the ringed and bearded seal) may occur in the action area, and may be adversely affected by the proposed action. This opinion considers the effects of the proposed action on these species (Table 1).

Table 1. Listing status and critical habitat designation for marine mammal species considered in this opinion.

Species	Stock	Status	Listing	Critical Habitat
Megaptera novaeangliae	Western North Pacific	Endangered	NMFS 1970, 35 FR 18321	Not designated
Balaneoptera physalus	Northeast Pacific	Endangered	NMFS 1970, 35 FR 18320	Not designated
Balanea mysticetus	Western Arctic	Endangered	NMFS 1970, 35 FR 18319	Not designated
Phoca hispida hispida	Alaska	Proposed Listing	NMFS 2010, 75 FR 77476	Not proposed
Erignathus barbatus barbatus, Beringia DPS	Alaska	Proposed Listing	NMFS 2010, 75 FR 77496	Not proposed

Critical Habitat

Critical habitat has not been designated for any of the listed or proposed listed species considered under this opinion and conference. As a result, we conclude that the proposed activities will not affect designated critical habitat. Therefore, critical habitat will not be considered further in this biological and conference opinion.

Introduction to Status of Listed Species

The rest of this section of our opinion consists of narratives for each of the endangered and proposed listed species that occur in the action area and that may be adversely affected by the proposed action. In each narrative, we present a summary of information on the distribution and population structure of each species to provide a foundation for the exposure analyses that appear later in this opinion.

Bowhead whale (*Balaena mysticetus*) Endangered

Distribution

Bowhead whales have a circumpolar distribution in high latitudes in the Northern Hemisphere, and range from 54º to 85ºN latitude. They live in pack ice for most of the year, typically wintering at the southern limit of the pack ice, or in polynyas (large, semi-stable open areas of water within the ice), and move north as the sea ice breaks up and recedes during the spring.

In the North Pacific Ocean, bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60°N and south of 75°N in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year. The largest population of bowhead whales can be found in the Bering Sea in winter, migrating north into the western Arctic, Beaufort, and Chukchi Seas in the spring. The Okhotsk population has been observed in summertime along the western and northern portion of the Sea of Okhotsk, notably around the Shantar Islands.

In the North Atlantic Ocean, three additional populations are found in the Atlantic and Canadian Arctic in the Davis Strait and in Baffin Bay, Hudson Bay, and Foxe Basin, as well as Spitsbergen Island and the Barents Sea. The Hudson Bay-Foxe Basin population is believed to overwinter in Hudson Strait. In the spring some migrate west until they reach northwestern Hudson Bay around Roes Welcome Sound, and Frozen Strait, and others move north into northern Foxe Basin.

Population Structure

The International Whaling Commission (IWC) recognizes five stocks of bowhead whales for management purposes. Three of these stocks occur in the North Atlantic: the Spitsbergen, Baffin Bay-Davis Strait, and Hudson Bay-Foxe Basin stocks. The remaining two stocks occur in the North Pacific: the Sea of Okhotsk and Bering-Chukchi-Beaufort stocks. Out of all of the stocks, the Bering-Chukchi-Beaufort stock is the largest, and the only stock to inhabit U.S. waters. NMFS identifies this stock as the Western Arctic stock of bowhead whales, which is how they are referred to in the remainder of this evaluation.

The bowhead whale was listed as endangered under the ESA in 1970 (35 FR 8495). They are also protected by the Convention on International Trade in Endangered Species of wild flora and fauna and the MMPA. Critical habitat has not been designated for bowhead whales. The IWC continued a prohibition on commercial whaling, and called for a ban on subsistence whaling in 1977. The U.S. requested a modification of the ban and the IWC responded with a limited quota. Currently, subsistence harvest is limited to nine Alaskan villages.

Woodby and Botkin (1993) summarized previous efforts to determine a minimum worldwide population estimate prior to commercial whaling of 50,000, with 10,400-23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). This stock is currently estimated to be increasing at a rate of 3.2% per year. The most recent abundance estimate, based on surveys conducted in 2001, is 10,545 (Coefficient of Variation (CV) = 0.128) (updated from George *et al*. 2004 by Zeh and Punt 2004). See Table 2 for a summary of population abundance estimates (Allen and Angliss 2010).

George *et al.* (2004) reported that the Western Arctic stock of bowhead whales has increased at a rate of 3.4% (95% Confidence Interval (CI) = 1.7.5%) from 1978-2001, during which time abundance doubled from approximately 5,000 to approximately 10,000 whales. The count of 121 calves during the 2001 census was the highest yet recorded and was likely caused by a combination of variable recruitment and the large population size (George *et al.* 2004). The calf count provides corroborating evidence for a healthy and increasing population.

Year	Abundance estimate (CV)	Year	Abundance estimate (CV)
Historical estimate	10,400-23,000	1985	5,762 (0.253)
End of commercial whaling	1,000-3,000	1986	8,917 (0.215)
1978	4,765 (0.305)	1987	5,298 (0.327)
1980	3,885 (0.343)	1988	6,928 (0.120)
1981	4,467 (0.273)	1993	8,167 (0.017)
1982	7,395 (0.281)	2001	10,545 (0.128)
1983	6,573 (0.345)		

Table 2. Summary of population abundance estimates for the Western Arctic stock of bowhead whales. The historical estimates were made by back-projecting using a simple recruitment model. All other estimates were developed by corrected ice-based census counts. Historical estimates are from Woodby and Botkin (1993); 1978-2001 estimates are from George et al. (2004) and Zeh and Punt (2004).

The Sea of Okhotsk stock, estimated at about 3,000-6,500 animals prior to commercial exploitation (Shelden and Rugh 1995), currently numbers about 150-200, although reliable population estimates are not currently available. It is possible this population has mixed with the Bering Sea population, although the available evidence indicates the two populations are essentially separate (Moore and Reeves 1993).

The estimated abundance of the Spitsbergen stock was 24,000 prior to commercial exploitation, but currently numbers less than one hundred. The Baffin Bay-Davis Strait stock was estimated at about 11,750 prior to commercial exploitation (Woody and Botkin 1993) and the Hudson Bay-Foxe Basin stock at about 450. The current abundance of the Baffin Bay-Davis Straight is estimated at about 350 (Zeh *et al*. 1993), and recovery is described as “at best, exceedingly slow” (Davis and Koski 1980). No reliable estimate exists for the Hudson Bay-Foxe Basin stock;

however, Mitchell (1977) places a conservative estimate at 100 or less. More recently, estimates of 256-284 whales have been presented for the number of whales within Foxe Basin (Cosens *et al.*, 1997). There has been no appreciable recovery of this population.

ESA Listing History and Status

The bowhead whale was listed as a Federal endangered species on June 2, 1970 (35 FR 8495). While five stocks are recognized, the Western Arctic population of the bowhead whale is the only one known to occur in the action area. All further references to the bowhead whale in this document concern only the Western Arctic population. No critical habitat has been designated for the species.

Feeding and Prey Selection

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouth. They feed throughout the water column, including bottom feeding as well as surface skim feeding (Würsig *et al.* 1989). Skim feeding can occur when animals are alone or may occur in coordinated echelons of over a dozen animals (Würsig *et al*. 1989). Bowhead whales typically spend a high proportion of time on or near the ocean floor. Even when traveling, bowhead whales visit the bottom on a regular basis (Quakenbush, Small, and Citta 2010). Laidre *et al.* (2007) and others have identified krill concentrated near the sea bottom and bowhead whales have been observed with mud on heads and bodies and streaming from mouths. Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods (Moore *et al.* 2010; Lowry, Sheffield, and George 2004). Euphausiids and copepods are thought to be their primary prey. Lowry, Sheffield, and George (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

Available data indicate that bowhead whales feed in both the Chukchi and Beaufort Sea OCS Planning Areas and that this use varies in degree among years, among individuals, and among areas. It is likely that bowheads continue to feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea, similar to what they are thought to do during the spring migration. Observations from the 1980s documented that some feeding occurs in the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (e.g., Ljungblad *et al.* 1988, Carroll *et al.* 1987). Stomach contents from bowheads harvested between St. Lawrence Island and Point Barrow during April into June also indicated it is likely that some whales feed during the spring migration (Carroll *et al*., 1987; Shelden and Rugh, 1995, 2002). Carroll et al. (1987) reported that the region west of Point Barrow seems to be of particular importance for feeding, at least in some years, but whales may feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant food. Lowry (1993) reported that the stomachs of 13 out of 36 spring-migrating bowheads harvested near Point Barrow between 1979 through 1988 contained food. Lowry estimated total volumes of contents in stomachs ranged from less than 1 to 60 liters (L.), with an average of 12.2 L. in eight specimens. Shelden and Rugh (1995) concluded that “In years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring.” Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring.

Bowhead whales feed in the Canadian Beaufort in the summer and early fall and in the Alaskan Beaufort in late summer/early fall (Lowry and Frost 1984, Schell and Saupe 1993, Lowry, Sheffield, and George 2004; summarized in Richardson and Thomson 2002). Available information indicates it is likely there is considerable inter-annual variability in the locations where feeding occurs during the summer and fall in the Alaska Beaufort Sea, in the length of time individuals spend feeding, and in the number of individuals feeding in various areas in the Beaufort Sea. Recent satellite tagging data suggest bowhead whales may feed extensively in late fall along the Chukotka coastline (ADFG, 2009).

Social Behavior

The bowhead whale usually travels alone or in groups of three to four individuals. Loose aggregations of 50 or more individuals are sometimes observed on the feeding grounds or when ice moving through ice leads. Bowhead whale calls might help maintain social cohesion of groups (Würsig and Clark, 1993). Wursig *et al*. (1985) indicated that low-frequency tonal calls, believed to be long distance contact calls by a female and higher frequency calls by calf, have been recorded in an instance where the pair were separated and swimming toward each other.

Bowhead whales sometimes feed cooperatively (Wursig and Clarke, 1993), taking advantage of dense swarms of invertebrates.

Vocalizations and Hearing

Bowhead whales are among the more vocal of the baleen whales. They mainly communicate with low frequency sounds. Most underwater calls are at a fairly low frequency and easily audible to the human ear. Vocalization is made up of moans of varying pitch, intensity and duration, and occasionally higher-frequency screeches. Bowhead calls have been distinguished by Würsing and Clark (1993): pulsed tonal calls, pulsive calls, high frequency calls, low-frequency calls (upsweeps, inflected, downsweeps, and constant frequency calls). However, no direct link between specific bowhead activities and call types was found. Bowhead whales may use low-frequency sounds to provide information about the ocean floor and locations of ice.

Bowhead whales have well-developed capabilities for navigation and survival in sea ice. Bowhead whales are thought to use the reverberations of their calls off the undersides of ice floes to help them orient and navigate (Wursig and Clarke, 1993). This species is well adapted to ice-covered waters and can easily move through extensive areas of nearly solid sea ice cover. Their skull morphology allows them to break through ice up to 18 cm thick to breathe in ice covered waters (Wursig and Clarke, 1993).

Bowhead whales are grouped among low frequency functional hearing baleen whales (Southall *et al*. 2007). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz-5 kHz, with maximum sensitivity between 100-500 Hz.

Distribution and Habitat Use

The Western Arctic stock of bowheads generally occurs north of 60° N. and south of 75° N. (Angliss and Outlaw, 2005) in the Bering, Chukchi, and Beaufort seas. They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year. Bowhead whales of the Western Arctic stock overwinter in the central and western Bering Sea. Most mating probably occurs in the Bering Sea. The amount of feeding in the Bering Sea in the winter is unknown as is the amount of feeding in the Bering Strait in the fall (Richardson and Thomson, 2002). In the Bering Sea, bowheads frequent the marginal ice zone, regardless of where the zone is, and polynyas. Important winter areas in the Bering Sea include polynyas along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island. Bowheads congregate in these polynyas before migrating (Moore and Reeves, 1993).   During their southward migration in the autumn, bowheads pass through the Bering Strait in late October through December on their way to overwintering areas in the Bering Sea.

Most of the bowheads that winter in the Bering Sea migrate northward through the Bering Strait to the Chukchi Sea and through the Alaskan Beaufort Sea to summer feeding grounds in the Canadian Beaufort Sea. The bowhead northward spring migration appears to coincide with ice breakup and probably begins most years in April (possibly late March depending on ice conditions) and early May. It is thought to occur after the peak of breeding, which is believed to occur in March-April (C. George, cited in IWC, 2004b).

The migration past Barrow takes place in pulses in some years (e.g., in 2004) but not in others (e.g., 2003) (IWC, 2004b). At Barrow, the first migratory pulse is typically dominated by juveniles. This pattern gradually reverses and by the end of the migration, there are almost no juveniles. Currently, the whales are first seen at Barrow around April 9-10. In later May (May 15-June), large whales and cow/calf pairs are seen (H. Brower, in USDOC, NOAA and NSB, 2005). Koski et al. (2004b) found that females and calves constituted 31-68% of the total number of whales seen during the last few days of the migration. Their rate of spring migration was slower and more circuitous than other bowheads. Calves had shorter dive duration, surface duration, and blow interval than their mothers. Calf blow rate was nearly 3 times that of their mothers. Most calving probably occurs in the Chukchi Sea. Some subset of the population may summer in the Chukchi Sea.

Bowheads arrive on their summer feeding grounds near Banks Island from mid-May through June (July: IWC, 2005b) and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September (Moore and Reeves, 1993). Bowhead whales are seen also in the central Chukchi Sea and along the Chukotka coast in July and August. They may occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore, 1992; USDOC, NOAA, and NSB, 2005), but it is unclear if these are "early-autumn" migrants or whales that have summered nearby (Moore et al., 1995) or elsewhere. Bowhead whales have been observed near Barrow in the mid-summer (e.g., Brower, as cited in USDOI, MMS, 1995). Moore and DeMaster (2000:61) noted that these observations are consistent with Russian scientist suggestions that "…Barrow Canyon is a focal feeding area for bowheads and that they 'move on' from there only when zooplankton concentrations disperse (Mel'nikov et al. 1998)" and consistent with the time frame of earlier observations summarized by Moore (1992.)

Some biologists conclude that almost the entire Bering Sea bowhead population migrates to the Beaufort Sea each spring and that few whales, if any, summer in the Chukchi Sea. Incidental sightings suggest that bowhead whales may occupy the Chukchi Sea in the summer more regularly than commonly believed. Moore (1992) summarized observations of bowheads in the northeastern Chukchi in late summer. Other scientists maintain that a few bowheads swim northwest along the Chukotka coast in late spring and summer in the Chukchi Sea. Recent satellite tagging studies of Western Arctic bowheads provide support for this (ADFG 2009). Observation by numerous Russian authors (cited in Mel'nikov, Zelensky, and Ainana [1997:8]) indicates that bowheads occur in waters of the Chukchi Sea off the coast of Chukotka in the summer.

Those bowheads that have been summer feeding in the Canadian Beaufort Sea begin moving westward into Alaskan waters in August and September. While few bowheads generally are seen in Alaskan waters until the major portion of the migration takes place (typically mid-September to mid-October), in some years bowheads are present in substantial numbers in early September (Greene and McLennan, 2001; Treacy, 1998). There is some indication that the fall migration, just as the spring migration, takes place in pulses or aggregations of whales (Moore and Reeves, 1993). Eskimo whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham et al., 1984, as reported in Moore and Reeves, 1993). During the autumn migration Koski and Miller (2004, cited in IWC, 2004b) found decreasing proportions of small whales and increasing proportions of large whales as one moved offshore. "Mothers and calves tended to avoid water depths less than (<) 20 m." (Koski and Miller, cited in IWC, 2004b:14). These authors also found that in the Central Beaufort Sea in late August, the vast majority of the whales were subadults and this percentage declined throughout the autumn to about 35% by early October. They reported that mother/calf pairs "arrived in September and were common until early October" (Koski and Miller, 2004, cited in IWC, 2004b).

Data are limited on the bowhead fall migration through the Chukchi Sea before the whales move south into the Bering Sea. Bowhead whales commonly are seen from the coast to about 150 km (93 mi) offshore between Point Barrow and Icy Cape, suggesting that most bowheads disperse southwest after passing Point Barrow and cross the central Chukchi Sea near Herald Shoal to the northern coast of the Chukotka Peninsula. However, sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. Mel'nikov, Zelensky, and Ainana (1997) argued that data suggest that after rounding Point Barrow, some bowheads head for the northwestern coast of the Chukotka Peninsula and others proceed primarily in the direction of the Bering Strait and into the Bering Sea. Mel'nikov (in USDOC, NOAA, and NSB, 2005) reported that abundance increases along northern Chukotka in September as whales come from the north. More whales are seen along the Chukotka coast in October. J.C. George (cited in IWC, 2004b) noted that bowheads pass through the Bering Strait into the Bering Sea between October and November on their way to overwintering areas in the Bering Sea.

The timing, duration, and location of the fall migration along the Chukotka Peninsula are highly variable and are linked to the timing of freezeup (Mel'nikov, Zelensky, and Ainana, 1997). Whales migrate in "one short pulse over a month" in years with early freezeup, but when ice formation is late, whales migrate over a period of 1.5-2 months in 2 pulses (Mel'nikov, Zelensky, and Ainana, 1997.

Fin whale

Distribution

Rice (1974) reported that the summer distribution of fin whales included immediate offshore waters throughout the North Pacific from central Baja California to Japan, and as far north as the Chukchi Sea. They occurred in high densities in the northern Gulf of Alaska and southeastern Bering Sea from May to October, with some movement through the Aleutian passes into and out of the Bering Sea (NMFS 2006). Fin whales were observed and taken by Japanese and Soviet whalers off eastern Kamchatka and Cape Navarin, both north and south of the eastern Aleutians, and in the northern Bering and southern Chukchi Seas (NMFS 2006). They were also taken by whalers off central California throughout the year.

Status and Trends

The fin whale is considered one of the more abundant large whale species, with a worldwide population estimate of 120,000. Three stocks are currently recognized in U.S. waters: 1) Alaska (North Pacific), 2) California/Washington/Oregon, and 3) Hawaii. Prior to exploitation by whaling vessels, the North Pacific population consisted of an estimated 42,000 to 45,000 fin whales (Ohsumi and Wada 1974). Between 1914 and 1975, over 26,040 fin whales were harvested throughout the North Pacific (in Perry and others 1999). Annual catches in the North Pacific and Bering Sea ranged between 1,000 and 1,500 fin whales during the 1950s and 1960s. However, not all Soviet catches were reported. No reliable current population estimate exists, however Allen and Angliss (2011) report a minimum estimate of 5,700 for the North Pacific stock within Alaskan waters based on incomplete surveys over a portion of their range. Reliable trend data are also lacking, although surveys within a portion of the range of the North Pacific stock provide an estimated rate of increase of 4.8% (Allen and Angliss, 2011)

The distinctness of North Pacific and North Atlantic fin whales has been supported by recent genetic analysis and by differences in vocalizations (NMFS 2006). At present, there are two named subspecies, *B. p. physalus* in the North Atlantic and *B. p. quoyi* in the southern oceans. Most experts consider the North Pacific fin whales a separate unnamed subspecies. On a global scale, populations in the North Atlantic, North Pacific, and Southern Ocean probably mix rarely (if at all), and there are geographical populations within these ocean basins. In general, fin whales in the Northern Hemisphere attain a smaller maximum body length (by up to 3 m) than Antarctic fin whales, and those in the North Atlantic are leaner than their Antarctic counterparts (Lockyer and Waters 1986).

Feeding and Prey Selection

Fin whales feed primarily on euphausiids, or “krill”, but also consume substantial quantities of fish. In the North Pacific overall, fin whales apparently prefer euphausiids (mainly *Euphausia pacifica*, *Thysanoessa longipes*, *T. spinifera*, and *T. inermis*) and large copepods (mainly *Calanus cristatus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin (Nemoto 1970; Kawamura 1982). Fin whales killed off central California in the early twentieth century were described as having either plankton (assumed to have been mainly or entirely euphausiids) or sardines (assumed to have been anchovies, *Engraulis mordax*) in their stomachs (Clapham et al. 1997). A larger sample of fin whales taken off California in the 1950s and 1960s were feeding mainly on krill (*Euphausia pacifica*), with only about 10% of the individuals having anchovies in their stomachs.

Mizroch et al. 2001 report Thyanoessa raschii is the only species of euphausiid taken by fin whales in the northern Bering Sea, while fishes consumed by fin whales in Arctic and Subarctic waters are mainly capelin, Alaska pollock, herring, and saffron cod. Fish is the main food for fin whales north of 58 degreees in the Bering Sea, and consists mainly of capelin, pollock, and herring.

Foraging areas tend to occur along continental shelves with productive upwellings or thermal fronts. Fin whales tend to avoid tropical and pack ice waters (NMFS 2006) with the northern limit set by ice and the southern limit by warm water of approximately 15°C (60°F.

Vocalizations and hearing

Underwater sounds of the fin whale are one of the most studied of the *Balaenopteras*. Fin whales produce a variety of low frequency sounds in the 10 to 200 Hz band (NMFS 2005). As with other mysticete sounds, the function of vocalizations produced by fin whales is unknown. As with blue whales, the low frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long distance communication occurs (Edds-Walton 1997; Payne and Webb 1971).

No studies have directly measured the sound sensitivity of fin whales. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Habitat Use

NMFS (2006) reports that fin whales have been observed year-round off central and southern California, with peak numbers in summer and fall, in summer off Oregon, and in summer and fall in the Gulf of Alaska (including Shelikof Strait), and the southeastern Bering Sea. Their regular summer occurrence has also been noted in recent years around the Pribilof Islands in the northern Bering Sea. Data suggest that, as in the North Atlantic, the migratory behavior of fin whales in the eastern North Pacific is complex: whales can occur in any one season at many different latitudes, perhaps depending on their age or reproductive state as well as their stock affinity. Movements can be either inshore/offshore or north/south. Some individuals remain at high latitudes through the winter. Fin whale concentrations in the northern North Pacific and Bering Sea generally form along frontal boundaries, or mixing zones between coastal and oceanic waters, which themselves correspond roughly to the 200-m isobath (shelf edge) (NMFS 2006).

Humpback Whale

Distribution

Humpback whales are found primarily in coastal and continental shelf waters, but are known to migrate through deep waters between tropical/sub-tropical breeding and calving habitats during the winter and temperate/polar feeding habitats during the summer. Known breeding areas in the Pacific Ocean include Japan, the Hawaiian Islands, coastal Central America and Mexico, and

Revillagigedo Archipelago. Humpback whales summer throughout the central and western portions of the Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula, as well as the coast of California. It is believed that minimal feeding occurs in wintering grounds (Salden 1987).

Surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution of humpback whales in these areas (Moore et al. 2002). The only sightings of humpback whales in the central-eastern Bering Sea were southwest of St. Lawrence Island; animals co-occurred with a group of killer whales and a large aggregation of Arctic cod. A few sightings occurred in the southeast Bering Sea, primarily outside Bristol Bay and north of the eastern Aleutian Islands (Moore et al. 2002). In a NMFS survey cruise in 2001 and 2002 of the central and eastern Aleutian Islands, humpback whales were most common in the area between Samalga and Unimak Islands (Sinclair et al. 2005). Of the 259 individuals seen, only 3 were west of Samalga. These recent sightings clearly demonstrate that the Aleutian Islands and Bering Sea remain important feeding areas (NMFS 2006a). In addition, a NOAA survey conducted in 2005 found numerous humpback whales north of the central Aleutian Islands, reinforcing the idea that the Bering Sea is an important foraging habitat (Angliss and Outlaw 2008).

NMFS (1991a) (citing Nikulin, 1946 and Berzin and Rovnin, both in Russian), summarized that the northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback. Figure 38 of the most recent (Allen and Angliss, 2011) stock assessment for the Western North Pacific Stock depicts the southwestern Chukchi Sea as part of the “approximate distribution” of humpback whales in the North Pacific. Other references indicate that both the historical and current summer feeding habitat of the humpback included, and at least sometimes includes, the southern portion, especially the southwestern portion, of the Chukchi Sea.

Status and trends

Three management units (populations) of humpback whales currently are recognized in the North Pacific. The following units migrate between their respective summer/fall feeding areas to winter/spring calving and mating areas in the North Pacific (Calambokidis et al. 1997, Baker et al. 1998):

1) the California/Oregon/Washington and Mexico population, which are found winter/spring in coastal Central America and Mexico and migrate to the coast of California to southern British Columbia in summer/fall (Calambokidis et al. 1989, Steiger et al. 1991, Calambokidis et al. 1993);

2) the Central North Pacific population, which are found winter/spring in the Hawaiian Islands and migrate to northern British Columbia/southeast Alaska (including Glacier Bay) and Prince William Sound west to Kodiak in summer/fall (Baker et al. 1990, Perry et al. 1990, Calambokidis et al. 1997); and

3) the Western North Pacific population, which occurs in winter/spring off Japan and, based on Discovery Tag information, probably migrate to waters west of the Kodiak Archipelago (the Bering Sea and Aleutian Islands) in summer/fall (Berzin and Rovnin 1966, Nishiwaki 1966, Darling 1991).

Life history

Humpback whale reproductive activities occur primarily in winter. Humpback whales exhibit a wide range of foraging behaviors, and feed on a range of prey types including small schooling fishes, euphausiids, and other large zooplankton. Fish prey in the North Pacific include herring, anchovy, capelin, pollock, Atka mackerel, eulachon, sand lance, pollack, Pacific cod, saffron cod, arctic cod, juvenile salmon, and rockfish. Invertebrate prey include euphausiids, mysids, amphipods, shrimps, and copepods.

Vocalizations and hearing

Humpbacks produce a wide variety of sounds. During the breeding season males sing long, complex songs, with frequencies in the 25 to 5000 Hz range and intensities as high as 181 dB (Payne 1970; Thompson et al 1986). Source levels average 155 dB and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km (six to 12 mi). Animals in mating groups produce a variety of sounds (Silber 1986; Tyack 1981; Tyack and Whitehead 1983). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2 to 0.8 sec and source levels of 175 to 192 dB (Thompson and others 1986). No studies have directly measured the sound sensitivity of humpback whales. In a study of the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing.

Ringed Seal – Arctic sub species (*Phoca hispida hispida)* – Proposed for listing as threatened

Distribution

Arctic ringed seals have a circumpolar distribution. They occur in all seas of the Arctic Ocean, and range seasonally into adjacent seas including the Bering Sea. In the Chukchi and Beaufort seas, where they are year-round residents, they are the most widespread seal species.

Arctic ringed seals have an affinity for ice-covered waters and are able to occupy areas of even continuous ice cover by abrading breathing holes in that ice (Hall 1865, Bailey and Hendee 1926, Chapskii 1940, McLaren 1958a). Throughout most of their range, Arctic ringed seals do not come ashore and use sea ice as a substrate for resting, pupping, and molting (Kelly 1988, Kelly *et al*. 2010). Outside the breeding and molting seasons, they are distributed in waters of nearly any depth; their distribution is strongly correlated with seasonally and permanently ice-covered waters and food availability (e.g. Simpkins *et al.* 2003, Freitas *et al.* 2008).

The seasonality of ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation. Three ecological seasons have been described as important to ringed seals: the “open-water “ or “foraging” period when ringed seals forage most intensively, the subnivean period in early winter through spring when seals rest primarily in subnivean lairs on the ice, and the basking period between lair abandonment and ice break-up (Born *et al.* 2004, Kelly *et al.* 2010b).

Overall, the record from satellite tracking indicates that during the foraging period, ringed seals breeding in shorefast ice either forage within 100 km of their shorefast breeding habitat or they make extensive movements of hundreds or thousands of kilometers to forage in highly productive areas and along the pack ice edge. Movements during the foraging period by ringed seals that breed in the pack ice are unknown. During the winter subnivean period, ringed seals excavate lairs in the snow above breathing holes where the snow depth is sufficient. These lairs are occupied for resting, pupping, and nursing young in annual shorefast and pack ice. Movements during the subnivean period are typically limited, especially when ice cover is extensive. During the (late) spring basking period, ringed seals haul out on the surface of the ice for their annual molt.

Because Arctic ringed seals are most readily observed during the spring basking period, aerial surveys to assess abundance are conducted during this period. Frost *et al.* (2004) reported that water depth, location relative to the fast ice edge, and ice deformation showed substantial and consistent effects on ringed seal densities during May and June in their central Beaufort Sea study area—densities were highest in relatively flat ice and near the fast ice edge, as well as at depths between 5 and 35 m. Bengston *et al*. (2005) found that in their eastern Chukchi Sea study area during May and June, ringed seals were four to ten times more abundant in nearshore fast and pack ice than in offshore pack ice, and that ringed seal preference for nearshore or offshore habitat was independent of water depth. They observed higher densities of ringed seals in the southern region of the study area south of Kivalina and near Kotzebue Sound.

Population Structure

A single Alaska stock of ringed seals is currently recognized in U.S. waters. This stock is part of the Arctic ringed seal subspecies. The genetic structuring of the Arctic subspecies has yet to be thoroughly investigated, and Kelly *et al.* (2010) cautioned that it may prove to be composed of multiple distinct populations.

Status

NMFS proposed to list Arctic ringed seals as threatened under the ESA on December 10, 2010 (75 *FR* 77476). At that time, NMFS did not propose to designate critical habitat because we found that critical habitat for the Arctic ringed seal in U.S. waters was not determinable. The deadline for a final determination regarding the listing proposal has been extended to June 10, 2012 (76 FR 77466).

There are no specific estimates of population size available for the Arctic subspecies of the ringed seal, but most experts would postulate that the population numbers in the millions. Based on the available abundance estimates for study areas within the Chukchi-Beaufort Sea region and extrapolations for pack ice areas without survey data, Kelly *et al.* (2010) indicated that a reasonable estimate for the Chukchi and Beaufort Seas is 1 million seals, and for the Alaskan portions of these seas is at least 300,000 seals. Bengston *et al.* (2005) estimated the abundance of ringed seals from spring aerial surveys conducted along the eastern Chukchi coast from Shishmaref to Barrow at 252,000 seals in 1999 and 208,000 in 2000 (corrected for seals not hauled out). Frost *et al.* (2004) conducted spring aerial surveys along the Beaufort Sea coast from Oliktok Point to Kaktovik in 1996–1999. They reported density estimates for these surveys, but did not derive abundance estimates. Based on the average density reported by Frost *et al.* (2004) for all years and ice types and the size of the survey area, Allen and Angliss (2011) derived an estimate of approximately 18,000 seals hauled out in that survey area (uncorrected for seals not hauled out).

Feeding and Prey Selection

Many studies of the diet of Arctic ringed seals have been conducted and although there is considerable variation in the diet regionally, several patterns emerge. Most ringed seal prey is small, and preferred prey tends to be schooling species that form dense aggregations. Ringed seals rarely prey upon more than 10-15 prey species in any one area, and not more than 2-4 of those species are considered important prey. Fishes are generally more commonly eaten than invertebrate prey, but diet is determined to some extent by availability of various types of prey during particular seasons as well as preference, which in part is guided by energy content of various available prey (Reeves 1998, Wathne *et al*. 2000). Invertebrate prey seem to become more important in the diet of Arctic ringed seals in the open water season and often dominate the diet of young animals (e.g., Lowry *et al.* 1980, Holst *et al.* 2001).

Despite regional and seasonal variations in the diet of Arctic ringed seals, fishes of the cod family tend to dominate the diet from late autumn through early spring in many areas. Arctic cod (*Boreogadus saida*) is often reported to be the most important prey species for ringed seals, especially during the ice-covered periods of the year (Labansen *et al*. 2007). Quakenbush *et al.* (2011) reported evidence that in general, the diet of Alaska ringed seals sampled consisted of cod, amphipods, and shrimp. They found that fish were consumed more frequently in the 2000s than during the 1960s and 1970s, and identified the five dominant species or taxa of fishes in the diet during the 2000s as: Arctic cod, saffron cod, sculpin, rainbow smelt, and walleye pollock. Invertebrate prey were predominantly mysids, amphipods, and shrimp, with shrimp most dominant.

Diving, Hauling out, and Social Behavior

Behavior of ringed seals is poorly understood because both males and females spend much of their time in lairs built in pressure ridges or under snowdrifts for protection from predators and severe weather (ADFG 1994). Figure 2 summarizes the approximate annual timing of reproduction and molting for Arctic ringed seals.

Arctic Ringed Seals

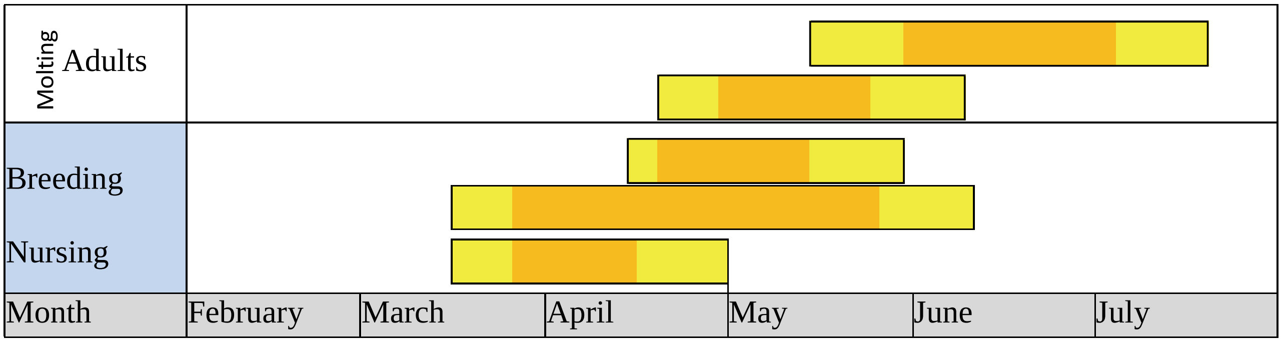

Figure 2. Approximate annual timing of reproduction and molting for Arctic ringed seals. Yellow bars indicate the "normal" range over which each event is reported to occur and orange bars indicated the "peak" timing of each event (from Kelly *et al.* 2010).

Arctic ringed seals use sea ice as a platform for resting throughout the year, and they make and maintain breathing holes in the ice from freeze-up until breakup (Frost *et al.* 2002). They normally give birth in late winter-early spring in subnivean lairs constructed in the snow on the sea ice above breathing holes, and mating takes place typically in May shortly after parturition. In the spring, as day length and temperature increase, ringed seals haul out in large numbers on the surface of the ice near breathing holes or lairs. This behavior is associated with the annual May-July molt.

Tagging studies revealed that Arctic ringed seals are capable of diving for at least 39 minutes (Teilmann et al. 1999) and to depths of over 500 m (Born et al. 2004), however, most dives reportedly lasted less than 10 minutes and dive depths were highly variable and were often limited by the relative shallowness of the areas in which the studies took place (Lydersen 1991, Kelly and Wartzok 1996, Teilmann et al. 1999, Gjertz et al. 2000,). Based on three-dimensional tracking, Simpkins et al. (2001) categorized ringed seal dives as either travel, exploratory, or foraging/social dives. Ringed seals tend to come out of the water during the daytime and dive at night during the spring to early summer breeding and molting periods, while the inverse tended to be true during the late summer, fall, and winter (Kelly and Quakenbush 1990, Lydersen 1991, Teilmann et al. 1999, Carlens et al. 2006, Kelly et al. 2010). Captive diving experiments conducted by Elsner et al. (1989) indicated that ringed seals primarily use vision to locate breathing holes from under the ice, followed by their auditory and vibrissal senses for short-range pilotage.

Vocalizations and Hearing

Ringed seals vocalize underwater in association with territorial and mating behaviors. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz, though they can hear underwater sounds at frequencies up to 60 kHz and make calls between 90 Hz and 16 kHz (Richardson *et al*. 1995). A more recent review suggests that the functional auditory bandwidth for pinnipeds in water is between 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz (Southall *et al*. 2007).

Beringia DPS of Bearded Seals (*Erignathus barbatus barbatus)* Proposed for listing as threatened.

Distribution

The range of the Beringia DPS of the bearded seal is defined as extending from an east-west Eurasian dividing line at Novosibirskiye in the East Siberian Sea, south into the Bering Sea (Kamchatka Peninsula and 157°E division between the Beringia and Okhotsk DOSs), and to a north American dividing line (between the Beringia DPS of the E. b. nauticus subspecies and the E. B. barbatus subspecies) at 122°W (midpoint between the Beaufort Sea and Pelly Bay).

Bearded seals are closely associated with sea ice – particularly during the critical life history periods related to reproduction and molting – and can be found in a broad range of ice types. They generally prefer ice habitat that is in constant motion and produces natural openings and areas of open water such as leads, fractures, and polynyas, for breathing, hauling out on the ice, and access to water for foraging (Heptner et al. 1976, Fedoseev 1984, Nelson et al. 1984). The bearded seal's effective range is generally restricted to areas where seasonal sea ice occurs over relatively shallow waters. Based on the best available data, Cameron et al. (2010) therefore defined the core distribution of bearded seals as those areas over waters less than 500 m deep.

The region that includes the Bering and Chukchi seas is the largest area of continuous habitat for bearded seals (Burns 1981, Nelson *et al.* 1984). The Bering-Chukchi Platform is a shallow intercontinental shelf that encompasses half of the Bering Sea, spans the Bering Strait, and covers nearly all of the Chukchi Sea. Bearded seals can reach the bottom everywhere along the shallow shelf and so it provides them favorable foraging habitat (Burns 1967). The Bering and Chukchi seas are generally covered by sea ice in late winter and spring and are then mostly ice free in late summer and fall, a process that helps to drive a seasonal pattern in the movements and distribution of bearded seals in this area (Burns 1967, Burns 1981, Nelson *et al.* 1984). During winter, most bearded seals in Alaskan waters are found in the Bering Sea, while smaller numbers of year-round residents remain in the Beaufort and Chukchi Seas, mostly around lead systems, and polynyas. From mid-April to June, as the ice recedes, many bearded seals that overwinter in the Bering Sea migrate northward through the Bering Strait into the Chukchi and Beaufort Seas, where they spend the summer and early fall at the southern edge of the Chukchi and Beaufort Sea pack ice at the wide, fragmented margins of multiyear ice. A small number of bearded seals, mostly juveniles, remains near the coasts of the Bering and Chukchi seas for the summer and early fall instead of moving with the ice edge. These seals are found in bays, brackish water estuaries, river mouths, and have been observed up some rivers (Burns 1967, Heptner *et al.* 1976, Burns 1981).

Population Structure

There are two recognized subspecies of the bearded seal: *E. b. barbatus,* often described as inhabiting the Atlantic sector (Laptev, Kara, and Barents seas, North Atlantic Ocean, and Hudson Bay; Rice 1998); and *E. b. nauticus*, which inhabits the Pacific sector (remaining portions of the Arctic Ocean and the Bering and Okhotsk seas; Ognev 1935, Scheffer 1958, Manning 1974, Heptner *et al*. 1976). Two distinct population segments (DPS) were identified for the *E. b. nauticus* subspecies–the Okhotsk DPS in the Sea of Okhotsk, and the Beringia DPS, encompassing the remainder of the range of this subspecies. Only the Beringia DPS of bearded seals is found in U.S. waters, and these are of a single recognized Alaska stock.

Harvest

Bearded seals were among those species hunted by early Arctic inhabitants (Krupnik 1984), and today they remain a central nutritional and cultural resource for many northern communities (Hart and Amos 2004, ACIA 2005, Hovelsrud et al. 2008). The solitary nature of bearded seals has made them less suitable for commercial exploitation than many other seal species. Still, within the Beringia DPS they may have been depleted by commercial harvests in the Bering Sea during the mid-20th century. There is currently no significant commercial harvest of bearded seals and significant harvests seem unlikely in the foreseeable future.

Alaska Native hunters mostly take bearded seals of the Beringia DPS during their northward migration in the late spring and early summer, using small boats in open leads among ice floes close to shore (Kelly 1988). Allen and Angliss (2010) reported that based on subsistence harvest data maintained by ADF&G primarily for the years 1990 to 1998, the mean estimated annual harvest level in Alaska averaged 6,788 bearded seals as of August 2000 (Coffing et al. 1998, Georgette *et al.* 1998, Wolfe and Hutchinson-Scarbrough 1999, Allen and Angliss 2010). The estimate of 6,788 bearded seals is considered by Allen and Angliss (2010) to be the best estimate of the subsistence harvest level in Alaska. Cameron *et al.* (2010) noted that ice cover in hunting locations can dramatically affect the availability of bearded seals and the success of hunters in retrieving seals that have been shot, which can range from 50-75% success in the ice (Burns and Frost 1979, Reeves et al. 1992) to as low as 30% in open water (Burns 1967, Smith and Taylor 1977, Riewe and Amsden 1979, Davis *et al*. 1980). Using the mean annual harvest reported from 1990-1998, assuming 25 to 50% of seals struck are lost, they estimated the total annual hunt by Alaska Natives would range from 8,485 to 10,182 bearded seals. Assuming contemporary harvest levels in eastern Siberia are similar to Alaska, as was the pattern in the 1970s and 1980s, and a comparable struck-loss rate of 25-50%, the total annual take from the entire Bering and Chukchi Seas would range from 16,970 to 20,364 bearded seals (Cameron *et al.* 2010).

Cameron et al. (2010) concluded that although the current subsistence harvest is substantial in some areas, there is little or no evidence that subsistence harvests have or are likely to pose serious risks to the Beringia DPS (Cameron *et al.* 2010). Village harvest estimates for the Alaskan Chukchi villages for 1994-2003 are: Pt. Hope - 39, Pt. Lay – 32; Wainwright – 728; and Barrow – 491 (Bacon *et al.* 2009).

Status

NMFS proposed to list the Beringia DPS of bearded seals as threatened under the ESA on December 10, 2010 (75 *FR* 77496). At that time, NMFS did not propose to designate critical habitat because we found that critical habitat for the Beringia DPS in U.S. waters was not determinable. The deadline for a final determination regarding the listing proposal has been extended to June 10, 2012 (76 FR 77465).

Although the present population of the Beringia DPS is highly uncertain, it has been estimated to be about 155,000 individuals. Based on extrapolation from existing aerial survey data, Cameron et al. (2010) considered the current population of bearded seals in the Bering Sea to be about double the 63,200 estimate reported by Ver Hoef *et al.* (2010; corrected for seals in the water) for U.S. waters, or approximately 125,000 individuals. In addition, Cameron et al. (2010) derived crude estimates of: 3,150 bearded seals for the Beaufort Sea (uncorrected for seals in the water), which was noted as likely a substantial underestimate given the known subsistence harvest of bearded seals in this region; and about 27,000 seals for the Chukchi Sea based on extrapolation from limited aerial surveys (also uncorrected for seals in the water).

Feeding and Prey Selection

Bearded seals feed primarily on a variety of invertebrates (crabs, shrimp, clams, worms, and snails) and some fishes found on or near the sea bottom (Kelly 1988; Reeves, Stewart, and Leatherwood 1992; ADFG 1994; Cameron *et al*. 2010; Burns 1981; Hjelset *et al*. 1999). They primarily feed on or near the bottom, diving is to depths of less than 100 m (though dives of adults have been recorded up to 300 m and young-of-the-year have been recorded diving down to almost 500 m; Gjertz 2000). Satellite tagging indicates that adults, subadults, and to some extent pups, show some level of fidelity to feeding areas, often remaining in the same general area for weeks or months at a time (Cameron 2005; Cameron and Boveng, 2009). Diets may vary with age, location, season, and possible changes in prey availability (Kelly 1988).

Quakenbush *et al.* (2011b) reported that fish consumption appeared to increase between the 1970s and 2000s for Alaska bearded seals sampled in the Bering and Chukchi Seas, although the difference was not statistically significant. Bearded seals also commonly consumed invertebrates, which were found in 95% of the stomachs sampled. In the 2000s, sculpin, cod, and flatfish were the dominant fish taxa consumed (Quakenbush *et al.* 2011b). The majority of invertebrate prey items identified in the 2000s were mysids, isopods, amphipods, and decapods. Decapods were the most dominant class of invertebrates, and were strongly correlated with the occurrence of shrimp and somewhat correlated with the occurrence of crab. Mollusks were also common prey, occurring in more than half of the stomachs examined throughout the years of the study.

Diving, Hauling out, and Social Behavior

Figure 3 summarizes the approximate annual timing of reproduction and molting in the Bering Strait, Central Chukchi, and Western Canadian Arctic. Females give birth to a single pup in the spring on suitable broken pack ice over shallow waters. Pups enter the water within hours of birth and nurse on the ice. Though not specifically studied, the molting period of bearded seals in the Bering and Chukchi seas is reportedly protracted, occurring between April and August with a peak in May and June (Tikhomirov 1964, Kosygin 1966, Burns 1981). Adult and juvenile bearded seals haul out more frequently during this annual molt,

There are only a few quantitative studies concerning the activity patterns of bearded seals. Based on limited observations in the southern Kara Sea and Sea of Okhotsk it has been suggested that from late May to July bearded seals haul out more frequently on ice in the afternoon and early evening (Heptner *et al*. 1976). From July to April, three males (2 subadults and 1 young adult) tagged as part of a study in the Bering and Chukchi Seas rarely hauled out at all, even when occupying ice covered areas. This is similar to both male and female young-of-year bearded seals instrumented in Kotzebue Sound, Alaska (Frost *et al*. 2008); suggesting that, at least in the Bering and Chukchi Seas, bearded seals may not require the presence of sea ice for a significant part of the year. The timing of haulout was different between the age classes in these two studies however, with more of the younger animals hauling out in the late evening (Frost *et al*. 2008) while adults favored afternoon.

The diving behavior of adult bearded seals is closely related to their benthic foraging habits and in the few studies conducted so far, dive depths have largely reflected local bathymetry (Gjertz *et al*. 2000, Krafft *et al*. 2000). The preferred depth range is often defined as less than 200 m, though dives of adults have been recorded up to 300 m and young-of-the-year have been recorded diving down to almost 500 m (Kovacs 2002, Cameron and Boveng 2009). Studies using depth recording devices have until recently focused on lactating mothers and their pups. These studies showed that mothers in the Svalbard Archipelago make relatively shallow dives, generally <100 m in depth, and for short periods, generally less than 10 min in duration. Nursing mothers dived deeper on average than their pups, but by 6 weeks of age most pups had exceeded the maximum dive depth of lactating females (448-480 m versus 168-472 m)(Gjertz *et al*. 2000).

Bearded seals are solitary throughout most of the year except for the breeding season. The social dynamics of mating in bearded seals are not well known because detailed observations of social interactions are rare, especially underwater where copulations are believed to occur. Theories regarding their mating system have centered around serial monogamy and promiscuity, and more specifically on the nature of competition among breeding males to attract and gain access to females (Stirling 1983, Budelsky 1992, Stirling and Thomas 2003). Whichever mating system is favored, sexual selection driven by female choice is predicted to have strongly influenced the evolution of male displays, and possibly size dimorphism, and caused the distinct geographical vocal repertoires recorded from male bearded seals in the Arctic (Stirling, 1983; Atkinson, 1997; Risch *et al*., 2007).

Vocalizations and Hearing

Bearded seals vocalize underwater in association with territorial and mating behaviors. The predominant calls produced by males during breeding, termed trills, are described as frequency-modulated vocalizations. Trills show marked individual and geographical variation, are uniquely identifiable over long periods, can propagate up to 30 km, are up to 60 s in duration, and are usually associated with stereotyped dive displays (Cleator *et al*. 1989, Van Parijs *et al*. 2001, Van Parijs 2003, Van Parijs *et al*. 2003, Van Parijs *et al*. 2004, Van Parijs and Clark 2006).

Underwater audiograms for ice seals suggest that they have very little hearing sensitivity below

1 kHz; but hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al., 1995a). A more recent review suggests that the functional auditory bandwidth for pinnipeds in water is between 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz (Southall *et al*., 2007). Masking of biologically important sounds by anthropogenic noise could be considered a temporary loss of hearing acuity. Brief, small-scale masking episodes might, in themselves, have few long-term consequences for individual marine mammals. There are few situations or circumstances where low frequency sounds could mask biologically important signals.

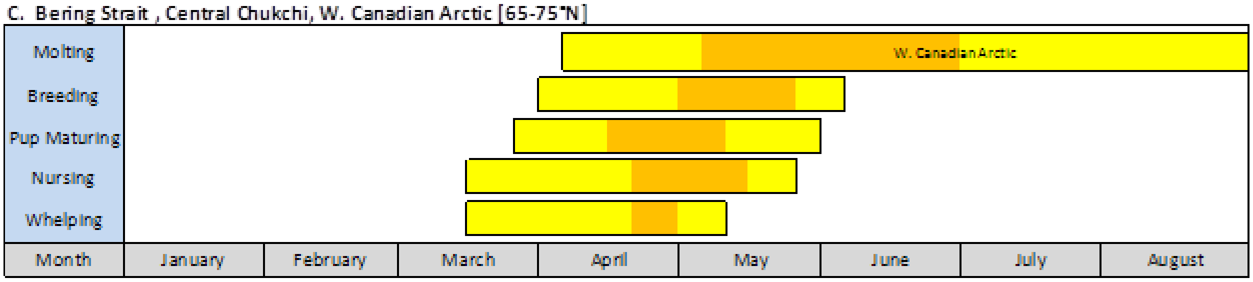

Figure 3. Approximate annual timing of reproduction and molting for the Beringia DPS of bearded seals. Yellow bars indicate the "normal" range over which each event is reported to occur and orange bars indicate the peak timing of each event. For molting, reports for juveniles and adults were combined. "Pup Maturing" refers to the period when weaned pups may remain at least partially dependent on sea ice while they develop proficiency at diving and foraging for themselves. Locations are noted where differences within the region occur (from Cameron *et al.* 2010).

III. ENVIRONMENTAL BASELINE

This section provides the reference condition for the species within the action area. By regulation, the baseline includes the impacts of past and on-going actions (except the effects of the proposed action) on the species. This section also contains summaries of the impacts from stressors that will be ongoing in the same areas and times as the effects of the proposed action (future baseline). This information forms part of the foundation of our exposure, response, and risk analyses.

Climate Change

There is widespread consensus within the scientific community that atmospherictemperatures on earth are increasing (warming) and that this will continue for at least the next several decades. There is also consensus within the scientific community that this warming trend will alter current weather patterns. The strongest warming is expected in the north, exceeding the estimate for mean global warming by a factor or 3, due in part to the "ice-albedo feedback", whereby as the reflective areas of arctic ice and snow retreat, the earth absorbs more heat, accentuating the warming (NRC 2003). The proximate effects of climate change in the arctic are being expressed as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al. 2000). These changes in turn result in physical changes such as reduced sea ice, increased coastal erosion, changes in hydrology, depth to permafrost, and carbon availability (ACIA 2005).

Changes in sea level, snow cover, ice extent, and precipitation are consistent with a warming climate near the Earth's surface. The IPCC (2001b) noted "Examples include…increases in sea level and ocean-heat content, and decreases in snow cover and sea-ice extent and thickness" and consider their statement that "rise in sea level during the 21st century that will continue for further centuries" to also be a "robust finding." However, they highlight the uncertainty of understanding the probability distribution associated with both temperature and sea-level projections.

The 4th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007) reports that warming will be greatest over land and at most high northern latitudes. They also predict the continuation of recent observed trends such as contraction of snow cover area, increases in thaw depth over most permafrost regions, and decrease in sea ice extent. Projected surface temperature changes along the North Slope of Alaska may increase by 6.0-6.5 degrees C for the late 21st century (2090-2099), relative to the period 1980-1999 (IPCC 2007)
The NRC (2001) also concluded that: "The predicted warming is larger over higher latitudes than over low latitudes, especially during winter and spring, and larger over land than over sea."

A general summary of the changes attributed to the current trends of arctic warming indicate sea ice in the Arctic is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general, the sea-ice extent is becoming much less in the arctic summer and slightly less in winter. The thickness of arctic ice is decreasing. The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial arctic ice pack. It is generally thought that the Arctic will become ice free in summer, but at this time there is considerable uncertainty about when that will happen.

Sea ice and ocean observations over the past decade (2001-2011) suggest that the Arctic Ocean climate has reached a new state with characteristics different than those observed previously. The new ocean climate is characterized by less sea ice (both extent and thickness) and a warmer and fresher upper ocean than in 1979-2000. The extent of winter sea ice, generally measured at the maximum in March, began changing in the late 1990s and has declined through 2006 (Comiso, 2006; Stroeve et al., 2007; Francis and Hunter, 2007). Comiso (2006) attributed the changes to corresponding changes in increasing surface temperature and wind-driven ice motion. The factors causing the reduction in the winter sea-ice extent are different from those in the summer. The reduction of the winter sea-ice extent in the Bering Sea preconditions the environment during the melt season for the Chukchi Sea. The end-of-winter perennial sea-ice extent was the smallest on record in March 2007 (Nghiem et al., 2007). The arctic sea ice reached its maximum on March 10, 2008. Although the maximum in 2008 was greater than in 2007, it was below average and was thinner than normal (Martin and Comiso, 2008; University of Colorado, NSDIC, 2008).

Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2005). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting of sea ice. Threats posed by the direct and indirect effects of global climatic change are or will be common to northern species. These threats will be most pronounced for ice-obligate species such as the polar bear, walrus, and ringed seal.

Table 3. Phenomena associated with projections of global climate change including levels of confidence associated with projections (adapted from IPCC 2001 and Campbell-Lendrum Woodruff 2007).

Phenomenon	**Confidence in Observed Changes (observed in latter 20th Century)**	**Confidence in Projected Changes (during the 21st Century)**
Higher max temperatures and greater number of hot days over almost all land areas	Likely	Very likely
Higher min temperatures with fewer cold days and frost days over almost all land areas	Very likely	Very likely
Reduced diurnal temperature range over most land areas	Very likely	Very likely
Increased heat index over most land areas	Likely over many areas	Very likely over most areas
More intense precipitation events	Likely over many mid-to-high latitude areas in Northern Hemisphere	Very likely over most areas
Increased summer continental drying and associated probability of drought	Likely in a few areas	Likely over most mid-latitude continental interiors (projections are inconsistent for other areas)
Increase in peak wind intensities in tropical cyclones	Not observed	Likely over some areas
Increase in mean and peak precipitation intensities in tropical cyclones	Insufficient data	Likely over some areas

Ocean Acidification

The threats posed to marine ecosystems due to ocean acidification are becoming increasingly apparent. Recently, in a report entitled "Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean, the NRC (2010) explained that as carbon dioxide has been released into the atmosphere due to human activities, the ocean has absorbed about 1/3 of the total emissions for the past 200 years. When the oceans uptake this CO_2, decreases to water pH can result (IPCC 2007), leading to other chemical changes which have been termed "ocean acidification. NRC (2010) highlighted the fact that this rate of change in ocean chemistry is greater than any known for at least 800,000 years and is increasing too rapidly for natural processes to maintain the ocean's pH. The potential effects and the specific timeframes for effects of ocean acidification are uncertain. The NRC (2010) concluded that while direct biological effects of this ocean acidification will vary and are not certain, the chemical effects are "well understood" and:

"…the long-term consequences of ocean acidification are not known but are likely to include serious impacts on ecosystems….".

The IAP (2009) summarized the direction of the likely impacts of ocean acidification:

> "The high CO_2 waters in polar and upwelling regions such as the eastern Pacific and Bering Sea for example, will experience low pH more rapidly than other regions…The ocean chemistry changes projected will exceed the range of natural variability, which is likely to be too rapid for many species to adapt to. Many coastal animals and groups of phytoplankton and zooplankton may be directly affected with implications for fish, marine mammals and the other groups that depend on them for food…The impacts of these changes on oceanic ecosystems…cannot yet be estimated accurately but they are potentially large…Although some species may benefit, most are adapted to current conditions and the impacts on ocean biological diversity and ecosystem functioning will likely be severe."

One of the key effects that is predicted to occur from increasing ocean acidification derives from observations that acidifying seawater negatively affects the ability of species to form and maintain shells and skeletons made of calcium carbonate. This observation indicates that there will likely be adverse effects on organisms such as zooplankton, key elements in many food webs. Based on all of the available information, the ecosystems of Chukchi and Beaufort Seas may be seriously threatened by ocean acidification and climate change in this century. Both climate warming and continued acidification of the ocean are foreseeable. However, we do not know the precise timeframe, or the series of events that would need to occur before an adverse population level effect on the fin, humpback, or bowhead whale, or ringed or bearded seal would be realized.

Status of Species within the Action Area

Bowhead Whale

Bowhead whales of the western Arctic stock overwinter in the central and western Bering Sea, then move north and eastward in spring through the Chukchi Sea within the action area during their migration to the Canadian Beaufort Sea. The bowhead northward spring migration appears to coincide with ice breakup and probably begins most years in April (possibly late March depending on ice conditions) and early May. It is thought to occur after the peak of breeding, which is believed to occur in March-April.

Most of these whales remain in the Canadian Beaufort during summer to feed, returning in fall along the Alaska coast and entering the Chukchi Sea beginning sometime in late September. Data are limited on the bowhead fall migration through the Chukchi Sea before the whales move south into the Bering Sea. Whaling captains from Wainwright reported that bowheads do not typically follow the Alaska coast southward in the autumn, but bowheads have been seen a few times in October near Wainwright. Bowhead whales commonly are seen from the coast to about 150 km (93 mi) offshore between Point Barrow and Icy Cape, suggesting that most bowheads disperse southwest after passing Point Barrow and cross the central Chukchi Sea near Herald Shoal to the northern coast of the Chukotka Peninsula. However, sightings north of 72° N.

latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. Satellite tagging research has recently provided new insights into the fall movements of these whales in the Chukchi Sea and the action area. Fifteen bowhead tagged between 2006 and 2008 were followed into the Chukchi Sea during the fall migration (Quakenbush, Small, and Citta, 2010). Most of these whales moved into the Chukchi between the latitudes of 71° N and 74° N. Some whales returned to the Barrow area before continuing on to the Chukotka coast. Sightings made by NMFS (Clarke *et al.*, 2011) indicated that bowhead whales were distributed broadly west and southwest from Barrow across the Alaskan Chukchi Sea during the autumn migration; this was also observed during surveys conducted from 1982-1991 (Moore and Clarke, 1992). All observed feeding occurred close to shore between Pt. Franklin and Barrow, Alaska, in June, July and September of 2009. Whales crossing through the Chukchi OCS planning area (including the action area) did so in less than one week, although at least one whale lingered in the area. Kernel densities estimated from GPS locations of whales suggest that bowheads do not spend much time (e.g. feeding or resting) in the north-central Chukchi Sea near the area of planned activities (Quakenbush et al. 2010).

Not all bowheads migrate into the Canadian Beaufort in summer; some likely remain in the Chukchi or move throughout the Beaufort and Chukchi Seas. Data from the Barrow-based boat surveys in 2009 (George and Sheffield, 2009) showed that bowheads were observed almost continuously in the waters near Barrow, including feeding groups in the Chukchi Sea at the beginning of July. Many whales (including a cow/calf pair), some feeding, were observed northeast of Barrow in early August and there were large numbers of feeding whales east of Point Barrow, later in August into September. While sample sizes from the tagging study are insufficient to draw broad conclusions about relative distribution, it is clear from all sources of data that bowheads may be in the U.S. Beaufort and the Chukchi Sea in spring, summer, and fall. Bowhead whales are seen also in the central Chukchi Sea and along the Chukotka coast in July and August. They may occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore, 1992; USDOC, NOAA, and NSB, 2005). These new data add to previous observations of bowhead whales that were near Barrow, in the central Beaufort Sea, or in the Chukchi Sea in the summer. For example, bowheads were observed near Barrow in the mid-summer (e.g., Brower, as cited in USDOI, MMS, 1995). Eight bowheads were observed near Barrow on July 25, 1999, 2 at 71° 30’ N., 155° 40’W. to 155° 54’ W. from a helicopter during a search, and six at 71° 26’ N., 156° 23’ W. from the bridge of the icebreaker *Sir Wilfrid Laurier* (Moore and DeMaster, 2000).

Harry Brower, Jr. observed whales in the Barrow area in the middle of the summer, when hunters were hunting bearded seals on the ice edge (Brower, as cited in USDOI, MMS, 1995). The monitoring program conducted while towing the single steel drilling caisson to the McCovey location in 2002 recorded five bowhead whales off Point Barrow on July 21. COMIDA surveys and the BOWFEST have also showed bowhead whales in the Chukchi Sea in the summer.

The Chukchi Sea is an integral part of the total range of western Arctic bowhead whales. During the spring (widely bracketed as mid-March to approximately mid-June), bowheads migrate through leads on their way to summer feeding grounds. Most calving apparently occurs during the spring migration. Hunter reports and harvest data at Barrow indicate that most pregnant females pass Barrow in late May through mid-June (C. George, NSB unpublished data). Calving is likely to occur in mid-May to mid-June, when whales are between the Bering Strait and Point Barrow (in the Chukchi Sea). Reese *et al*. (2001) said this is consistent with other observations in the region, including: (a) relatively few neonate-cow pairs reported by whalers at St. Lawrence Island; (b) many neonates seen during the whale census in late May; (c) relatively few term females taken at Barrow; (d) taken females with term pregnancies appeared close to parturition; and (e) most of the herd believed to have migrated past Barrow by late May.

In some years, parts of the spring lead system in the Chukchi Sea west, northwest, and southwest of Barrow are used as feeding areas over extended periods of time during the spring migration, but this use is inconsistent. Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring. Wainwright whaling captains have identified feeding areas in the Chukchi Sea (Quakenbush and Huntington, 2010). Clarke *et al*. (2011) reported observing bowhead feeding near Pt. Franklin (between Barrow and Wainwright) in 2009 during late June through mid July and suggested that this area may sometimes be important to bowhead whales in the summer. Bowheads have been previously identified as feeding in September near the area in which they were seen feeding in 2009, although far fewer in number (Moore, 1992). Bowheads feeding nearshore in the northeastern Chukchi Sea may be taking advantage of euphausiids and other prey advected north in the Alaska Coastal Current. Feeding observed in 1983, a heavy ice year, was farther from shore and in deeper water. COMIDA surveys observed feeding behavior in bowheads in the Chukchi twenty seven percent of the time (Clarke *et al*., 2011). The actual amount of feeding in the Chukchi Sea in the fall is unknown, as is the amount of feeding in the Bering Sea in the winter (Richardson and Thomson, 2002).

Other Factors Affecting the Bowhead Whale within the Action area

Commercial Hunting

There are no data available that indicate that, other than historic commercial whaling, any previous human activity has had a significant population-level adverse impact on the current status of the Western Arctic stock of bowheads or their recovery. It is clear that commercial whaling between 1848 and 1915 was the human activity that had the greatest adverse effect on this population. Commercial whaling severely depleted bowhead whales. Woody and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woody and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Commercial whaling also may have caused the extinction of some subpopulations and some temporary changes in distribution. Following protection from whaling, this population (but not some other bowhead populations) has shown marked progress toward recovery. Population estimates for 2001 range between 10,470 (SE = 1,351) with a 95% confidence interval of 8,100–13,500 (George *et al.,* 2004) and 10,545 CV(N) = 0,128 (Zeh and Punt, 2004, cited in Angliss and Outlaw, 2005. Thus estimated population size is within the lower bounds of estimates of the historic population size. Shelden *et al*. (2001, 2003) concluded that this population should be removed from the list of species designated as endangered under the ESA.

Subsistence Hunting

Indigenous peoples of the arctic and subarctic of what is now Alaska have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the Alaska Eskimo Whaling Commission (AEWC) through a cooperative agreement between the AEWC and the United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA).

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, monitored, managed, and regulated, helps to determine the resilience of the population to other impacts that could potentially cause lethal takes. Currently, Alaskan Native hunters from 10 villages harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. The status of the population is closely monitored, and these activities are closely regulated. Strike limits are established by the IWC and set at a 5-year quota of 280 landings. The sustained growth of the Western Arctic bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters, it is unlikely this source of mortality will contribute to a significant adverse effect on the recovery and long-term viability of this population.

Several Native villages participate in bowhead whaling along the Chukchi coast. These villages and their bowhead strike quotas are as follows: Wainwright: 7, Pt. Lay: 1, Barrow: 22, and Pt. Hope: 10. Barrow hunts in both spring and fall, while the other villages hunt primarily during the spring migration. Recent changes in sea ice conditions and the timing of the migrations have provided opportunities for these villages to take whales at other times of the year, although this is unusual.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales. Whales in the vicinity of a struck whale could be disturbed by the sound of the explosive used in the hunt, the boat motors, and any sounds made by the injured whale. NMFS (2003a) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: "…the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians, listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike …" (NMFS, 2003). We are not aware of data indicating how far hunting-related sounds (for example, the sounds of vessels and/or bombs) can propagate in areas where hunting typically occurs, but this is likely to vary with environmental conditions. It is not known if whales issue an "alarm call" or a "distress call" after they, or another whale, are struck.

NMFS (2003) reported that:
…whales may act skittish" and wary after a bomb detonates, or may be displaced further offshore (E. Brower, pers. com.). However, disturbances to migration as a result of a strike are temporary (J. George, 1996), as evidenced when several whales may be landed at Barrow in a single day. There is some potential that migrating whales, particularly calves, could be forced into thicker offshore ice as they avoid these noise sources. The experience of Native hunters suggests that the whales would be more likely to temporarily halt their migrations, turn 180 degrees away…(i.e., move back through the lead systems), or become highly sensitized as they continue moving (E. Brower, pers. com.).

Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where hunting was occurring on multiple, perhaps dozens or more, occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. However, we are not aware of information indicating long-term habitat avoidance has occurred with present levels of activity. Additionally, if whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions, over the short-term, to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

Commercial-Fishing, Marine Vessel Traffic

Based on available data, previous incidental take of bowhead whales apparently has occurred only rarely. The bowhead's association with sea ice limits the amount of fisheries activity occurring in bowhead habitat. However, the frequency of such interactions in the future would be expected to increase if commercial fishing activities expand northward. There is some uncertainty about whether such expansion will occur. The Arctic Fisheries Management Plan of the North Pacific Fishery Management Council bans commercial fishing in federal waters north of the Bering Strait. The Canadian government has established a similar ban for the Canadian Beaufort.

Nonetheless, commercial fishing does occur in other portions of the range of the Western Arctic bowhead, and interaction with commercial fishing gear has been documented. There have been two confirmed occurrences of entanglement in crab-pot gear, one in 1993 and one in 1999 (Angliss and Lodge, 2008). Citing a personal communication from Craig George of the North Slope Borough, Department of Wildlife Management, Angliss and Lodge (2008 report a preliminary result from reexamination of bowhead harvest records suggest that there may be more than 20 cases indicating entanglements or scarring attributable to ropes in the bowhead harvest records.

Potential effects on bowhead whales from commercial-fishing activities include incidental take in the fisheries and/or entanglement in derelict fishing gear resulting in death, injury, or effects on the behavior of individual whales; disturbance resulting in temporary avoidance of areas; and whales being struck and injured or killed by vessels. Bowheads have been entangled in ropes from crab pots, harpoon lines, or fishing nets; however, the frequency of occurrence is not known.

Marine vessel traffic, in general, can pose a threat to bowheads because of the risk of ship strikes. Shipping and vessel traffic is expected to increase in the Arctic if warming continues. Additionally, noise associated with ships or other boats potentially could cause bowheads to alter their movement patterns or make other changes in habitat use. Pollution from marine vessel traffic, especially from large vessels such as large cruise ships, also could cause degradation of the marine environment and increase the risk of the whales' exposure to contaminants and disease vectors. The frequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low but may be increasing. Between 1976 and 1992, only three ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George *et al.* 1994). The low number of observations of ship-strike injuries suggests that bowheads either do not often encounter vessels, or they avoid interactions with vessels, or that interactions usually result in the animals' death.

Pollution and Contaminants

Initial studies of bowhead tissues collected from whales landed at Barrow in 1992 (Becker *et al.,* 1995) indicate that bowhead whales have very low levels of mercury, PCBs, and chlorinated hydrocarbons, but they have fairly high concentrations of cadmium in their liver and kidneys. The study concluded that the high concentration of cadmium in the liver and kidney tissues of bowheads warrants further investigation. Becker (2000) noted that concentration levels of chlorinated hydrocarbons in bowhead whale blubber generally are an order of magnitude less than what has been reported for beluga whales in the Arctic. This probably reflects the difference in the trophic levels of these two species; the bowhead being a baleen whale feeding on copepods and euphausiids, while the beluga whale being toothed whale feeding at a level higher in the food web. The concentration of total mercury in the liver also is much higher in beluga whales than in bowhead whales.

Bratton et al. (1993) measured organic arsenic in the liver tissue of one bowhead whale and found that about 98% of the total arsenic was arsenobetaine. Bratton et al. (1997) looked at eight metals (arsenic, cadmium, copper, iron, mercury, lead, selenium, and zinc) in the kidneys, liver, muscle, blubber, and visceral fat from bowheads harvested from 1983-1990. They observed considerable variation in tissue metal concentration among the whales tested. Metal concentrations evaluated did not appear to increase over time between 1983 and 1990. Based on metal levels reported in the literature for other baleen whales, the metal levels observed in all tissues of the bowhead are similar to levels in other baleen whales. The bowhead whale has little metal contamination as compared to other Arctic marine mammals, except for cadmium, which requires further investigation as to its role in human and bowhead whale health. The study recommended limiting the consumption of kidney from large bowhead whales pending further evaluation.

Cooper et al. (2000) analyzed anthropogenic radioisotopes in the epidermis, blubber, muscle, kidney, and liver of marine mammals harvested for subsistence food in northern Alaska and in the Resolute, Canada region. The majority of samples analyzed had detectable levels of ^{137}Cs. Among tissues of all species of marine mammals analyzed, ^{137}Cs was almost always undetectable in the blubber and significantly higher in epidermis and muscle tissue than in the liver and kidney tissue. The levels of anthropogenic radioisotopes measured were orders of magnitude below levels that would merit public health concern. The study noted there were no obvious geographical differences in ^{137}Cs levels between marine mammals harvested in Resolute, Canada and those from Alaska. However, the ^{137}Cs levels in marine mammals were two to three orders of magnitude lower than the levels reported in caribou in northern Canada and Alaska.

In its Beaufort Sea multiple-sale EIS in 2003, the Minerals Management Service concluded that the levels of metals and other contaminants measured in bowhead whales appear to be relatively low, with the exception of cadmium. Since the finalization of the multiple-sale EIS, additional information (included in the review presented above) on contaminants in Western Arctic bowheads has become available. This information supports this same general conclusion.

Offshore Oil- and Gas-Related Activities and other Industrial Activities

Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Chukchi seas as a result of previous lease sales.

Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. There is no existing OCS offshore development or production in the Chukchi Sea. Outer Continental Shelf Lease Sale 193 (Chukchi Sea OCS planning area) was held on February 6, 2008. Sale 193 offered approximately 12 million acres for leasing, and bids were received for over 1,100,000 acres. Five exploratory wells have been drilled in the Chukchi Sea from past lease sales, all using drillships. These wells were drilled between 1989 and 1991, inclusive. The last Chukchi Sea well was drilled in 1991 at the Diamond Prospect. Recently several companies have conducted 2D/3D seismic work in the Chukchi, work that is expected to continue post-lease as prospects are explored. Many of these offshore activities also required ice management (icebreaking), helicopter traffic, fixed wing monitoring, other support vessels, and, in some cases stand-by barges.

Shell will also be conducting an exploratory drilling program during the summer and fall of 2012 in the central Beaufort Sea near Camden Bay. This work is described, and the impacts of the drilling considered, in an environmental assessment prepared by NMFS (http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_ea_draft2012.pdf). A separate biological opinion of this action has been prepared by NMFS and is available at this site: http://www.fakr.noaa.gov/. The impacts and exposures associated with the Beaufort program are similar to those described here for the Chukchi. Like their Chukchi location, the sites for Shell's 2012 Beaufort Sea drilling are within the fall migratory corridor of the Western Arctic bowheads. While Shell proposes to stop drilling and re-locate the drillship during the fall subsistence whale hunts at Kaktovik and Nuiqsut, the remaining drilling time would coincide with a significant portion of this migration, with the potential for acoustic exposer of a large percentage of this stock. The Shell drilling sites in the Chukchi are approximately 400 miles to the west of their Beaufort Sea drilling sites.

Available information does not indicate that oil- and gas-related activity (or any recent activity) has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of the Western Arctic population. Data indicate that the Western Arctic population has continued to increase over the timeframe that oil and gas activities has occurred. There is no evidence of long-term displacement from habitat. However, there are no long-term oil and gas developments in the offshore within bowhead high use areas. Northstar Island (a Beaufort Sea oil production facility operated by British Petroleum) is at the southern end of the migratory corridor and Endicott (another oil facility in the Beaufort Sea) is within the barrier islands. Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor.

Data on past drilling in both federal and state waters is relatively complete, especially since 1990. Data on other activities, such as hunting activity, barge traffic, and shipping noise are incomplete. Thus, while it is clear there have been multiple noise and disturbance sources in the Beaufort Sea over the past 30 years, because of the incompleteness of data, even for the 1990s, for many types of activities, we cannot evaluate the totality of past effects on bowhead whales resulting from multiple noise and disturbance sources (e.g., 2D seismic in state and federal waters, drilling, ice-management, high-resolution acoustic surveys, vessel traffic, construction, geotechnical bore-hole drilling, aircraft surveys, and hunting). Because data are also incomplete for the Chukchi Sea, we reach the same general conclusions.

Climate Change

Conceptual models by Moore and Laidre (2006) suggested that overall; reductions in sea ice cover should increase the Western Arctic stock of bowhead whale prey availability. This theory may be substantiated by the steady increase in the population during the nearly 20 years of sea ice reductions (Walsh 2008). Moore and Huntington (2008) anticipate that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change. Sheldon et al. (2003) notes that there is a high probability that bowhead abundance will increase under a warming global climate.

Braund (2009) reports the observations of one whale hunter:

> Global warming is affecting the whole Iñupiat life from what it was to what it is now. We used to have six to eight weeks of solid whale hunting on solid ice. Our last spring whaling was only five days of whaling. Hardly anyone has been successful in the springtime. We used to see 20 to 25 whales landed and today we are catching two or three whales. The fall hunt has become more important. That was always reversed. When that happens, Nalukataq will disappear. Nalukataq is a celebration for our spring hunt to carry you through the year. There is no fall

festival. It will be lost. The whole Iñupiat community has always had a Nalukataq, we look forward to it and we are losing it.

Fin Whale

Fin whales may occur seasonally in the southwestern Chukchi Sea, north of the Bering Strait along the coast of the Russian Chukotka (also referenced as the Chukchi) Peninsula. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea along the Asian coast. This species' current use of parts of its historic range probably is modified due to serious population reduction during commercial hunting.

However, there is no indication that fin whales typically occur within the Chukchi Sea or Beaufort Sea Planning Areas or in areas directly adjacent. There have been only rare observations of fin whales into the eastern half of the Chukchi Sea. In the southeast Chukchi Sea on September 23, 2006, three adult fin whales were seen from a vessel by marine mammal observers (Patterson, et al., 2007). In 1981, three fin whales (two adults, one calf) were observed (Ljungblad, et al., 1982) in the extreme southern Chukchi Sea associated with the aerial surveys of endangered whales in the Beaufort Sea, Chukchi Sea, and northern Bering Sea. These represent the only confirmed observations since 1979 in or near the planning areas (neither of these occurrences occurred within the planning areas). No other sightings of fin whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of lat. 66º N. and east of the International Date Line, and the Alaskan Beaufort Sea from long. 157º01' W. east to long. 140º W. and offshore to lat. 72º N. (Ljungblad et al., 1988). Fin whales have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2007 (e.g., Monnett and Treacy, 2005; Moore *et al*., 2000; Treacy, 2002). During a research cruise in the Chukchi and Beaufort seas (from July 5-August 18, 2003), in which all marine mammals observed were recorded, no fin whales were observed (Bengtson and Cameron, 2003). Aerial surveys of the Chukchi Sea between 2008 and 2010 recorded sighting only a single fin whale (Clarke *et al*., 2011). Fin whales have been detected by passive acoustics in the Chukchi (Hannay *et al*., 2011; Delarue *et al*., 2010).

Thus, for the purposes of our analyses, we assume that fin whales are uncommon to the eastern Chukchi Sea and the action area. Continued Arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of fin whale prey species, and the seasonal distribution and movements of fin whales.

Other Factors Affecting the Fin Whale within the Action Area

Potential consequences of these factors to fin whales would be similar to those described earlier for bowhead whales, although there is no subsistence hunting of fin whales. Fin whales are much less likely to be encountered in the action area, and therefore even less likely to suffer ship strikes than bowheads, encounter fishing gear, or be affected by pollutants.

Humpback Whale

Until 2007, historic and recent information did not indicate humpback whales inhabit northern portions of the Chukchi Sea or enter the Beaufort Sea. No sightings of humpback whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of lat. 66º N. and east of the International Date Line, and the Alaskan Beaufort Sea from long. 157º01' W. east to long. 140º W. and offshore to lat. 72º N. (Ljungblad *et al*., 1988). They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2007 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002). During a 2003 research cruise in which all marine mammals observed were recorded from July 5 to August 18 in the Chukchi and Beaufort seas, no humpback whales were observed (Bengtson and Cameron, 2003). One observation of one humpback whale was recorded in 2006 by marine mammal observers aboard a vessel in the southern Chukchi Sea outside of the Chukchi Sea Planning Area (Patterson *et al*., 2007; unpublished MMS marine mammal-observer reports, 2006). During summer 2007 between August 1 and October 16, humpback whales were observed during seven observation sequence events in the western Alaska Beaufort Sea (1) and eastern and southeastern Chukchi Sea (6) (unpublished MMS marine mammal-observer reports, 2007) and one other observation in the southern Chukchi Sea in 2007 (Sekiguchi, in prep.). Aerial surveys of the Chukchi Sea between 2008 and 2010 recorded sighting only a single humpback whale (Clarke *et al*., 2011).

Thus, for the purposes of our analyses, we assume that:

- Humpback whales are uncommon to the eastern Chukchi Sea and the action area.
- Humpback whales recently have been observed in the western Alaskan Beaufort Sea (2007) and southern and eastern Chukchi Sea (2006, 2007). We assume these areas are a portion of the potentially expanding summer distribution or summer feeding grounds for this species.
- Humpback whales recently encountered in the Chukchi most likely would belong to the Western North Pacific Stock, but individual photo-identification and genetic data are needed to confirm stock origin.
- It is unlikely that humpback whales from the Central North Pacific Stock would be present in the northernmost Bering Sea near Bering Strait or seasonally be present within the southwestern, southeastern, or eastern Chukchi Sea or the western Beaufort Sea.
- Humpback whales do not tend to occur farther north but can and do occur within the Chukchi Sea, and may continue to do so in the future.
- Continued Arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of humpback whale prey species, and the seasonal distribution and movements of humpback whales.

Other Factors Affecting the Humpback Whale within the Action Area

Potential consequences of these factors to humpback whales would be similar to those described earlier for bowhead whales, although there is no subsistence hunting of humpback whales. Humpback whales are much less likely to be encountered in the action area, and therefore even less likely to suffer ship strikes than bowheads, encounter fishing gear, or be affected by pollutants.

Ringed Seal

Status of the Species within the Action Area

Because this subspecies occurs in waters of the Action area, the information on these seals presented in the previous section is largely applicable to those Arctic ringed seals within the Action area. Here we present information on its status within the Action area and discuss any threats that are relevant to our determinations in this opinion.

We have little information on the numbers of ringed seals within the Action area. Extensive surveys of ringed and bearded seals have been conducted in the Beaufort Sea, but most surveys have been conducted over the landfast ice, and few seal surveys have occurred in open water or in the pack ice. These surveys provide the most relevant information on densities of ringed seals in the ice margin zone of the Beaufort Sea. The density estimate in Kingsley (1986) was used as the average density of ringed seals that may be encountered in the ice margin. The average ringed seal density in the nearshore zone of the Alaskan Beaufort Sea was estimated from results of ship–based surveys at times without seismic operations reported by Moulton and Lawson (2002). WesternGeco conducted marine mammal monitoring during its open-water seismic program in the Alaskan Beaufort Sea from 1996 to 2001. Operations were conducted in nearshore waters, and of a total 454 seals that were identified to species while no airguns were operating, 4.4% were bearded seals, 94.1% were ringed seals and 1.5% were spotted seals (Moulton and Lawson 2002).

Ringed seals construct lairs for pupping. However, this species typically does not construct lairs until late winter/early spring on the landfast ice. Because Shell will cease operations by October 31, they will not be in the area during the ringed seal pupping season. Foraging would be the most common behavior by ringed seals in the Action area during the time the proposed drilling would occur. Tracking seals in Alaska and the western Canadian Arctic, Kelly et al. (2010) referred to the open water period when ringed seals forage most intensively as the "foraging period," early winter through late May to early June when seals rested primarily in subnivean lairs on the ice as the "subnivean period," and the period between abandonment of the lairs (May or June) and ice break-up (typically June or July) as the "basking period."

Overall, the record from satellite tracking indicates that ringed seals breeding in shorefast ice practice one of two strategies during the open water foraging period (Freitas *et al.*, 2008). Some forage within 100 km of their shorefast ice breeding habitat while others make extensive movements of 100s or 1,000s of kilometers to forage in highly productive areas (e.g., Viscount Melville Sound) and along the pack-ice edge. Just prior to freeze up, large groups of ringed seals frequently feed on dense schools of cod in near shore areas of Amundsen Gulf and Prince Albert Sound, Beaufort Sea (Smith 1987). In offshore areas of the Beaufort Sea and Amundsen Gulf, large, loose feeding aggregations of ringed seals have also been documented in the late summer and early fall (Harwood and Stirling 1992). High quality, abundant food is important to the annual energy budgets of ringed seals. Fall and early winter periods, prior to the occupation of breeding sites, are important in allowing ringed seals to accumulate enough fat stores to support estrus and lactation. However, we are not aware of any information regarding the relative value of the action area for foraging by ringed seals.

Other factors affecting ringed seals within the Action area

Predation

Polar bears are the main predator of ringed seals, but other predators include Arctic and red foxes, walruses, wolves, wolverines, killer whales, and ravens (Burns and Eley 1976, Heptner *et al.* 1976, Fay *et al.* 1990, Sipliä 2003, Derocher *et al.* 2004, Melnikov and Zagrebin 2005). Ringed seals and bearded seals are the primary prey of polar bears. Polar bear predation on ringed seals is most successful in moving offshore ice, often along flow edges and rarely in ice-free waters. Hammill and Smith (1991) further noted that polar bear predation on ringed seal pups increased 4-fold in a year when average snow depths in their study area decreased from 23 to 10 cm. We conclude that the threat posed to ringed seals by predation is currently moderate, but predation risk is expected to increase as snow and sea ice conditions change with a warming climate.

Destruction, modification, or curtailment of habitat

The main concern about the conservation status of ringed seals stems from the likelihood that their sea ice habitat has been modified by the warming climate and, more so, that the scientific consensus projections are for continued and perhaps accelerated warming in the foreseeable future. A second concern related by the common driver of carbon dioxide emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem.

Climate Change

Diminishing ice and snow cover are the greatest challenges to persistence of all of the ringed seal subspecies. Ringed seals depend on ice as a platform for resting, whelping, nursing, and molting, and they depend on snow cover to provide protection from cold and predators. Ice and snow cover are changing and will continue to do so as the climate warms.

Sea-ice extent at the end of summer (September) 2007 in the Arctic Ocean was a record low (4.3 million km2), nearly 40% below the long-term average and 23% below the previous record set in 2005 (5.6 million km2) (Stroeve *et al*. 2008). Sea-ice extent in September 2008 and 2009 was greater than in 2007 but still more than two standard deviations below the 1979-2000 average. Most of the loss of sea ice was on the Pacific side of the Arctic.

Northern Hemisphere snow cover has declined in recent decades and spring melt times have become earlier (ACIA 2005). In most areas of the Arctic Ocean, snow melt advanced 1-6 weeks from 1979 to 2007 (Kelly *et al.* 2010). Throughout most of the ringed seal's range, snow melt occurred within a couple of weeks of weaning. Thus, in the past three decades, snow melts in many areas have been pre-dating weaning. The southern edge of the ringed seal's range may shift north, because ringed seals stay with the ice as it annually advances and retreats (Tynan and DeMaster 1997). Whether ringed seals will continue to move north with retreating ice over the deeper, less productive Arctic Basin waters and whether forage fishes that they prey on will also move north is uncertain. Changes in the phenology and extent of ice extent will alter community composition, presenting ringed seals with new competitors, predators, and prey (Grebmeier *et al*. 2006b).

Harwood et al. (2000) reported that an early spring break-up negatively impacted the growth, condition, and apparent survival of nursing ringed seal pups. Early break-up was believed to have interrupted lactation in adult females, which in turn, negatively affected the condition and growth of pups. Earlier ice break-ups similar to those documented by Harwood *et al*. (2000) and Ferguson *et al*. (2005) are predicted to occur more frequently with warming temperatures and result in a predicted decrease in productivity and numbers of ringed seals (Kelly 2001, Ferguson *et al*. 2005). Additionally, high fidelity to birthing sites exhibited by ringed seals makes them more susceptible to localized degradation of snow cover (Kelly *et al*. 2010). Warming temperatures that melt snow-covered birth lairs can result in pups being exposed to ambient conditions and suffering from hypothermia (Stirling and Smith 2004). Others have noted that when lack of snow cover has forced birthing to occur in the open, nearly 100% of pups died from predation (Kumlien 1879, Lydersen *et al*. 1987, Lydersen and Smith 1989, Smith *et a*l. 1991, Smith and Lydersen 1991).

Ocean Acidification

Although no scientific studies have directly addressed the impacts of ocean acidification on ringed seals, the effects would likely be through their ability to find food. Most pinniped species are high trophic predators that live in regions with high productivity at least seasonally (e.g., Bowen and Siniff 1999). Ringed seals consume most of their annual energy in a period from late summer through to early winter (Ryg and Øritsland 1991), focusing on lipid rich, large zooplankton, Arctic cod, and polar cod. Climate warming, however, has been credited with global declines in phytoplankton concentrations (Boyce et al. 2010) and shifts in community organization and productivity in the Bering Sea, Aleutian Islands, and Gulf of Alaska (Anderson and Piatt 1999, Ciannelli *et al*. 2005, Grebmeier *et al*. 2006b, Litzow *et al*. 2006, Litzow and Ciannelli 2007, Mueter and Litzow 2008). Ocean acidification is likely to have increasingly profound impacts on the ecosystem structure in the ringed seal habitats. The exact nature of these impacts cannot be predicted, and some likely will amplify more than others. For example, populations of upper trophic level pelagic species' may decline if their early life stages consume prey items (e.g., pteropods; Comeau *et al*. 2009) that cannot survive the added stress of ocean acidification. Pteropods are important food sources for larval and juvenile walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasii*), and cod. The ringed seals depend on cod, particularly juvenile cod that are less than 20 cm in length (Lowry *et al*. 1980). The loss of calcifying species like pteropods from the ecosystem could have a cascading effect on the ringed seals.

Harvest

Ringed seals were harvested commercially in large numbers during the 20th century, which led to the depletion of their stocks in many parts of their range. No commercial harvests occur within U.S. waters or the action area.

Ringed seals are by far the most important seal species for human consumption and utilization in the Canadian Arctic (ACIA 2005). Reeves et al. (1998) reviewed the catch history of ringed seals in Canada and concluded that harvest levels were probably highest (likely exceeding 100,000 ringed seals per year) during the 1960s and 1970s when both the value of sealskins and the local demand for seal products were particularly high. Ringed seals may have been locally depleted within the vicinity of some communities where exploitation was most intensive (Mansfield 1970 cited in Reeves et al. 1998). Catches of ringed seals declined substantially during the 1980s following a European ban on pup skins and the subsequent decline in sealskin prices (Reeves et al. 1998). Reeves et al. (1998) estimated that the total catch in Canada ranged between about 50,000 and 65,000 ringed seals per year during the 1980s and early 1990s, with the total kill (accounting for hunting losses) ranging between about 60,000 and 80,000 ringed seals per year.

Ringed seals have been hunted by humans for millennia and remain a fundamental subsistence resource for many northern coastal communities today. Ringed seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The best estimate of the statewide annual ringed seal subsistence harvest is 9,567 (Allen and Angliss 2010). Although subsistence harvest of the Arctic subspecies is currently substantial in some regions, harvest levels appear to be sustainable.

Commercial Fisheries Interactions

We are aware of no commercial fishery within the action area.

Commercial fisheries may impact ringed seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Based on data from 2002–2006, there has been an annual average of 0.46 mortalities of Arctic ringed seals incidental to commercial fishing operations in Alaskan waters (Allen and Angliss 2010). Drowning in fishing gear has been reported as one of the most significant mortality factors for seals in the Baltic Sea, especially for young seals, which are prone to getting trapped in fishing nets. There are no reliable estimates of seal bycatch in this sea, and existing estimates are known to be low in many areas, making risk assessment difficult.

Shipping

Current shipping activities in the Arctic pose varying levels of threats to ringed depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with ringed seal habitats. These factors are inherently difficult to know or predict, making threat assessment highly uncertain. Most ships in the Arctic purposefully avoid areas of ice and thus prefer periods and areas which minimize the chance of encountering ice. This necessarily mitigates many of the risks of shipping to populations of ringed seals, since they are closely associated with ice throughout the year. Icebreakers pose special risks to ringed seals because they are capable of operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (*e.g.*, tankers and bulk carriers) through ice-covered areas.

We were unable to find data on recent levels of vessel activity within the Chukchi Sea, although this would include vessels transiting between the Beaufort Sea and the lower 48 states, often associated with oil and gas activities or supplies to Alaskan villages along the Beaufort coast. All of this traffic is restricted to ice-free months from July to October and occurs at low to moderate levels. Also, not all of this traffic would be expected to move through the action area.

Contaminants

Contaminants research on ringed seals is very extensive and has been conducted in most parts of the species' range (with the exception of the Sea of Okhotsk), particularly throughout the Arctic environment where ringed seals are an important diet item in coastal human communities. Pollutants such as organochlorine (OC) compounds and heavy metals have been found in all of the subspecies of ringed seal (with the exception of the Okhotsk ringed seal). Reduced productivity in the Baltic Sea ringed seal in recent decades resulted from impaired fertility that was associated with pollutants. We do not have any information to conclude that there are currently population-level effects on Baltic ringed seals from contaminant exposure.

Oil and Gas

Within the action area, oil and gas exploration, development, and production activities include, but are not limited to: seismic surveys; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. These activities have the potential to impact bearded seals, primarily through noise, physical disturbance, and pollution, particularly in the event of a large oil spill or blowout. Oil and gas activities have been conducted off the coast of Alaska since the 1970s, with most of the activity occurring in the Beaufort Sea.

Shell will also be conducting an exploratory drilling program during the summer and fall of 2012 in the central Beaufort Sea near Camden Bay. This work is described, and the impacts of the drilling considered, in an environmental assessment prepared by NMFS (http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_ea_draft2012.pdf). A separate biological opinion of this action has been prepared by NMFS and is available at this site: http://www.fakr.noaa.gov/. The impacts and exposures associated with the Beaufort program are similar to those described here for the Chukchi. The Shell drilling sites in the Chukchi are approximately 400 miles to the west of their Beaufort Sea drilling sites, making it unlikely these seals would be exposed to both projects.

Parasitism and Disease

Exposures to two phocid herpesviruses have been detected in phocid seals in Alaska; phocid herpesvirus-1 (PhHV-1), an alpha herpesvirus, and herpesvirus-2 (PhHV-2), a gamma herpesvirus. Zarnke et al. (1997) tested marine mammals from Alaska and Russia for antibodies to PhHV-1 and PhHV-2. In ringed seals, serum antibody prevalence for PhHV-1 and PhHV-2 were both 50%, and antibody prevalence for neither virus was 25%. Antibody prevalence for PhHV-1 was higher than for PhHV-2 in most of the species examined, and the highest prevalence of antibodies to PhHV-1 was found in phocid seals. Zarnke et al. (1997) suggested that serum antibody prevalences found in this study indicate that marine mammals off the coasts of Alaska and Russia are regularly exposed to PhHV-1 and PhHV-2 and possibly to other related herpesviruses.

A variety of parasites are recorded within ringed seals in the Arctic. A complete discussion on this subject may be found in Kelly *et al.*, 2010.

Recently, an outbreak of disease has been observed within ringed seals and other marine mammals within the Beaufort Sea. This disease manifests in ulcerated lesions, hair loss, and emaciated body condition. NMFS has declared this as an unusual mortality event and is currently working to describe this disease's type and origin. At present, the cause for this outbreak in unknown.

Demographic Threats

The Arctic subspecies may number well over one million or more seals and is not believed to be currently at risk from the effects of demographic stochasticity, inbreeding, loss of genetic diversity, or depensation.

Contaminants

Contaminants research on ringed seals is very extensive and has been conducted in most parts of the species' range (with the exception of the Sea of Okhotsk), particularly throughout the Arctic environment where ringed seals are an important diet item in coastal human communities. Pollutants such as organochlorine (OC) compounds and heavy metals have been found in all of the subspecies of ringed seal (with the exception of the Okhotsk ringed seal). Reduced productivity in the Baltic Sea ringed seal in recent decades resulted from impaired fertility that was associated with pollutants. We do not have any information to conclude that there are currently population-level effects on Baltic ringed seals from contaminant exposure.

Oil and gas activities have the potential to impact ringed seals primarily through noise, physical disturbance, and pollution, particularly in the event of a large oil spill or blowout. Offshore oil and gas exploration occurs within the action area, including the drilling program associated with this action.

Although planning, management, and use of best practices can help reduce risks and impacts, the history of oil and gas activities, including recent events, indicates that accidents cannot be eliminated. Tanker spills, pipeline leaks, and oil blowouts are likely to occur in the future, even under the most stringent regulatory and safety systems. To date, there have been no large spills in the Arctic marine environment from oil and gas activities.

Bearded Seal

Status of the Species within the Action area.

Because this DPS occurs in waters of the Action area, the information on these seals presented in the previous section is largely applicable to those bearded seals within the Action area. Here we present information on the status of the Beringia DPS within the Action area and discuss any threats that are relevant to our determinations in this opinion.

There are no reliable abundance estimates for bearded seals within the action area during summer months. Cameron *et al*. (2010) report a crude estimate for the U.S. Chukchi of 13,600 bearded seals, noting the surveys this was based on covered only a portion of the Chukchi. Undoubtedly any abundance estimate would vary with ice conditions. Costal surveys along the Chukchi coast in 1999 and 2000 found densities of 0.07 and 0.14 seals/km^2, respectively (Bengtson *et al*., 2005). Clarke et al., 2001 reported aerial survey observed 150 sightings of 174 bearded seals in the northeastern Chukchi Sea between 2008 and 2010, with the highest numbers observed in August.

Bearded seals will be present in the action area during the time of the Shell drilling. Their presence may be due to their affinity for sea ice which generally retreats northward through the

Chukchi Sea during spring and summer, or due to feeding in this general area. These seals feed primarily on benthic organisms such as clams, crabs, and shrimp, but their diet may also include fish such as sculpin and cod (Cameron *et al*., 2010). Analysis of bearded seal stomachs has found the consumption of fish by bearded seals in the Chukchi has increased in the 2000s compared to the 1960s and 1970s (Quakenbush *et al*., 2010). The Chukchi shelf provides relatively shallow waters easily within the diving depths of bearded seals, providing favorable foraging habitat (Cameron *et al*., 2010).

We have found no information to describe the relative value of feeding habitat of the Chukchi Sea, but no exceptional bearded seal feeding habitat value is known within the action area. Hanna Shoals to the northeast of this area is generally considered to be a high use feeding area for marine mammals.

Other factors affecting bearded seals within the Action area.

Predation

A reduction in suitable sea ice habitat would likely increase the overlap in the distribution of bearded seals and walrus (*Odobenus rosmarus*), another ice-associated benthic feeder with similar habitat preferences and diet (Lowry *et al*. 1980). The walrus is also a predator of bearded seal, though seemingly infrequent. Hauling out closer to shore or on land could also increase the risks of predation from polar bears, and terrestrial carnivores (75 FR 77505). Polar bears are the primary predators of bearded seals, but other predators include brown bears, killer whales, sharks, and walruses. Predation under the future scenario of reduced sea ice is difficult to assess; polar bear predation may decrease, but predation by killer whales, sharks and walrus may increase (Cameron 2010).

Around Svalbard and in the Barents Sea in April and May, bearded seals are the predominant prey of polar bears by biomass (50%) and; about a third of kills were pups (Derocher et al. 2002). Stirling and Archibald (1977) noted that bearded seals were more a more important prey items to polar bears in the active ice of the western Arctic than in the more stable ice of the High Arctic. However, Smith (1980) stated that some bearded seals are also taken in the shorefast ice. Stirling and Archibald (1977) suggest that pups and subadults appear to be most vulnerable to polar bear predation, but their sample sizes were small.

Bearded seal adaptations that may have evolved because of polar bear predation include large, highly aquatic and mobile pups and female preference for small, drifting ice floes for nursing. These adaptations might afford mothers and pups some protection against polar bear predation (Burns and Frost 1979, Burns 1981, Kovacs and Lavigne 1986, Lydersen and Kovacs 1999, Kovacs 2002).

Destruction or Modification of Habitat

The main concern about the conservation status of bearded seals stems from the likelihood that their sea ice habitat has been modified by the warming climate and, more so, that the scientific consensus projections are for continued and perhaps accelerated warming in the foreseeable future. A second concern related by the common driver of carbon dioxide emissions, is the modification of habitat by ocean acidification, which may alter prey populations and other important aspects of the marine ecosystem.

Climate Change

For at least some part of the year, bearded seals rely on the presence of sea ice over the productive and shallow waters of the continental shelves where they have access to food–primarily benthic and epibenthic organisms–and a platform for hauling out of the water.

Sea ice extent at the end of the summer (September) 2007 in the Arctic Ocean was a record low nearly 40% below the long-term average and 23% below the previous record set in 2005 (Stroeve *et al.* 2008). Sea ice extent in September 2010 was the third lowest in the satellite record for the month, behind 2007 and 2008 (second lowest). Of even greater long-term significance was that the loss of over 40% of Arctic multi-year sea ice over the last five years (Kwok *et al.* 2009). It would take many years to restore the ice thickness through annual growth, and the loss of multi-year sea ice makes it unlikely that the Arctic will return to previous climatological conditions (Cameron *et al.* 2010). Although there are connections between sea ice conditions in the Arctic and the seasonal ice zones, the early loss of summer sea ice in the Arctic cannot be extrapolated to the seasonal ice zones. For example, the Bering Sea has had four years of colder than normal winter and spring conditions from 2007 to 2010, with near record sea ice extents, rivaling the sea ice maximum in the mid-1970s, despite record retreats in summer.

For bearded seals, the presence of sea ice in April and May is considered a requirement for whelping and nursing young (Reeves *et al*. 1992, Kovacs *et al*. 1996). Similarly, the molt in phocid seals is believed to be promoted by elevated skin temperatures that, in polar regions, can only be achieved when seals haul out of the water (Feltz and Fay 1966, Boily 1995). Thus, if suitable ice cover is absent from shallow feeding areas during times of peak whelping and nursing (April/May), or molting (May/June and sometimes through August), bearded seals would be forced to seek either sea-ice habitat over deeper waters (perhaps with poor access to food) or coastal regions in the vicinity of haul-out sites on shore (perhaps with increased risks of disturbance, predation, and competition). Both scenarios would require bearded seals to adapt to novel (i.e., suboptimal) conditions, and to exploit habitats to which they may not be well adapted, likely compromising their reproduction and survival rates. Further, the spring and summer ice edge may retreat to deep waters of the Arctic Ocean basin, which could separate sea ice suitable for pup maturation and molting from benthic feeding areas.

Ocean Acidification

Ocean acidification is an ongoing process whereby chemical reactions occur that reduce both seawater pH and the concentration of carbonate ions when CO_2 is absorbed by seawater. Results from global ocean CO_2 surveys over the past t decades have shown that ocean acidification is a predictable consequence of rising atmospheric CO_2 levels. The process of ocean acidification has long been recognized, but the ecological implications of such chemical changes have only recently begun to be appreciated. The waters of the Arctic and adjacent seas are among the most vulnerable to ocean acidification. The most likely impact of ocean acidification on bearded seals will be through the loss of benthic calcifiers and lower trophic levels on which the species' prey depends. Cascading effects are likely both in the marine and freshwater environments. Our limited understanding of planktonic and benthic calcifiers in the Arctic (*e.g.*, even their baseline geographical distributions) means that future changes will be difficult to detect and evaluate.

Ocean acidification may impact bearded seal survival and recruitment through changes in the demography or distribution of prey populations, particularly prey that are calcifying or that feed on calcifying prey. Bearded seals of different age classes are thought to feed at different trophic levels, so any ecosystem change could be expected to impact bearded seals in a variety of ways. Changes in bearded seal prey, anticipated in response to ocean warming and loss of sea ice and, potentially, ocean acidification, have the potential for negative impacts, but the possibilities are complex. These ecosystem responses may have very long lags as they propagate through trophic webs. Because of bearded seals' apparent dietary flexibility, these threats are of less concern than the direct effects of potential sea ice degradation.

Ocean acidification may also impact bearded seals by affecting the propagation of sound in the marine environment. Researchers have suggested that effects of ocean acidification will cause low-frequency sounds to propagate more than 1.5X as far (Hester *et al.* 2008, Brewer and Hester 2009), which, while potentially extending the range bearded seals can communicate under quiet conditions, will increase the potential for masking when man-made noise is present.

Harvest

Evidence of seal hunting by Native villages in the Arctic goes back at least 5000 years (Riewe 1991). Bearded seals were among those species hunted by the early Arctic inhabitants (Krupnik 1984), and today they remain a central nutritional and cultural resource for many northern communities (Hart and Amos 2004, ACIA 2005, Hovelsrud *et al*. 2008). By about the late 19th century, bearded seals were harvested commercially in large numbers causing local depletions. Though commercial operations were primarily interested in seal oil and skins, Native hunters have traditionally used all parts of bearded seals: their meat has been used as food for people, sled dogs, and livestock; their durable skins used for foot gear, umiaks (whaling boats), lines, and harnesses, traded for goods, or sold for cash; their blubber rendered into oil for food and fuel; and their flippers, bones, and viscera used for many household, industrial, or medicinal purposes (Krylov et al. 1964, Stewart et al. 1986).

Hunters mostly take seals during their northward migration in the late spring and early summer, using small boats in open leads among ice floes close to shore (Kelly 1988). Alaskan villages harvested about 1,700 bearded seals annually from 1966 to 1979, with reported takes remaining fairly constant except in 1977 when an estimated range of 4,750-6,308 were taken (Matthews 1978, Burns 1981). About a decade later, in 1986, curtailed monitoring from just five Alaska villages in the Bering Strait area reported 791 bearded seals taken (Kelly 1988). More recently in Alaska, under more comprehensive subsistence monitoring, the estimated harvest peaked from 1990 to 1998 at mean levels of 6,788 bearded seals per year (Coffing *et al*. 1998, Georgette et al. 1998, Wolfe and Hutchinson-Scarbrough 1999, Allen and Angliss 2010). The most recent harvest estimates (from 2003) cover only villages in the North Slope Borough and suggest that a minimum of 1545 bearded seal are taken from just the eastern Chukchi and western Beaufort Seas (Bacon et al. 2009). The 1990-1998 harvest estimates are the most comprehensive and thus considered the most current for the subsistence hunt in Alaska (Allen and Angliss 2010). It is unclear if variations in the harvest, especially the dramatic shifts, are real or reflect changes in survey methodology, coverage, or reporting. Ice cover in hunting locations can dramatically affect the availability of seals and the success of hunters in retrieving seals that have been shot. Using the mean annual harvest reported from 1990-1998, assuming 25 to 50% of seals struck are lost, the total annual hunt by Alaska Natives would range from 8,485 to 10,182 bearded seals.

The current subsistence harvest is substantial in some areas, but there is little or no evidence that subsistence harvests have or are likely to pose serious risks to the species.

Commercial Fisheries Interactions

We are aware of no commercial fishery within the action area.

Commercial fisheries may impact bearded seals through direct interactions (i.e., incidental take or bycatch) and indirectly through competition for prey resources and other impacts on prey populations. Estimates of bearded seal bycatch could only be found for commercial fisheries that operate in Alaska waters. Based on data from 2002–2006, there has been an annual average of 1.0 mortalities of bearded seals incidental to commercial fishing operations (Allen and Angliss 2010). Although no information could be found regarding bearded seal bycatch in the Sea of Okhotsk, given the intensive levels of commercial fishing that occur in this sea, bycatch of bearded seals likely occurs there as well. For indirect impacts, we note that commercial fisheries target a number of known bearded seal prey species, such as walleye pollock (*Theragra chalcogramma*) and cod. These fisheries may affect bearded seals indirectly through reduction in prey biomass and through other fishing mediated changes in their prey species. Bottom trawl fisheries also have the potential to indirectly affect bearded seals through destruction or modification of benthic prey and/or their habitat.

Shipping

Current shipping activities in the Arctic pose varying levels of threats to bearded seals depending on the type and intensity of the shipping activity and its degree of spatial and temporal overlap with bearded seal habitats. These factors are inherently difficult to know or predict, making threat assessment highly uncertain. Most ships in the Arctic purposefully avoid areas of ice and thus prefer periods and areas which minimize the chance of encountering ice. This necessarily mitigates many of the risks of shipping to populations of bearded seals, since they are closely associated with ice throughout the year. Icebreakers pose special risks to bearded seals because they are capable of operating year-round in all but the heaviest ice conditions and are often used to escort other types of vessels (*e.g.*, tankers and bulk carriers) through ice-covered areas.

Contaminants

Research on contaminants and bearded seals is limited compared to the extensive information available for ringed seals. Pollutants such as organochlorine compounds (OC) and heavy metals have been found in most bearded seal populations. The variety, sources, and transport mechanisms of the contaminants vary across the bearded seal’s range, but these compounds appear to be ubiquitous in the Arctic marine food chain. Statistical analysis of OCs in marine mammals has shown that, for most OCs, the European Arctic is more contaminated than the Canadian and U.S. Arctic. Present and future impacts of contaminants on bearded seal populations should remain a high priority issue. Climate change has the potential to increase the transport of pollutants from lower latitudes to the Arctic, highlighting the importance of continued monitoring of bearded seal contaminant levels.

Oil and Gas

Within the action area, oil and gas exploration, development, and production activities include, but are not limited to: seismic surveys; exploratory, delineation, and production drilling operations; construction of artificial islands, causeways, ice roads, shore-based facilities, and pipelines; and vessel and aircraft operations. These activities have the potential to impact bearded seals, primarily through noise, physical disturbance, and pollution, particularly in the event of a large oil spill or blowout. Oil and gas activities have been conducted off the coast of Alaska since the 1970s, with most of the activity occurring in the Beaufort Sea.

Shell will also be conducting an exploratory drilling program during the summer and fall of 2012 in the central Beaufort Sea near Camden Bay. This work is described, and the impacts of the drilling considered, in an environmental assessment prepared by NMFS (http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_ea_draft2012.pdf). A separate biological opinion of this action has been prepared by NMFS and is available at this site: http://www.fakr.noaa.gov/. The impacts and exposures associated with the Beaufort program are similar to those described here for the Chukchi. The Shell drilling sites in the Chukchi are approximately 400 miles to the west of their Beaufort Sea drilling sites, making it unlikely these seals would be exposed to both projects.

Parasitism and Disease

Exposures to two phocid herpesviruses have been detected in phocid seals in Alaska; phocid herpesvirus-1 (PhHV-1), an alpha herpesvirus, and herpesvirus-2 (PhHV-2), a gamma herpesvirus. Zarnke et al. (1997) tested marine mammals from Alaska and Russia for antibodies to PhHV-1 and PhHV-2. In bearded seals, serum antibody prevalence for PhHV-1 and PhHV-2 were 61% and 17%, and antibody prevalence for neither virus was 33%. Antibody prevalence for PhHV-1 was higher than for PhHV-2 in most of the species examined, and the three highest prevalence of antibodies to PhHV-1 were found in phocid seals. Zarnke et al. (1997) suggested that serum antibody prevalences found in this study indicate that marine mammals off the coasts of Alaska and Russia are regularly exposed to PhHV-1 and PhHV-2 and possibly to other related herpesviruses.

Quakenbush et al. (2010) collected serum from bearded seals harvested along the coast near Point Hope, Kotzebue, Shishmaref, and Little Diomede Island in 1998 and 2002-2008 and tested for several viruses, including PhHV-1, PhHV-2, phocine distemper virus (PDV), and canine distemper virus (CDV). PDV is a morbillivirus that causes respiratory distress and pneumonia and has been responsible for large die-offs of harbor seals in Europe (Kennedy et al. 1988). PDV has been identified in harbor seals from Alaska as well (Zarnke et al. 1997). Quakenbush *et al.* (2010) found antibodies for only one of the viruses tested; 29.5% (18 of 61) of bearded seals were positive for PhHV-1 antibodies; however, they did not identify antibodies for PhHV-2, PDV, or CDV in seals they examined. Six bearded seals collected from the native harvest around Gambell on St. Lawrence Island, Alaska were also negative for antibodies to PDV (Calle et al. 2008). Calle *et al.* (2008) also tested for influenza A virus, and all seals were negative for antibodies.

Quakenbush *et al.* (2010) examined bearded seals from the native Alaskan harvest for several bacterial diseases.
Quakenbush *et al.* (2010) also examined the stomach and intestinal contents from 19 bearded seals collected from the Bering and Chukchi Seas and tested them for domoic acid and saxitoxin. They found domoic acid or saxitoxin in four bearded seals, but only one seal was positive for both domoic acid and saxitoxin. Levels of both domoic acid and saxitoxin were low in all animals (Quakenbush *et al*. 2010).

Quakenbush *et al.* (2010) examined 43 bearded seals collected from the Alaska Native harvest in the Chukchi and Bering Seas for antibodies to *Toxoplamsa* spp., and dentified one seal positive for these antibodies. Fecal samples from 22 bearded seals collected from near Barrow, Alaska, were all negative for both *Giardia spp*. and *Cryptosporidium spp*. (Hughes-Hanks *et al.* 2005). Hughes-Hanks *et al*. (2005) found *Giardia spp*. and *Cryptosporidium spp*. in ringed seals, bowhead whales, and North Atlantic right whales from near Barrow, indicating that these protozoans are present in the marine environment; however, they have only been found in a few bearded seals (Dixon *et al*. 2008).

Many helminth parasites have been found in bearded seals throughout their circumpolar range, including the Kara and Barents Seas, northwest Atlantic, Gulf of St. Lawrence, Bering, Chukchi, and Okhotsk Seas (Cameron *et al*., 2010).

Recently, an outbreak of disease has been observed within ringed seals and other marine mammals within the Beaufort Sea. This disease manifests in ulcerated lesions, hair loss, and emaciated body condition. The disease has been primarily seen in ringed seals, although two cases are reported within bearded seals (NMFS 2011). NMFS has declared this as an unusual mortality event and is currently working to describe this disease's type and origin. At present, the cause for this outbreak in unknown.

Demographic Threats

The Beringia DPS is not believed to be currently at risk from the effects of demographic stochasticity, inbreeding, loss of genetic diversity, or depensation (Cameron *et al.* 2010).

IV. EFFECTS OF THE ACTION

The most significant effect of the proposed action on these species would be associated with increased levels of in-water noise, which may cause these animals to alter their behavior. The potential effects on the marine acoustic environment include sound generated by the drillship, support vessels, and the ZVSP airgun. The drillship and support vessels emit low-level continuous sound into the marine environment. The airgun to be used for short periods of time for the ZVSP surveys would emit impulse sounds into the marine environment. These sounds are anticipated to be more intense than those produced by the drillships or support vessels.

The ambient noise environment in the Arctic is complex and variable due to the seasonal changes in ice cover and sea state. Much research has been conducted in characterizing ambient noise in relation to sea ice coverage in the Arctic (e.g., Milne and Ganton, 1964; Diachok and Winoker, 1974; Lewis and Denner, 1987, 1988), however, none of these studies provide the broadband ambient noise levels in time and space that can be used in comparison to the broadband received noise levels from the proposed activities. Nevertheless, frequency band specific analysis showed that ambient levels reach to about 90 dB re 1 µPa at certain 1/3-octav band under 100 Hz near the ice edge (Diachok and Winoker 1974; Lewis and Denner 1987, 1988). Therefore, it is possible that at certain times and/or locations, such as near the ice margins or in open ocean with high sea state, natural ambient noise levels in the Arctic could reach or exceed 120 dB re 1 µPa, although the extent of these situations is unknown. The sounds introduced by Shell's activities are not anticipated to have a significant effect on the acoustic environment of the Arctic.

The specific sources of in-water noise associated with the proposed drilling program are discussed below.

Drilling Sounds

Drilling results in the generation of underwater sound from the use of generators, drilling machinery, and the rig itself. Received sound levels during vessel-based operations may fluctuate depending on the specific type of activity at a given time and aspect from the vessel. Underwater sound levels may also depend on the specific equipment in operation. Lower sound levels have been reported during well logging than during drilling operations (Greene, 1987b), and underwater sound levels appeared to be lower at the bow and stern aspects than at the beam (Greene, 1987a).

Sounds from the *Discoverer* have not previously been measured in the Arctic. However, measurements of sounds produced by the *Discoverer* were made in the South China Sea in 2009 (Shell, 2011). The results of those measurements were used to model the sound propagation from the *Discoverer* (including a nearby support vessel) at planned exploration drilling locations in the Chukchi and Beaufort seas (Shell, 2011). Broadband source levels of sounds produced by the *Discoverer* varied by activity and direction from the ship, but were generally between 177 and 185 dB re 1 µPa 1 m (rms). Shell has estimated the distance to the point at which exploration drilling sounds would likely fall below 120 dB as 3.3 km.

Vessel Sounds

In addition to the drillship, various types of vessels will be used in support of the operations, including ice management vessels, anchor handlers, offshore supply vessels, barges and tugs, and OSR vessels. Sounds from boats and vessels have been reported extensively (Greene and Moore, 1995; Blackwell and Greene, 2002, 2005, 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007 (e.g., Aerts *et al*., 2008; Hauser *et al*., 2008; Brueggeman, 2009; Ireland *et al*., 2009). For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB re 1 µPa at distances ranging from approximately 1.5 to 2.3 mi (2.4 to 3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater sound pressure levels (SPLs) from the seismic vessel *Gilavar* of 120 dB re 1 µPa at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB re 1 µPa at 85 ft (26 m) from the vessel. Like other industry-generated sound, underwater sound from vessels is generally at relatively low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross, 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Icebreakers contribute greater sound levels during icebreaking activities than ships of similar size during normal operation in open water (Richardson et al., 1995a). This higher sound production results from the greater amount of power and propeller cavitation required when operating in thick ice. Measurements of the icebreaking supply ship *Robert Lemeur* pushing and breaking ice during exploration drilling operations in the Beaufort Sea in 1986 resulted in an estimated broadband source level of 193 dB re 1 µPa at 1 m (Greene, 1987a; Richardson *et al*., 1995a).

Sound levels during ice management activities would not be as intense as during icebreaking. During ice management, the vessel's propeller is rotating at approximately 15-20 percent of the vessel's propeller rotation capacity. Instead of actually breaking ice, during ice management, the vessel redirects and repositions the ice by pushing it away from the direction of the drillship at slow speeds so that the ice floe does not slip past the vessel bow. Basically, ice management occurs at slower speed, lower power, and slower propeller rotation speed (i.e., lower cavitation), allowing for fewer repositions of the vessel, thereby reducing cavitation effects in the water compared to icebreaking.

Aircraft Sound

Helicopters may be used for personnel and equipment transport to and from the drillship. Under calm conditions, rotor and engine sounds are coupled into the water within a 26º cone beneath the aircraft. Some of the sound will transmit beyond the immediate area, and some sound will enter the water outside the 26º area when the sea surface is rough. However, scattering and absorption will limit lateral propagation in the shallow water.

Dominant tones in noise spectra from helicopters are generally below 500 Hz (Greene and Moore, 1995). Helicopter sounds contain numerous prominent tones at frequencies up to about 350 Hz, with the strongest measured tone at 20–22 Hz. Received peak sound levels of a Bell 212 passing over a hydrophone at an altitude of approximately 1,000 ft (300 m) varied between 106 and 111 dB re 1 µPa at 30 and 59 ft (9 and 18 m) water depth (Greene, 1982, 1985). Harmonics of the main rotor and tail rotor usually dominate the sound from helicopters; however, many additional tones associated with the engines and other rotating parts are sometimes present (Patenaude *et al*., 2002).

Because of doppler shift effects, the frequencies of tones received at a stationary site diminish when an aircraft passes overhead. The apparent frequency is increased while the aircraft approaches and is reduced while it moves away. Aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches an observer. Helicopters flying to and from the drillship will generally maintain straight-line routes at altitudes of at least 1,500 ft (457 m) above sea level, thereby limiting the received levels at and below the surface.

Vertical Seismic Profile Sound

A typical eight airgun array (4×40 in^3 airguns and 4×150 in^3 airguns, for a total discharge volume of 760 in^3) would be used to perform ZVSP surveys, if conducted after the completion of each exploratory well. The source level for the airgun array proposed for use by Shell will differ based on source depth. At a depth of 9.8 ft (3 m), the SPL is 238 dB re 1 µPa at 1 m, and at a depth of 16.4 ft (5 m), the SPL is 241 dB re 1 µPa at 1 m, with most energy between 20 and 140 Hz.

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. Typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain significant energy up to 500–1,000 Hz and some energy at higher frequencies (Goold and Fish, 1998; Potter et al., 2007).

Effects to Bowhead, Humpback, and Fin Whales

Potential Exposure of Whales to Drilling Activities

Bowhead whales have documented use of the Action area for spring and fall migration; feeding; calving; resting; and limited breeding. Most of the calving for this population probably occurs outside of the Action area, between the Bering Strait and Point Barrow. The principal exposure of the whales to the proposed drilling activities would occur during the fall migration from late August to early November.

Humpback and fin whales are not common to the northern Chukchi Sea nor the action area. Their presence would also be expected to be highly seasonal, restricted to the summer months. Throughout this discussion we present most attention to bowhead whales, as they are the most numerous within the action area, are recognized as having sensitivities equal to or exceeding humpback and fin whales, and therefore are likely to be most affected by the drilling program. Any assessment of whether the authorization of incidental harassment for Shell’s Chukchi drilling might jeopardize the continued existence of humpback and fin whales may be academic in that very few of these whales are believed to occur within the action area (tens of animals) while fewer still may be exposed by and react to the drilling program. Given the abundance of humpback and fin whales is in the thousands, any possible effect to the whales within the action area would not result in a condition of jeopardy.

Potential Effects from Exploratory Drilling Operations

Drilling for oil and gas generally produces low-frequency sounds with strong tonal components. There are few data on the noise from conventional drilling platforms. Recorded noise from an early study of one drilling platform and three combined drilling production platforms found that noise was so weak, it was almost not detectable alongside the platform at sea states of 3 or above. The strongest tones were at very low frequencies near 5 Hz, and received levels of these tones at near-field locations were 119-127 dB re 1 µPa (Richardson et al. 1995a).

Bowhead reaction to drillships is variable. Bowhead whales whose behavior appeared normal have been observed on several occasions within 10-20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 km (0.12-3 mi) from drillships (Richardson *et al*. 1985a; Richardson and Malme 1993). On several occasions, whales were well within the zone where drillship noise should be clearly detectable by them. In other cases, bowheads may avoid drillships and their support vessels at 20-30 km (see below and NMFS, 2003a). The factors associated with the variability are not fully identified or understood.

Some bowheads in the vicinity of drilling operations would be expected to respond to noise from drilling units by slightly changing their migration speed and swimming direction to avoid closely approaching these noise sources. Miles, Malme, and Richardson (1987) predicted the zone of responsiveness to continuous noise sources. They predicted that roughly half of the bowheads likely would respond at a distance of 0.02-0.2 km (0.12-1.12 mi) to drilling from an artificial island when the signal-to-noise ratio is 30 dB. By comparison, they predicted that roughly half of the bowheads likely would respond at a distance of 1-4 km (0.62-2.5 mi) from a drillship drilling when the signal-to-noise ratio is 30 dB. A smaller proportion would react when the signal-to-noise ratio is about 20 dB (at a greater distance from the source), and a few may react at a signal-to-noise ratio even lower or at a greater distance from the source.

Inupiat whalers believe that noise from drilling activities displaces whales farther offshore, away from their traditional hunting areas. These concerns were expressed primarily for drilling activities from drillships with icebreaker support that were operating offshore in the main migration corridor. Concerns also have been expressed about noise generated from the single steel drilling caisson, the drilling platform used to drill two wells on the Cabot Prospect east of Barrow in October 1990 and November 1991. Mr. Jacob Adams, Mr. Burton Rexford, Mr. Fred Kanayurak, and Mr. Van Edwardson, all with the Barrow Whaling Captain's Association, stated in written testimony at the Arctic Seismic Synthesis and Mitigating Measures Workshop on March 5-6, 1997, in Barrow: "We are firmly convinced that noise from the Cabot drilling platform displaced whales from our traditional hunting area. This resulted in us having to go further offshore to find whales" (USDOI, MMS 1997).

Richardson and Malme (1993) point out that the data, although limited, suggest that stationary industrial activities producing continuous noise, such as stationary drillships, result in less dramatic reactions by bowheads than do moving sources, particularly ships. It also appears that bowhead avoidance is less around an unattended structure than one attended by support vessels. Most observations of bowheads tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Because other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with a harmful event, this suggests that bowheads will habituate to certain noises that they learn are nonthreatening. Additionally, it is not known what components of the population were observed around the drillship (e.g., adult or juvenile males, adult females, etc.).

The distance at which bowheads may react to drilling activities is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The principal finding of this study was that migrating bowheads appeared to avoid the offshore drilling operation in fall 1986. Thus, some bowheads may avoid noise from drillships at 20 km (12.4 mi) or more.

In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 km (2.48 mi) from operating drillships, well within the zones ensonified by drillship noise. The whales were not heading away from the drillship but were socializing, even though exposed to strong drillship noise. Eleven additional whales on three other occasions were observed at distances of 10-20 km (6.2-12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10-12 km (6.2-7.4 mi) and 18-19 km (11.2-11.8 mi), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988, as cited in Richardson and Malme 1993) reported observations of bowheads within 0.2-5 km (0.12-3 mi) from drillships.

The *Kulluk* was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the *Kulluk* indicated broadband source levels (10-10,000 Hz) during drilling and tripping were estimated to be 191 and 179 dB re µPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Richardson et al. 1995a). Hall *et al*. (1994) conducted a site-specific monitoring program around the Kuvlum drilling site in the western portion of Camden Bay during the 1993 fall bowhead whale migration. Results of their analysis indicated that bowheads were moving through Camden Bay in a significantly nonrandom pattern but became more randomly distributed as they left Camden Bay and moved to the west. The results also indicated that whales were distributed farther offshore in the proximal survey grid (near the drill site) than in the distant survey grid (an area east of the drill site), which is similar to results from previous studies in this general area. The authors noted that information from previous studies indicated that bowheads routinely were present nearshore to the east of Barter Island and were less evident close to shore from Camden Bay to Harrison Bay (Moore and Reeves, as cited in Hall *et al*., 1994). The authors believed that industrial variables such as received level were insufficient as a single predictor variable to explain the 1993 offshore distribution of bowhead whales, and they suggested that water depth was the only variable that accounted for a significant portion of the variance in the model. They concluded that for 1993, water depth, received level, and longitude accounted for 85% of the variance in the offshore distribution of the whales. Based on their analyses, the authors concluded that the 1993 bowhead whale distribution fell within the parameters of previously recorded fall-migration distributions.

Davies (1997) used the data from the Hall *et al.* study in a Geographic Information System model to analyze the distribution of fall-migrating bowheads in relation to an active drilling operation. He also concluded that the whales were not randomly distributed in the study area, and that they avoided the region surrounding the drill site at a range of approximately 20 km (12.4 mi). He noted that the whales were located significantly farther offshore and in significantly deeper water in the area of the drilling rig. As noted by Hall *et al.* (1994), the distribution of whales observed in the Camden Bay area is consistent with previous studies (Moore and Reeves 1993), where whales were observed farther offshore in this portion of the Beaufort Sea than they were to the east of Barter Island. Davies concluded, as did Hall *et al*., that it was difficult to separate the effect of the drilling operation from other independent variables. The model identified distance from the drill rig and water depth as the two environmental factors that were most strongly associated with the observed distribution of bowheads in the study area. The Davies analysis, however, did not note that surface observers (Hall *et al.* 1994) observed whales much closer to the drilling unit and support vessels than did aerial observers. In one instance, a whale was observed approximately 400 m (436 yd) from the drill rig. Hall *et al.* suggest that bowheads, on several occasions, were closer to industrial activity than would be suggested by an examination of only aerial survey data.

Schick and Urban (2000) also analyzed data from the Hall *et al*. study and tested the correlation between bowhead whale distribution and variables such as water depth, distance to shore, and distance to the drilling rig. The distribution of bowhead whales around the active drilling rig in 1993 was analyzed and the results indicated that whales were distributed farther from the drilling rig than they would be under a random scenario. The area of avoidance was localized and temporary (Schick and Urban 2000); Schick and Urban stated they could not conclude that noise from the drilling rig caused the low density near the rig, because they had no data on actual noise levels. They also noted that ice, an important variable, is missing from their model and that 1992 was a particularly heavy ice year. Because ice may be an important patterning variable for bowheads, Schick and Urban said they were precluded from drawing strong inference from the 1992 results with reference to the interaction between whales and the drilling rig. Moore and DeMaster (1998, as cited in Schick and Urban 2002) proposed that migrating bowheads are often found farther offshore in heavy ice years because of an apparent lack of feeding opportunities. Schick and Urban (2002) stated that ultimately, the pattern in the 1992 data may be explained by the presence of ice rather than by the presence of the drilling rig.

In playback experiments, some bowheads showed a weak tendency to move away from the sound source at a level of drillship noise comparable to what would be present several kilometers from an actual drillship (Richardson and Malme 1993). In one study, sounds recorded 130 m (426 ft) from the actual *Karluk* drill rig were used as the stimulus during disturbance test playbacks (Richardson et al., 1991). For the overall 20- to 1,000-Hz band, the average source level was 166 dB re 1 µPa in 1990 and 165 dB re 1 µPa in 1989. Bowheads continued to pass the projector while normal *Karluk* drilling sounds were projected. During the playback tests, the source level of sound was 166 dB re 1 µPa. One whale came within 110 m (360 ft) of the projector. Many whales came within 160-195 m (525-640 ft), where the received broadband (20-1,000 Hz) sound levels were about 135 dB re 1 µPa. That level was about 46 dB above the background ambient level in the 20- to 1,000-Hz band on that day. Bowhead movement patterns were strongly affected when they approached the operating projector. When bowheads still were several hundred meters away, most began to move to the far side of the lead from the projector, which did not happen during control periods while the projector was silent.

Some migrating bowheads diverted their course enough to remain a few hundred meters to the side of the projector. Surfacing and respiration behavior, and the occurrence of turns during surfacings, were strongly affected out to 1 km (0.62 mi). Turns were unusually frequent out to 2 km (1.25 mi), and there was evidence of subtle behavioral effects at distances up to 2-4 km (1.25-2.5 mi). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant.

The authors stated that one of the main limitations of this study (during all 4 years) was the inability of a practical sound projector to reproduce the low-frequency components of recorded industrial sounds. Both the *Karluk* rig and the icebreaker *Robert Lemeur* emitted strong sounds down to ~10-20 Hz, and quite likely at even lower frequencies. It is not known whether the under-representation of low-frequency components (less than 45 Hz) during icebreaker playbacks had significant effects on the responses by bowheads. Bowheads presumably can hear sounds extending well below 45 Hz. It is suspected but not confirmed that their hearing extends into the infrasonic range below 20 Hz. The authors believed the projector adequately reproduced the overall 20- to 1,000-Hz level at distances beyond 100 m (109 yd), even though components below 80 Hz were under-represented. If bowheads are no more responsive to sound components at 20-80 Hz than to those above 80 Hz, then the playbacks provided a reasonable test of the responsiveness to components of *Karluk* sound above 20 Hz.

The authors also stated that the study was not designed to test the potential reactions of whales to nonacoustic stimuli detected via sight, olfaction, etc. At least in summer/autumn, responses of bowheads to actual dredges and drillships seem consistent with reactions to playbacks of recorded sounds from those same sites. Additional limitations of the playbacks identified by the authors included low sample sizes and the fact that responses were only evident if they could be seen or inferred based on surface observations. The numbers of bowhead whales observed during both playback and control conditions were low percentages of the total Beaufort Sea population. Also, differences between whale activities and behavior during playback versus control periods represent the incremental reactions when playbacks are added to a background of other activities associated with the research. Thus, playback results may somewhat understate the differences between truly undisturbed whales versus those exposed to playbacks.

In a subsequent phase of this continuing study, Richardson et al. (1995b) concluded:

…migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nautical mile). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

Richardson et al. (1995b) reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB re 1 µPa rms broadband drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson and Greene, 1993).

Some fall migrant bowheads within the action area may have been previously exposed to drilling noise associated with Shell's 2012 drilling activities in the Beaufort Sea, 400 miles to the east of their Chukchi drill sites. Available research indicates that reactions of bowhead whales to noise associated with oil and gas exploration would be localized and temporary, as described previously. The traditional knowledge of the Inupiat bowhead whalers records the heightened sensitivities of bowheads after exposure to certain sounds, and it is possible that because of this whales previously exposed during their fall migration may be more reactive to the noise within the action areas. We have little data to assess this possibility, as most monitoring efforts have focused on near-field effects.

The most probable effect of the Shell drilling activity to bowhead whales would be localized avoidance of the noise source, possibly extending out 3-13 km or more. Because the drilling would coincide with a large portion of the fall migration, a number of bowhead whales could be so affected, although much of the drilling would occur prior to the fall migration and the migratory corridor through the Chukchi Sea and action area is much broader than that in the Beaufort Sea, so we expect this drilling operation to affect far fewer whales. Whales that are actively migrating are likely to be more reactive than whales engaged in feeding behavior, although very few whales would be expected to occur in close proximity to the drill site. The drilling is not expected to result in biologically significant effects to the timing of the fall migration nor the migratory path for these whales. Some fall migrant and summer resident bowhead whales may be feeding in the action area. Noise from the drill ship is unlikely to cause significant loss of any feeding opportunities because the ensonified area would be relatively small, feeding whales have been observed to be more tolerant of noise, and the areas along the Chukchi coast in which feeding behavior has been recently observed (e.g. the Pt. franklin to Barrow area) are more than 100 km from the drill site.

Potential Effects of VSPS Surveys on Bowhead Whales

The Verticle Seismic Profiler will utilize an eight airgun array with source level of 238 dB re 1 µPa. The acoustic characteristics of the ZVSP array were modeled by Shell in their IHA application. Based on a similar airgun source used in the central Beaufort Sea in 2008, Shell predicts the 160 dB isopleth (the threshold NMFS recognizes for the onset of harassment from impulsive noise) would extend out 3.6 km.

Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 μPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances of 4.5 to 14.5 km (2.4 to 7.8 n.mi.) from the source. A substantial proportion of the baleen whales within those distances may show avoidance or other strong disturbance reactions to the airgun array. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and recent studies have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1 μPa rms.

Numerous studies have been conducted on the effects of noise from seismic surveys on bowhead whales. The results from these studies have varied, in some cases considerably. Among some of these studies important variables were different. These included the type of seismic survey (2D versus 3D), the location of the study, and the year in which the study was conducted. Ice (and other weather-related factors) also varies among years as does the use of total available habitat by bowhead whales. Numerous reports regarding whale response to sound have shown that multiple factors may be important in the whale's response (e.g., McCauley et al., 2000). In some studies, these factors have been shown to include (but may not be limited to): the physical characteristics of the location into which the sound is released and the physical characteristics of the location where the whale is located at the time the sound is released; the whale's sex and reproductive condition (e.g., groups with or without calves); the behavior of the whale (e.g., migrating or feeding); specific characteristics of the sound (e.g., frequency, duration, whether impulsive or not, etc.), and prior exposure to the sound.

During the 1980's, the behavior of bowhead whales exposed to noise pulses from seismic surveys was observed during the summer in the Canadian Beaufort Sea and during the fall migration across the Alaskan Beaufort Sea. In general, many of the seismic surveys conducted during the 1980's were 2D seismic surveys that covered fairly large areas in deeper waters. Additional studies on seismic surveys were conducted in the central Alaskan Beaufort Sea during the fall migration in 1996-1998. These surveys were 3D ocean bottom cable (OBC) seismic surveys that covered fairly small areas in relatively shallow water fairly close to shore. Reeves, Ljungblad, and Clarke (1983) conducted aerial surveys to observe bowhead whale behavior in the presence of active seismic vessels. Whales were observed as close as 3 km (1.86 mi) and as far away as 135 km (83.9 mi) from active seismic vessels. A pair of whales observed at a distance of 3 km (1.83 mi) were not moving while at the surface although the two whales' heads were in contact. This pair of whales was closer to a shooting seismic vessel than any other whales observed during the study. No obvious response was apparent, but the observation time was brief. (The received level of low-frequency underwater sound from an underwater source, generally is lower by 1-7 dB near the surface (depth of 3 m) than at deeper (greater than 9 m) depths (Richardson *et al*., 1995a). It is possible these whales may have been at the surface to avoid the louder noise in deeper water. For the group of 20 whales at a distance of approximately 135 km (83.9 mi), the blow frequency per surfacing and time at the surface were greater during the period immediately after the seismic vessel began shooting than before it began shooting. The authors stated that no major changes in whale behavior (such as flight reactions) were observed that could unequivocally be interpreted as responses to seismic noise. They noted a possible exception of "huddling behavior" which they thought may have been caused by the onset of seismic sounds. The authors concluded that although their results suggest some changes in behavior related to seismic sounds, the possibility that unquantified factors could be correlative dictates caution in attempting to establish causative explanations from the preliminary findings.

Ljungblad et al. (1985) also reported findings from early tests of bowhead reactions to active seismic vessels in the Beaufort Sea. However, methodological problems with this early study preclude us from drawing conclusions about probable bowhead reactions based on its findings. A subcommittee of the Scientific Committee of the IWC previously reviewed the data from this study and some members were critical of the methodology and analysis of the results. Comments included reference to: the small sample size; inconsistencies between the data and the conclusions; lack of documentation of calibration of sound monitoring; and possible interference from other active seismic vessels in the vicinity. The subcommittee acknowledged the difficulty of performing experiments of this kind, particularly in the absence of a control environment free of industrial noise. The subcommittee recommended that additional research taking into account the concerns expressed above be undertaken, and that the 1984 experimental results be subjected to rigorous reanalysis, before it could be used to draw any conclusions about the effects of seismic activity on this species (IWC 1987).

In the May 25, 2001 Biological Opinion for Federal Oil and Gas Leasing and Exploration by the MMS within the Alaskan Beaufort Sea and its effects on the endangered bowhead whale, NMFS (2001:20) noted that early tests of bowhead reactions to active seismic vessels by Ljungblad et al. (1985):
…were not conducted under controlled conditions (i.e., other noise sources were operating at the time), and approaches at greater ranges were not conducted, so results cannot be used to determine the range at which the whales first begin to respond to seismic activity.

In Fraker et al. (1985), an active seismic vessel traveled toward a group of bowheads from a distance of 19 km (11.8 mi) to a distance of 13 km (8.18 mi). The whales did not appear to alter their general activities. Most whales surfaced and dove repeatedly and appeared to be feeding in the water column. During their repeated surfacing and dives, they moved slowly to the southeast (in the same direction as seismic-vessel travel) and then to the northwest (in the opposite direction of seismic-vessel travel). The study first stated that a weak avoidance reaction may have occurred but then stated there is no proof that the whales were avoiding the vessel. The net movement was about 3 km (1.86 mi). The study found no evidence of differences in behavior in the presence and absence of seismic noise, but noted that observations were limited.

In another study (Richardson, Wells, and Wursig 1985) involving a full-scale seismic vessel with a 47-L airgun array (estimated source level 245-252 dB re 1 µPa), bowheads began to orient away from the approaching ship when its airguns began to fire from 7.5 km (4.7 mi) away. This airgun array had about 30 airguns, each with a volume of 80-125 in^3. The *Mariner* had been shooting seismic about 10 km to the west of a group of six whales. Prior to the start of the experimental seismic period, the whales were surfacing and diving and moving at slow to medium speed while at the surface. The vessel ceased shooting and moved within 7.5 km of the whales and began firing the airgun array while approaching the whales. The study reported no conspicuous change in behavior when the *Mariner* resumed shooting at 7.5 km away. The bowheads continued to surface and dive, moving at slow to medium speeds. The received level was estimated at 134-138 dB at 7 km (4.35 mi). Some near-bottom feeding (evidenced by mud being brought to the surface) continued until the vessel was 3 km (1.86 mi) away. The closest point of approach to any whale was approximately 1.5 km (0.93 mi), with the received level probably well over 160 dB. When the seismic vessel was within 1.5 km of whales at the original location, at least two of the whales were observed to have moved about 2 km to the south of the original location. The movements of the whales, at least while they were at the surface, were at the usual slow to moderate speeds. The study reported no conspicuous changes in behavior when the *Mariner* ceased shooting at 6 km beyond the whales. The bowheads were still surfacing and diving and moving at slow to medium speed. The most notable change in behavior apparently involved the cessation of feeding when the vessel was 3 km away. The whales began feeding again about 40 minutes after the seismic noise ceased.

While conducting a monitoring program around a drilling operation, Koski and Johnson (1987) noted that the call rate of a single observed bowhead whale increased after a seismic operation had ceased. During the 6.8 hours of observation, the whale was within 23-27 km (14.3-16.8 mi) from the drillship. A seismic vessel was reported to be from 120-135 km (74.58-83.9 mi) from the sonobuoy; the two loudest calls received were determined to be approximately 7 km (4.35 mi) and 9 km (5.6 mi) from the sonobuoy, with received levels of 119 and 118 dB, respectively. Approximate signal-to-noise ratios were 24 and 22 dB, respectively. No information is provided regarding the exact distance the whale was from the operating seismic vessel. The increase in call rate was noted within 25 minutes after seismic noise ceasedFew, if any, calls were heard during the two hours prior to the start of seismic operations, so it is unclear whether the increase in call rate relates to cessation of seismic noise, the presence of the operating drillship, the combination of both activities, or some other factor that occurred in the late afternoon. During this same study a subgroup of four to seven whales within a larger group (15-20 whales) was noted moving rapidly away from an approaching seismic vessel at a distance of 22-24 km (13.7-14.9 mi). The received level of seismic pulses was 137 dB at 19 km (11.8 mi) from the sonobuoy and 22 km from the whales. The surfacing and diving were unusually brief, and there were unusually few blows per surfacing. No information was available regarding the time required for these whales to return to normal behavior.

Many past studies were different from the real-world situation, and subject to various limitations. Most studies did not involve actively migrating whales; and those whales were being approached by the seismic ships whereas in the real world, the fall migrating whales are actively moving to the west and they are approaching a distant seismic boat that is firing. The MMS has noted that many studies were observational and involved opportunistic sightings of whales in the vicinity of seismic operations. The studies were not designed to show whether more subtle reactions are occurring that can displace the migration corridor, so no definitive conclusions can be drawn from them on whether or not the overall fall migration is displaced by seismic activity.

Based on early data, Richardson and Malme (1993) concluded that collectively, scientific studies have shown that most bowheads usually show strong avoidance response when an operating seismic vessel approaches within 6-8 km (3.8-5.0 mi). Strong avoidance occurs when received levels of seismic noise are 150-180 dB re 1 µPa (Richardson and Malme, 1993). Strong pulses of seismic noise often are detectable 25-50 km (15.5-31 mi) from seismic vessels, but in early studies, bowheads exposed to seismic sounds from vessels more than about 7.5 km (4.7 mi) away rarely showed avoidance. Seismic pulses can be detectable 100 km (62.2 mi) or more away. Bowheads also may show specific behavioral changes, such as reduced surfacing; reduced dive durations; changes in respiration rates, including fewer blows per surfacing, and longer intervals between successive blows; and they may temporarily change their individual swimming paths. The authors noted that surfacing, respiration, and dive cycles may be altered in the same manner as those of whales closer to the vessels. Bowhead surface-respiration-dive characteristics appeared to recover to pre-exposure levels within 30-60 minutes following the cessation of the seismic activity.

Since 1996, many of the open water seismic surveys in State of Alaska waters and adjacent nearshore Federal waters of the central Alaskan Beaufort Sea were ocean-bottom cable surveys. These surveys were 3D seismic programs. The area to be surveyed is divided into patches, each patch being approximately 5.9 by 4.0 km in size. Within each patch, several receiving cables are laid parallel to each other on the seafloor. Seismic data are acquired by towing the airguns along a series of source lines oriented perpendicular to the receiving cables. While seismic-data acquisition is ongoing on one patch, vessels are deploying cable on the next patch to be surveyed and/or retrieving cables from a patch where seismic surveys have been completed. Airgun arrays have varied in size each year from 1996-1998 with the smallest, a 560 in^3 array with 8 airguns, and the largest, a 1,500 in^3 array with 16 airguns. A marine mammal and acoustical monitoring program was conducted in conjunction with the seismic program each year in accordance with provisions of the NMFS Incidental Harassment Authorization. Based on 1996-1998 data, there was little or no evidence that bowhead headings, general activities, or swimming speeds were affected by seismic exploration. Bowheads approaching from the northeast and east showed similar headings at times with and without seismic operations. Miller et al. (1999) stated that the lack of any statistically significant differences in headings should be interpreted cautiously. Changes in headings must have occurred given the avoidance by most bowheads of the area within 20 or even 30 km of active seismic operations. Miller et al. (1999) noted that the distance at which deflection began cannot be determined precisely, but they stated that considering times with operations on offshore patches, deflection may have begun about 35 km to the east. However, some bowheads approached within 19-21 km of the airguns when they were operating on the offshore patches. It appears that in 1998, the offshore deflection might have persisted for at least 40-50 km west of the area of seismic operations. In contrast, during 1996-1997, there were several sightings in areas 25-40 km west of the most recent shotpoint, indicating the deflection in 1996-1997, may not have persisted as far to the west.

LGL Ltd.; Environmental Research Assocs., Inc.; and Greeneridge Sciences Inc. conducted a marine mammal monitoring program for a seismic survey near the Northstar Development Project in 1996 (Miller et al., 1997). The marine mammal monitoring program was continued for subsequent seismic surveys in nearshore waters of the Beaufort Sea in 1997 and 1998 (Miller, Elliot, and Richardson, 1998; Miller et al., 1999). Details of these studies are provided in the Beaufort Sea multiple-sale final EIS. These studies indicated that the bowhead whale-migration corridor in the central Alaskan Beaufort Sea during 1998 was similar to the corridor in many prior years, although not 1997. In 1997, nearly all bowheads sighted were in relatively nearshore waters. The results of the 1996-1998 studies indicated a tendency for the general bowhead whale-migration corridor to be farther offshore on days with seismic airguns operating compared to days without seismic airguns operating, although the distances of bowheads from shore during airgun operations overlapped with those in the absence of airgun operations. Aerial-survey results indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km. Sighting rates within a radius of 20 km of seismic operations were significantly lower during seismic operations than when no seismic operations were happening. Within 12-24 hours after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km. There was little or no evidence of differences in headings,

general activities, and swimming speeds of bowheads with and without seismic operations. Overall, the 1996-1998 results show that most bowheads avoided the area within about 20-30 km of the operating airguns. Within 12-24 hours after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km.
The observed 20-30 km area of avoidance is a larger avoidance radius than documented by previous scientific studies in the 1980s and smaller than the 30 mi suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson 2000). The seismic activities in the 1980s were 2D in deeper water. Recent seismic activities were 3D OBC concentrated in shallow water.
Based on recordings of bowhead whale calls made during these same studies, Greene et al. (1999), summarized that results for the 3 years of study indicated that: (1) bowhead whales call frequently during the autumn migration through the study area; (2) calling continued at times when whales were exposed to airgun pulses; and (3) call-detection rates at some locations differed significantly when airguns were detectable versus not detectable. However, there was no significant tendency for the call-detection rate to change in a consistent way at times when airguns started or stopped.

Richardson provided a brief comparison between observations from seismic studies conducted in the 1980s and the 1996 seismic survey at the Arctic Seismic Synthesis Workshop in Barrow (USDOI, MMS 1997). Observations from earlier seismic studies during the summer and early autumn show that most bowhead whales interrupt their previous activities and swim strongly away when a seismic ship approaches within about 7.5-8 km. At the distances where this strong avoidance occurs, received levels of seismic pulses typically are high, about 150-180 dB re 1 µPa. The surfacing, respiration, and dive cycles of bowheads engaged in strong avoidance also change in a consistent pattern involving unusually short surfacing and diving and unusually few blows per surfacing. These avoidance and behavioral effects among bowheads close to seismic vessels are strong, reasonably consistent, and relatively easy to document. Less consistent and weaker disturbance effects probably extend to longer distances and lower received sound levels at least some of the time. Bowheads often tolerate much seismic noise and, at least in summer, continue to use areas where seismic exploration is common. However, at least one case of strong avoidance has been reported as far as 24 km from an approaching seismic boat (Koski and Johnson 1987) and, as noted above, the aerial survey data (Miller et al. 1999) indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km. Richardson noted that many of the observations involved bowheads that were not actively migrating. Actively migrating bowheads may react somewhat differently than bowheads engaged in feeding or socializing. Migrating bowheads, for instance, may react by deflecting their migration corridor away from the seismic vessel. Monitoring of the bowhead migration past a nearshore seismic operation in September 1996 provided evidence consistent with the possibility that the closest whales may have been displaced several miles seaward during periods with seismic activity.

With respect to these studies conducted in the Beaufort Sea from 1996-1998, the peer-review group at the Arctic Open-Water Noise Peer Review Workshop in Seattle from June 5-6, 2001, prepared a summary statement supporting the methods and results reported in Richardson (1999) concerning avoidance of seismic sounds by bowhead whales:

Monitoring studies of 3-D seismic exploration (8-16 airguns totaling 560-1,500 in^3) in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active seismic source, while deflection may begin at distances up to 35 km. Sound levels received by bowhead whales at 20 km ranged from 117-135 dB re 1 µPa rms and 107-126 dB re 1 µPa rms at 30 km. The received sound levels at 20-30 km are considerably lower levels than have previously been shown to elicit avoidance in bowhead or other baleen whales exposed to seismic pulses.

A study in Canada provides information on the behavioral response of bowhead whales to seismic surveys (Miller and Davis, 2002). Bowheads were sighted at similar rates with and without seismic, although the no feeding-seismic sample was too small for meaningful comparisons. Bowheads were seen regularly within 20 km of the operations area at times influenced by airgun pulses. Aerial surveys were unable to document bowhead avoidance of the seismic operations area. The area of avoidance around the seismic operations area was apparently too small to be evident from the broadscale aerial surveys that were flown, especially considering the small amount of surveying done when seismic was not being conducted. General activities of bowheads during times when seismic operations were conducted were similar to times without seismic.

The bowheads that surfaced closest to the vessel (323-614 m) would have been exposed to sound levels of about 180 dB re 1 µPa rms before the immediate shutdown of the array (Miller *et al.* 2002). There were seven shutdowns of the airgun array in response to sightings of bowheads within 1 km of the seismic vessel. Bowheads at the average vessel-based sighting distance (1,957 m) during line seismic would have been exposed to sound levels of about 170 dB re 1 µPa rms. The many aerial sightings of bowheads at distances from the vessel ranging from 5.3-19.9 km would have been exposed to sound levels ranging from approximately 150-130 dB re 1 µPa rms, respectively.

The results from the study in summer 2001 are markedly different from those obtained during similar studies during the autumn migration of bowheads through the Alaskan Beaufort Sea (Miller *et al*. 2002). For example, during the Alaskan studies only 1 bowhead whale was observed from the seismic vessel(s) during six seasons (1996-2001) of vessel-based observations compared with 262 seen in 2001. The zone of avoidance for bowhead whales around the airgun operations in 2001 was clearly much smaller (~2 km) than that observed for migrating bowhead whales in recent autumn studies in Alaskan waters (up to 20-30 km). Davis (1987) concluded that migrating bowheads during the fall migration may be more sensitive to industrial disturbance than bowheads on their summering grounds, where they may be engaged in feeding activities.

Inupiat subsistence whalers have stated that industrial noise, especially noise due to seismic exploration, has displaced the fall bowhead migration seaward and, thereby, is interfering with the subsistence hunt at Barrow (Ahmaogak 1989). Whalers have reported reaction distances, where whales begin to divert from their migratory path, on the order of 10 mi (T. Albert cited in USDOI, MMS 1995) to 35 mi (F. Kanayurak in USDOI, MMS 1997. Kanayurak stated that the bowheads "…are displaced from their normal migratory path by as much as 30 miles." Also at the March 1997 workshop, Mr. Roxy Oyagak, Jr., a Nuiqsut whaling captain, stated in written testimony:

"Based on the industrial activity, there is an unmitigable adverse impact on the village of Nuiqsut on subsistence whaling. i.e., 1) by causing the whales to abandon the hunting area …and 3) placing physical barriers between the subsistence whalers and marine mammals, including altering the normal bowhead whale migration route."

Data available from MMS' BWASP surveys over about a 27 year period indicate that, at least during the primary open water period during the autumn (when open water seismic activities are most likely to occur), there are areas where bowheads are much more likely to be encountered and where aggregations, including feeding aggregations and/or aggregations with large numbers of females and calves, are more likely to occur. As previously discussed, data are not sufficient to fully understand the habitat value of the action area in terms of bowhead feeding. Feeding whales exposed to noise from the drilling operation could react by leaving the immediate area. The extent of avoidance will vary both due to the actual noise level radii around each seismic vessel, the context in which it is heard, and the motivation of the animal to stay within the area. It also may vary depending on the age, and most likely, the sex and reproductive status of the whale. It may be related to whether subsistence hunting has begun and/or is ongoing. Because the areas where large aggregations of whales have been observed during the autumn also are areas used, at least in some years, for feeding, it may be that the whales would show avoidance more similar to that observed in studies of whales on their summer feeding grounds. However, as noted above, it is not clear that reduced avoidance should be interpreted as a reduction in impact. It may be that bowheads are so highly motivated to stay on a feeding ground that they remain at noise levels that could, with long term exposure, cause adverse effects.

Acoustic recording of bowhead whale calls have been collected through a network of hydrophone arrays operated by Shell in the Beaufort Sea. These data indicate bowhead call rates decrease on exposure to seismic noise, or proximity to seismic sources, but that whales continue to migrate through the areas in which seismic exploration is occurring (Koski *et al.* 2012). The seismic sources used in here would be larger and of much longer duration than the VSP surveys. There is, then, evidence that bowhead whales would not be displaced from large areas of the Chukchi Sea on exposure to VSP survey noise. The ZVSP surveys are expected to elicit short term behavioral reactions similar to those described for other fall seismic surveys in the Beaufort Sea, and similar to the effects described for drilling. These impacts to bowhead whales would be expected to result in short term behavioral effects without significant consequence to the whales. Here again we note any possible long-term effects of this exposure are not presently fully known. However, the Western Artic population of bowhead whales has continued to grow over the last several decades despite oil and gas exploration activity, shipping, and subsistence harvests under a quota of 280 whales landed within five year blocks.

Strandings have been associated with exposure to certain impulsive underwater noise. There is no conclusive evidence of cetacean strandings or deaths as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Most of these events associated involved beaked whales, no such reactions have been observed in bowhead whales. Additionally, the sound produced from the proposed activities will be at much lower levels than those reported during stranding events.

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. Gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and much ship traffic in that area for decades. Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson et al. 1987). Populations of both gray whales and bowhead whales grew substantially during this time.

While the ZVSP is used for a different purpose than the marine seismic surveys that normally take place in the Beaufort Sea, the technology, equipment, and acoustic properties are very similar if not the same, and the previous analysis would apply to this program. A ZVSP may be conducted for each of the four wells Shell plans to drill. Drilling may begin sometime in mid-July, and Shell estimates 78 days will be required to complete the wells. This indicates that two of the four ZVSP surveys would occur before the fall bowhead migration when few whales would be expected within the action area. The seismic work would require approximately 10-14 hours, much less than that associated with marine seismic surveys. Also, the source would be stationary within the water column rather than towed behind a vessel.

Humpback whales summering in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64-L (100 in^3) airgun (Malme and Miles, 1985). Some humpbacks seemed “startled” at received levels of 150–169 dB re 1 µPa on an approximate rms basis. McCauley et al. (1998, 2000) studied the responses of humpback whales off Western Australia to a full-scale seismic survey with a 16-airgun 2,678-in^3 array, and to a single 20 in^3 airgun with source level 227 dB re 1 µPa·m (p-p). They found that the overall distribution of humpbacks migrating through their study area was unaffected by the full-scale seismic program. McCauley et al. (1998) did, however, document localized avoidance of the array and of the single gun. Avoidance reactions began at 5–8 km (2.7–4.3 n.mi.) from the array and those reactions kept most pods about 3–4 km (1.6–2.2 n.mi.) from the operating seismic boat. Observations were made from the seismic vessel, from which the maximum viewing distance was listed as 14 km (7.6 n.mi.). Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. Mean avoidance distance from the airgun corresponded to a received sound level of 140 dB re 1 µPa rms; this was the level at which humpbacks started to show avoidance reactions to an approaching airgun. The standoff range, i.e., the closest point of approach of the airgun to the whales, corresponded to a received level of 143 dB rms. The initial avoidance response generally occurred at distances of 5–8 km (2.7–4.3 n.mi.) from the airgun array and 2 km (1.1 n.mi.) from the single gun. However, some individual humpback whales, especially males, approached within distances 100–400 m (328–1312 ft), where the maximum received level was 179 dB re 1 µPa rms.

Humpback and fin whales that occur seasonally in the action area are likely feeding or migrating. The observations summarized above indicate that any fin or humpback whale that is exposed to seismic pulses at particular levels may alter their behaviors. The responses of these whales are likely dependent on the received level and duration of the airgun pulses, but they may exhibit avoidance, suspend feeding, or shift their migration pathway. Avoidance responses or other behavioral disruptions could be expected to last during the exposure. Whales that are migrating may be diverted from their path or feeding whales may be interrupted, but these disruptions would be temporary. Although we do not have evidence to support this assumption for all baleen whales, gray whales have been observed to migrate annually along the west coast of North America despite intermittent seismic exploration (and much ship traffic) and bowhead whales continue to travel to the eastern Beaufort Sea each summer despite seismic exploration in the summer and autumn range for many years. Also, humpback whales exposed to LFA sonar changed song length but then returned to "normal" duration after exposure (Miller *et al*., 2000). Fin and humpback whales are expected to resume their behavior after the seismic vessel has moved out of their immediate area without impairment of feeding, migration, or other behaviors.

Significant feeding/prey base impacts from these surveys are unlikely. Seismic activity should have little effect on bowhead prey species (mainly zooplankton). Bowheads feed on concentrations of zooplankton. Zooplanktons that are very close to the seismic source may react to the shock wave, but little or no mortality is expected (LGL Ltd. 2001). A reaction by zooplankton to a seismic impulse would be relevant only if it caused a concentration of zooplankton to scatter. Pressure changes of sufficient magnitude to cause zooplankton to scatter probably would occur only if they were very close to the source. Impacts on zooplankton behavior are predicted to be negligible and would have negligible effects on feeding bowheads (LGL Ltd. 2001).

While fin and humpback whales feed primarily on small fish, the ZVSP surveys would have, at most, a very localized effect on these resources that should not reduce their general availability to these whales. The potential effects of the drilling program, including the ZVSP surveys, are considered in the NMFS draft Environmental Assessment for the proposed IHA (NMFS 2012). That EA found that sound pulses at received levels of 160 dB re 1 µPa may cause subtle changes in fish behavior, but that fish often habituate to repeated strong sounds rather rapidly. Impacts on fish behavior were predicted to be inconsequential. We would not expect the seismic survey work to have significant effect on feeding for fin or humpback whales in the action area.

Potential Effects from Aircraft Traffic

Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines. Underwater sounds from aircraft are transient. According to Richardson *et al.* (1995a), the angle at which a line from the aircraft to the receiver intersects the water's surface is important. At angles greater than 13 degrees from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period while it passes overhead and is heard underwater.

Data on reactions of bowheads to helicopters are limited. Most bowheads are unlikely to react significantly to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. Observations of bowhead whales exposed to helicopter overflights indicate that most bowheads exhibited no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme 1993). This noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Patenaude *et al.* (1997) found that most reactions by bowheads to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. However, the majority of bowheads showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117-120 dB re 1 µPa in the 10-500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112-116 dB re 1 µPa in the 10-500-Hz band.

While the obvious behavioral reaction of a bowhead to a single low-flying helicopter or fixed-winged aircraft flying overhead is probably temporary (Richardson *et al*. 1995a), most “fleeing” reactions in mammals are accompanied by endocrine changes, which, depending on other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health.

Because Shell’s operational flight plans call for regular but infrequent flights, direct flight routes to the drill sites, and minimum altitudes of 457m (1500 ft.) for all aircraft, no significant effects to bowhead, fin, or humpback whales are expected to occur.

Potential Effects from Icebreakers

As detailed in Shell’s IMP (see Attachment B of Shell’s IHA application), actual breaking of ice would occur only in the unlikely event that ice conditions in the immediate vicinity of operations create a safety hazard for the drilling vessel. In such a circumstance, operations personnel will follow the guidelines established in the IMP to evaluate ice conditions and make the formal designation of a hazardous, ice alert condition, which would trigger the procedures that govern any actual icebreaking operations. Recent ice conditions in the Chukchi Sea in the vicinity of Shell’s planned operations, and during the timeframe for those operations, establish that there is a very low probability for the type of hazardous ice conditions that might necessitate icebreaking (e.g., records of the National Naval Ice Center archives). This probability could be greater at the shoulders of the drilling season (early July or late October); therefore, for purposes of evaluating possible impacts of the planned activities, Shell has assumed limited icebreaking activities for a very limited period of time, and estimated incidental takes of marine mammals from such activities.

Richardson et al. (1995a) reported that broadband (20-1,000 Hz) received levels at 0.37 km for the icebreaking supply vessel the Canmar Supplier underway in open water were 130 dB and 144 dB when it was breaking ice. The increase in noise during icebreaking is apparently due to propeller cavitation. Richardson *et al*. (1995a) summarized that icebreaking sound from the

Robert Lemeur pushing on ice were detectable >50 km away. Brewer *et al*. (1993) reported that in the autumn of 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by 25+ km. This ship was icebreaking almost daily. However, Richardson *et al.* (1995a) noted that in 1987, bowheads also avoided another drillsite with little icebreaking.

Response distances vary, depending on icebreaker activities and sound propagation conditions. Based on models in earlier studies, Miles, Malme, and Richardons (1987) predicted bowhead whales should respond to the sound of icebreakers at distances of 2-25 km (1.24-15.53 mil.) from active icebreakers. The same study predicts about half of the bowhead whales in an area can be expected to show avoidance response to an icebreaker underway in open water conditions at 2-12 km (1.25-7.46 mi.) distance, or to an icebreaker pushing ice at 4.6-20 km (2.86-12.4 mi.) distance, when the sound-to-noise ratio is 30 dB.

Richardson *et al*. (1995b) found that bowheads migrating in the nearshore lead often tolerated exposure to projected icebreaker sounds at received levels up to 20 dB or more above the natural ambient noise levels at corresponding frequencies. The source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in this study (median difference 34 dB over the frequency range 40-6,300 Hz). Over the two-season period (1991 and 1994) when icebreaker playbacks were attempted, an estimated 93 bowheads (80 groups) were seen near the ice camp when the projectors were transmitting icebreaker sounds into the water, and approximately 158 bowheads (116 groups) were seen near there during quiet periods. Some bowheads diverted from their course when exposed to levels of projected icebreaker sound greater than 20 dB above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise. However, not all bowheads diverted at that sound-to-noise ratio, and a minority of whales apparently diverted at a lower sound-to-noise ratio. The study concluded that exposure to a single playback of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable; however, for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi).

It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. The predicted “typical” radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 dB around the “typical” threshold, with commensurate variability in predicted reaction radius. Finally, traditional knowledge of bowhead whalers typically report increased sensitivities in spring migrant bowheads as opposed to the fall. This is exemplified in their use of traditional motorless skin boats and white hunting garb during spring hunting, while outboard motor powered skiffs are used in the fall. The proposed drilling program would not expose spring migrants to noise, and those whales exposed to noise in summer and fall may be less sensitive than their spring counterparts.

Although bowhead whales react to icebreaking and ice-management activities, these activities are expected to have a minor level of effect on these whales in the Chukchi Sea for the following reasons: any expected zone of effect would be much smaller than the area of the Chukchi Sea through which fall migrating bowhead whales are moving; the timing of this project would largely occur prior to the fall bowhead whale migration; the low likelihood of the presence of large amounts of sea ice; and the expected low densities of bowhead whales during the July-August segment of this project.

As might be expected, we found no applicable scientific papers or information concerning the reactions of fin or humpback whales to icebreakers. As low-frequency hearing baleen whales, we would expect the reactions of these species to icebreaker sound to be similar to that described for bowhead whales. Additionally, very few of these whales would be exposed to icebreaking noise. In the FR notice of the proposed IHA for the Shell Chukchi drilling program, NMFS estimates the maximum number whales exposed to received noise levels above 120 dB re 1µ Pa due to ice management activities at 38 bowhead whales, 5 fin whales, and 5 humpback whales.

Potential Effects of Vessel Traffic

Bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. This avoidance may be related to the fact that bowheads have been commercially hunted within the lifetimes of some individuals within the population and they continue to be hunted for subsistence throughout many parts of their range. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi), and a few whales may not react until the vessel is less than 1 km (less than 0.62 mi) away. Received noise levels as low as 84 dB re 1 µPa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme 1993).

In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of 2-4 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme 1993). Vessel disturbance during these experimental conditions temporarily disrupted activities and sometimes disrupted social groups, when groups of whales scattered as a vessel approached. Reactions to slow-moving vessels, especially if they do not approach directly, are much less dramatic. Bowheads often are more tolerant of vessels moving slowly or in directions other than toward the whales. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. After some disturbance incidents, at least some bowheads returned to their original locations (Richardson and Malme 1993). Some whales may exhibit subtle changes in their surfacing and blow cycles, while others appear to be unaffected. Bowheads actively engaged in social interactions or mating may be less responsive to vessels. Data are not sufficient to determine sex, age, or reproductive characteristics of response to vessels. We are not aware of data that would allow us to determine whether females with calves tend to show avoidance and scattering at a greater, lesser, or at the same distances as other segments of the population.

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead whales, causing injury or death. As noted in the baseline section of this evaluation, available information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not indicate that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality in the Chukchi Sea.

At present, available data do not indicate that strikes by oil and gas-related vessels would be likely to occur in association with the Shell drilling program. Vessel activities associated with the 2012 Shell drilling program are not expected to disrupt the bowhead migration, and small deflections in individual swimming paths for bowhead, humpback, or fin whales and a reduction in use of possible feeding in the action area should not result in significant adverse effects on these species.

Summary of Potential Effects of Noise and Disturbance Sources

Available information indicates that bowhead, humpback, or fin whales are responsive (in some cases highly responsive) to anthropogenic noise in their environment. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source and the reasons for this variability are not fully understood. The proposed exploration drilling could result in considerable increase in noise and disturbance to these whales. This noise may result from various activities, including drilling, vessel traffic and icebreaker operation, seismic profiling, and support activities.

The observed response of bowhead whales to seismic noise has varied among studies. The factors associated with variability are not entirely clear. However, data indicate that fall migrating bowheads show greater avoidance of active seismic vessels than do feeding bowheads. Recent monitoring studies (1996-1998) and traditional knowledge indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 km and may begin avoidance at greater distances. Received sound levels at 20 km ranged from 117-135 dB re 1 µPa rms and 107-126 dB re 1µ Pa rms at 30 km. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980's. Avoidance did not persist beyond 12-24 hours after the end of seismic operations. In some early studies, bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Available data indicate that behavioral changes are temporary. Baleen whales respond to drilling noise at different distances depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km or possibly more.

The Shell drilling program will result in an increase in marine vessel activity, and includes icebreakers, spill response vessels, supply and crew boats, and other vessels. Whales respond strongly to vessels directly approaching them. Avoidance of vessels usually begins when a rapidly approaching vessel is 1-4 km away, with a few whales possibly reacting at distances from 5-7 km. Received noise levels as low as 84 dB re 1 µPa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

Icebreaker response distances vary. Predictions from models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km, with roughly half of the bowhead whales showing avoidance response to an icebreaker underway in open water at a range of 2-12 km when the sound-to-noise ratio is 30 dB and roughly half of the bowhead whales showing avoidance response to an icebreaker pushing ice at a range of 4.6-20 km when the sound-to-noise ratio is 30 dB. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

The Chukchi Sea drilling program would result in increased aircraft traffic within the Action area. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some whales probably would dive quickly in response to the aircraft noise. Bowheads are relatively unaffected by aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft.

Overall, fin, humpback, or bowhead whales exposed to the Shell Chukchi drilling program most likely would experience temporary, nonlethal effects. Data are sufficient to conclude that response to seismic noise is likely to vary with time of year; sex and reproductive status of individuals exposed; site (because of differences in noise propagation and use by bowheads); activity and the exact characteristics of that activity (e.g seismic source, airgun array and configuration, etc.); the animal's motivation to be in an area; and options for alternative routes, places to feed, etc. While habituation is seen in some species, and behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic operations, localized avoidance still occurred. Bowheads may be less likely to habituate to at least certain types of noise than fin or humpback whales because they are hunted annually, and thus, many individuals may have a strong negative association with human noise.

Importantly, the number of fin, humpback, and bowhead whales that would be expected to receive noise levels that may elicit behavioral reactions to the drilling activities is small; based on density estimates for the Chukchi Sea the total animals exposed harassing levels of noise would be 53 bowhead whales, 15 fin whales, and 15 humpback whales (76 FR 69958). All of these estimates would fall below one percent of the population of these species. No injurious takes are anticipated to occur.

Potential Effects from Discharges

The proposed drilling would require the discharge of certain pollutants into the receiving waters of the Chukchi Sea. Impacts to water quality are possible from vessel mooring, mud line cellar (MLC) construction, discharge of drill cuttings, mud, and other permitted discharges, and from small fuel spills (<1,000 bbl) during fuel transfers. While NMFS' proposed action is not anticipated to have impacts on water quality, Shell's activities could potentially impact water quality in the project area.

The Environmental Protection Agency must permit such discharges under their National Pollutant Discharge Elimination System (NPDES) program. The NPDES discharges are not part of this action. The EPA has previously consulted with NMFS on the Chukchi Sea Exploration NPDES general permit. NMFS issued a letter concurring with EPA's determination that discharges authorized under that general permit were not likely to affect threatened or endangered species. However, the following discussion is presented to provide general information on these discharges and their potential affects.

Shell proposes to drill three wells and a partial fourth well during the open water season. Each well will generate about 4,100 bbl (652 m^3) of cuttings from the MLC and two upper well sections. Seawater will be used to drill these upper hole sections. These sediments totaling approximately 24,700 bbl (3,927 m^3) will be discharged on the surface of the seafloor and a portion of the sediments would be suspended in the water column resulting in a plume with increased TSS, turbidity, and BOD. Mooring would displace about 120,124 bbl (19,098 m^3) and would result in some additional suspension of solids in the water column. TSS loading in the plume is expected to be less than 1,000 ppm and could be less than 300 ppm (LaSalle et al., 1991).

The release of drill cuttings and drilling muds associated with exploratory drilling activity would also result in increased turbidity and concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff, 1981; Neff, 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate [$BaSO_4$]) and various additives to modify the properties of the mud (Neff, 2005).

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90% of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10% of the mass of the mud solids consists of fine-grained particles that would drift with prevailing currents away from the drilling site (NRC, 1983; Neff, 2005). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Nedwed *et al.*, 2004; Smith et al., 2004; Neff, 2005). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 33 ft (10 m) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 328 ft (100 m) from the platform (Neff, 2005). Therefore, effects on water quality resulting from turbidity from discharged drill cuttings and drilling fluids are expected to be temporary, localized to the vicinity of the discharge.

Discharge of drill cuttings and drilling fluids from exploratory drilling programs could result in elevated levels of metals in the water (Neff, 1981; NRC, 1983). Chromium, copper, mercury, lead, and zinc are the metals of greatest concern resulting from the discharge of drill cuttings and drilling fluids (Neff, 1981). Arsenic, nickel, vanadium, and manganese may also be present at elevated concentrations in some drill cuttings and drilling fluids. Barium, as $BaSO_4$, is usually present at high concentrations in drilling fluids, but due to its low solubility in seawater and low reactivity, barium sulfate would settle to the seafloor as it is discharged, and would not be expected to have any effects on water quality (DHHS, 2007). Some metals are present in additives that may be mixed with the drilling mud to improve the physical and chemical properties of the mud, while other metals may be contaminants of major mud ingredients or may be present in drill cuttings (Neff, 1981). Additives such as drill pipe dope, which contains 15% copper and seven percent lead, and drill collar dope, which can contain 35% zinc, 20% lead, and seven percent copper, may also contribute trace metals to discharges of drill cuttings and drilling fluids (EPA, 2006b). Lignosulfonate compounds that are commonly added to drilling fluids as deflocculants and thinners are another source of metals in discharges from exploratory drilling programs. A detailed discussion related to the environmental distribution of trace metals from exploratory drilling activities is available in the *Final Ocean Discharge Criteria Evaluation of the Arctic NPDES General Permit for Oil and Gas Exploration (Permit No.: AKG280000). Expired: 26 June 2011* (EPA 2006b), and is incorporated here by reference.

Most of the discharged drill cuttings and drilling fluids would rapidly sink to the bottom near the discharge location (Neff, 2005). The actual distance traveled by the discharge would depend on the water depth, lateral transport, particle size and the density of the discharged material (NRC, 2003). A smaller fraction of the discharge plume, consisting of soluble components and fine-grained particles, is likely to remain in the water column longer, and may be transported considerable distances from the discharge site. Depending on the composition of the discharged drill cuttings and drilling fluids, as well as the rate of discharge, lateral transport, and dilution rates, concentrations of soluble metals may exceed EPA marine water quality criteria for dissolved metals within a small area around the site of discharge. Effects on water quality would be local and would generally be restricted to the areas within 328 ft (100 m) of the activity (NRC, 1983; Neff, 2005).

Indirect effects could result from resuspension of deposited sediments with elevated concentrations of trace metals. Metals from resuspended sediments could contribute to elevated concentrations of metals dissolved in the water. The magnitude of effects on water quality resulting from elevation of metal concentrations would depend on the composition of the sediments, concentrations of certain metal ions in the water column, and the uses of the affected water. Concentrations of certain dissolved metals above the established threshold values would result in adverse effects on water quality within the proposed EA project area (EPA, 2009b). These effects could occur indirectly (i.e. at a later time than the proposed action) if deposited sediments with elevated concentrations of soluble metals were resuspended by tides, waves, or other natural or unnatural events. The magnitude of such indirect effects on water quality would depend on the composition of the deposited sediments, as well as other factors. Based on analysis of sediments discharged from oil and gas operations (NRC, 1983) and chemical assessment of sediments at a drillsite in the Beaufort Sea (Trefry and Trocine, 2009), concentrations of metals dissolved from resuspended sediments are unlikely to exceed the EPA Water Quality Criteria (EPA, 2009b). If such indirect effects were to occur, the effects on water quality in the proposed project area are expected to be of low intensity and temporary and local in nature.

Non-contact cooling water is comprised of seawater that would be pumped continuously to provide cooling for certain pieces of machinery associated with exploratory drilling activities. Heat transferred from the machinery to the water is expected to raise the temperature of the seawater in the system by about 1º Celsius (MMS, 2002). Chlorine, as calcium hypochlorite, or a similar biocide, would be added to the non-contact cooling water to reduce biofouling and would contribute to the overall salinity of the waste stream. Before discharge, water from the cooling system would generally be mixed with other discharges. After mixing, sodium metabisulfate may be added to the effluent to reduce total residual chlorine concentration to comply with regulatory limits (MMS, 2002; EPA, 2006b). Discharged waters would be slightly warmer and would contain higher concentrations of dissolved salts relative to the ambient waters of the Beaufort and Chukchi Seas. Therefore, discharged waters would increase the temperature and salinity of the seawater in the immediate vicinity of the discharge.

There is a potential for fuel spills during fuel transfers. A fuel spill would introduce hydrocarbons and temporary toxicity effects to the surface water. The effects of a fuel spill would be limited by required deployment of booming equipment during fuel transfers and automatic shutdown of fuel lines triggered by decreased pressure.

Overall, impacts to water quality in the Action area are anticipated to be low given the fact that turbidity will only be increased for a short period of time in close proximity to the actual activities and discharged waste streams would be diluted within close proximity to the vessel. No impacts to bowhead, humpback, or fin whales are anticipated due to these discharges; although it is possible whales may detect (smell or taste) such releases in the immediate area of the discharge. We have no information on the possible reactions by bowheads, humpbacks, or fin whales to such discharges.

The probability of an oil spill occurring during drilling is remote. Based on modeling conducted by Bercha (2008), the predicted frequency of an exploration well oil spill in waters similar to those in the Beaufort Sea is 0.000612 per well for a blowout sized between 10,000 barrels (bbl) to 149,000 bbl and 0.000354 per well for a blowout greater than 150,000 bbl. Such probabilities are discountable under our ESA analysis [*Discountable effects* are those that are extremely unlikely to occur. Based on best judgment, one would not 1) be able to meaningfully measure, detect, or evaluate insignificant effects; or 2) expect discountable effects to occur]. Nonetheless, in recognition of the significant impacts that may occur to these species if a spill were to occur, this opinion includes an analysis of the effects of oil spills.

Potential Effects of Oil Spills from Exploration Activity

The Department of the Interior has considered the likelihood of a large or very large (i.e. ≥1,000 barrels or ≥150,000 barrels, respectively) oil spill occurring during Shell's proposed exploration drilling. On the Beaufort and Chukchi OCS, the oil industry drilled 35 exploratory wells between 1982 and 2003. No blowouts occurred. During the time of this drilling, industry has had 35 small spills totaling 1,120 gallons (gal) or 26.7 bbl. Of the 26.7 bbl spilled, approximately 24 bbl were recovered (MMS, 2007a; BOEMRE, 2011).

Small (1,000 gal or less) operational spills of diesel, refined fuel, or crude oil may occur. These small spills often are onto containment and gravel islands or ice and can be cleaned up. Since 1971, industry has drilled approximately 172 exploration wells in the Pacific, 51 in the Atlantic, 10,524 in the Gulf of Mexico, and 97 in Alaska, for a total of 10,844 wells (Brajas, Howard, and Monkelein, 1999). From 1971-1999, there were 53 blowouts during exploration drilling. With the exception of three spills of 200, 100, and 11 bbl, no additional oil spills occurred during that period. Based on modeling conducted by Bercha (2008), the predicted frequency of an exploration well oil spill in waters similar to those in Shell's program is 0.000612 per well for a blowout sized between 10,000 barrels (bbl) to 149,000 bbl and 0.000354 per well for a blowout greater than 150,000 bbl.

Shell has implemented several design standards and practices to reduce the already low probability of an oil spill occurring as part of its operations. The wells proposed to be drilled in the Arctic are exploratory and will not be converted to production wells; thus, production casing will not be installed, and the well will be permanently plugged and abandoned once exploration drilling is complete. Shell has also developed and will implement the following plans and protocols: Shell's Critical Operations Curtailment Plan; IMP; Well Control Plan; and Fuel Transfer Plan. Many of these safety measures are required by the Department of the Interior's interim final rule implementing certain measures to improve the safety of oil and gas exploration and development on the Outer Continental Shelf in light of the Deepwater Horizon event (see 75 FR 63346, October 14, 2010). Operationally, Shell has committed to the following to help prevent an oil spill from occurring in the Beaufort Sea:

- Shell's Blow Out Preventer (BOP) was inspected and tested by an independent third party specialist;
- Further inspection and testing of the BOP have been performed to ensure the reliability of the BOP and that all functions will be performed as necessary, including shearing the drill pipe;
- Subsea BOP hydrostatic tests will be increased from once every 14 days to once every 7 days;
- A second set of blind/shear rams will be installed in the BOP stack;
- Full string casings will typically not be installed through high pressure zones;
- Liners will be installed and cemented, which allows for installation of a liner top packer;
- Testing of liners prior to installing a tieback string of casing back to the wellhead;
- Utilizing a two-barrier policy; and
- Testing of all casing hangers to ensure that they have two independent, validated barriers at all times.

Analyses of Potential Effects of an Oil Spill on Whales

The effects of a large oil spill and subsequent exposure of bowhead, humpback, or fin whales to fresh crude oil are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact, the amount of oil spilled, and the age/degree of weathering of the spilled oil at the time of contact. The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. If a very large slick of fresh oil contacted a large aggregation or aggregations of feeding bowheads, especially with a high percent of calves, the effect might be expected to be greater than under more typical circumstances. There is great uncertainty about the effects of fresh crude oil on cetacean calves. Prolonged exposure to freshly spilled oil could kill some adult whales, but, based on available information, the number likely would be small if the spill contacted bowheads in open water. However, Engelhardt (1987) theorized that bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration into arctic waters because of their use of ice edges and leads, where spilled oil would tend to accumulate. Several other researchers (Geraci and St. Aubin, 1982; St. Aubin, Stinson, and Geraci, 1984) concluded that exposure to spilled oil is unlikely to have serious direct effects on baleen whales. There is some uncertainty and disagreement within the scientific community on the results of studies on the impacts of the Exxon *Valdez* oil spill on large cetaceans (for example, Loughlin, 1994, Dahlheim and Matkin, 1994, Dahlheim and Loughlin, 1990). Bowheads may also have heightened vulnerability to spilled oil because of the functional morphology of their baleen. If baleen is fouled, and if crude oil is ingested, there could be adverse effects on the feeding efficiency and food assimilation of bowhead whales. Such effects are expected to be of most importance to calves, pregnant females, and lactating females. However, loss of feeding efficiency could potentially reduce the chance of survival of any whale and could affect the amount of energy female whales have to invest in reproduction.

Despite the fact that there is no definitive mortality of a large cetacean exposed to an oil spill, based on the fact that certain components of crude oil are highly toxic to other mammals, such mortality could potentially occur. Ingestion, surface contact with, and especially inhalation of fresh crude oil has been shown to cause serious damage and even death in many species of mammals. This does not mean that such effect would occur. Such an assumption, if it provides an overestimate of potential effects, is more protective of the population than erring on the side of assuming that such impacts could not occur because they previously have not been documented. Relatedly, because of unique ecological characteristics of the bowhead, particularly their feeding mechanisms and behavior and their migratory movements through narrow ice leads during spring, they may be more vulnerable than other cetaceans to large and very large oil spills within their range.

A computer simulation of the probability for bowhead whales to contact oil spills originating from five launch points within the Chukchi Sea resulted in the oiling (contact) of an average of 0.6% of the bowhead population (Reed *et al*., 1987). However, the proposed drilling locations are within the fall migratory corridor and would occur (at least partially) during this migration. Therefore we believe larger numbers of bowhead whales could be adversely affected if a large spill occurred, particularly if large aggregations of bowheads were feeding. Larger groups could be adversely affected if a large spill occurred when large aggregations of bowheads were feeding. Cetaceans that inhabit areas that are in the path of a major oil spill can be impacted in several different ways. First, individuals potentially could be directly affected by contact with the oil or its toxic constituents through inhalation of aromatic fractions of unweathered oil (probably the most serious threat to cetaceans), ingestion (of the oil itself or contaminated prey), fouling of their baleen, and surface contact. Second, they could be indirectly impacted if the quality or quantity of their prey were reduced. Third, individuals could be directly or indirectly affected due to maternal effects (for example, changes in food assimilation during pregnancy, or reduced maternal health) or in-utero exposure to toxic components of oil. Fourth, they could be affected by disturbance of spill response and cleanup activities. Although there is evidence for all of the aforementioned types of effects in other types of mammals from experiments and/or post-spill studies, there is very little evidence regarding the probability for any of the aforementioned in cetaceans due to limitations discussed above.

There are no data available on which to evaluate the potential effect of a large or very large spill on baleen whale newborn or other calves, on females who are very near term or who have just given birth, or on females accompanied by calves of any age. However, it is not unlikely that newborn and other young calves would be more vulnerable to the acute and chronic effects of oil than would adult whales. Calves swim slower, take more breaths, are on the surface more often, and have higher metabolisms than do adults. They could be exposed to oil on their mother's skin during nursing. They could receive pollutants through their mothers' milk, as well as through direct ingestion.

In the event of exposure to spilled oil, it is likely that some whales would experience temporary or perhaps permanent nonlethal effects, including one or more of the following symptoms:

- inhaling hydrocarbon vapors;
- ingesting oil and oil-contaminated prey;
- fouling of their baleen and reduced foraging efficiency;
- oiling their skin, causing irritation;
- losing some proportion of their food source; and
- temporary displacement from some feeding areas.

Some whales could die as a result of contact with spilled oil, particularly if there is prolonged exposure to freshly spilled oil, such as in a lead. The extent of the effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Under some circumstances, some whales could die as a result of contact with spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small.

Cleanup activities associated with an oil spill, other than during winter, are likely to result in disturbance to whales. If an oil spill does occur, it is likely that large numbers of personnel, vessels, and aircraft will be present and conducting cleanup operations in the Chukchi or Beaufort Sea. If spilled oil is present during the bowhead whale migration, it could result in disturbance and possible displacement of whales from their normal migration route. Response actions may also cause bowhead whales to abandon feeding areas. Disturbance effects are expected to persist for the duration of cleanup operations if the operations are conducted during the summer or fall period.

In conclusion, we reiterate that there is uncertainty about effects on bowhead, humpback, or fin whales in the unlikely event of a very large spill. If a large amount of fresh oil contacted a significant portion of a bowhead whale feeding aggregation, effects potentially could be greater than typically would be assumed. Additionally, highly significant effects could occur if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. This potential would exist only for bowhead whales, as very few humpback or fin whales occur in the actin area. Available information indicates it is unlikely that bowhead whales would be likely to suffer significant population-level adverse effects from a large spill originating in the Chukchi Sea due to their seasonal occurrence, densities, and the expected effects of oil contacting these animals. However, individuals or small groups could be injured or potentially even killed in a large spill. Oil spill response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance.

Effects to Ringed and Bearded Seals

Potential Exposure to Drilling Activities

Pinnipeds generally seem to be less responsive to exposure to industrial sound than most cetaceans. Pinniped responses to underwater sound from some types of industrial activities such as seismic exploration appear to be temporary and localized (Harris *et al.*, 2001; Reiser *et al.*, 2009).

Blackwell *et al.* (2004) reported little or no reaction of ringed seals in response to pile-driving activities during construction of a man-made island in the Beaufort Sea. Ringed seals were observed swimming as close as 151 ft (46 m) from the island and may have been habituated to the sounds which were likely audible at distances <9,842 ft (3,000 m) underwater and 0.3 mi (0.5 km) in air. Moulton *et al*. (2003) reported that ringed seal densities on ice in the vicinity of a man-made island in the Beaufort Sea did not change significantly before and after construction and drilling activities.

Southall *et al.* (2007) reviewed literature describing responses of pinnipeds to non-pulsed sound and reported that the limited data suggest exposures between approximately 90 and 140 dB generally do not appear to induce strong behavioral responses in pinnipeds exposed to non-pulse sounds in water; no data exist regarding exposures at higher levels. It is important to note that among these studies, there are some apparent differences in responses between field and laboratory conditions. In contrast to the mid-frequency odontocetes, captive pinnipeds responded more strongly at lower levels than did animals in the field. Again, contextual issues are the likely cause of this difference.

Jacobs and Terhune (2002) observed harbor seal reactions to AHDs (source level in this study was 172 dB) deployed around aquaculture sites. Seals were generally unresponsive to sounds from the AHDs. During two specific events, individuals came within 141 and 144 ft (43 and 44 m) of active AHDs and failed to demonstrate any measurable behavioral response; estimated received levels based on the measures given were approximately 120 to 130 dB.

Costa *et al.* (2003) measured received noise levels from an Acoustic Thermometry of Ocean Climate (ATOC) program sound source off northern California using acoustic data loggers placed on translocated elephant seals. Subjects were captured on land, transported to sea, instrumented with archival acoustic tags, and released such that their transit would lead them near an active ATOC source (at 939-m depth; 75-Hz signal with 37.5- Hz bandwidth; 195 dB maximum source level, ramped up from 165 dB over 20 min) on their return to a haul-out site. Received exposure levels of the ATOC source for experimental subjects averaged 128 dB (range 118 to 137) in the 60- to 90-Hz band. None of the instrumented animals terminated dives or radically altered behavior upon exposure, but some statistically significant changes in diving parameters were documented in nine individuals. Translocated northern elephant seals exposed to this particular non-pulse source began to demonstrate subtle behavioral changes at exposure to received levels of approximately 120 to 140 dB.

Kastelein *et al.* (2006) exposed nine captive harbor seals in an approximately 82 × 98 ft (25 × 30 m) enclosure to non-pulse sounds used in underwater data communication systems (similar to acoustic modems). Test signals were frequency modulated tones, sweeps, and bands of noise with fundamental frequencies between 8 and 16 kHz; 128 to 130 [± 3] dB source levels; 1- to 2-s duration [60-80 percent duty cycle]; or 100 percent duty cycle. They recorded seal positions and the mean number of individual surfacing behaviors during control periods (no exposure), before exposure, and in 15-min experimental sessions (n = 7 exposures for each sound type). Seals generally swam away from each source at received levels of approximately 107 dB, avoiding it by approximately 16 ft (5 m), although they did not haul out of the water or change surfacing behavior. Seal reactions did not appear to wane over repeated exposure (i.e., there was no obvious habituation), and the colony of seals generally returned to baseline conditions following exposure. The seals were not reinforced with food for remaining in the sound field.

The proposed drilling program would likely expose several hundred ringed seals, and much fewer numbers of bearded seals to noise capable of harassing these animals. The most probable reaction to this exposure would be localized avoidance of the noise source. Some seals remain close to the noise sources, and most behavior reactions should be temporary; either because the animals have moved away from the noise or habituated to it. Shell's Chuchi Sea drilling program presents no novel technology or physical factors that would cause effects to ringed or bearded seals to differ from the discussion and analysis presented here. Owing to the low frequencies and source levels associated with drilling, we do not expect seals to be significantly affected by this work.

Potential Effects of VSPS Surveys

Ringed and bearded seals are not likely to show a strong avoidance reaction to the airgun sources proposed for use. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds and only slight (if any) changes in behavior. Ringed seals frequently do not avoid the area within a few hundred meters of operating airgun arrays (Harris *et al.*, 2001; Moulton and Lawson, 2002; Miller *et al.*, 2005). Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of seals exposed to seismic pulses (Harris *et al.*, 2001; Moulton and Lawson, 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes of 560 to 1,500 in^3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson, 2002). However, these avoidance movements were relatively small, on the order of 328 ft (100 m) to a few hundreds of meters, and many seals remained within 328–656 ft (100–200 m) of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Mate and Harvey, 1987; Jefferson and Curry, 1994; Richardson *et al.*, 1995a). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson *et al.*, 1998). Even if reactions of the species occurring in the Action area are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on individuals or populations. Additionally, the airguns are only proposed to be used for a short time during the exploration drilling program (approximately 10-14 hours for each well, for a total of 20-28 hours over the entire open-water season, which lasts for approximately 4 months).

Systematic studies of temporary hearing threshold shift (TTS) on captive pinnipeds have been conducted (Bowles *et al.*, 1999; Kastak *et al.*, 1999, 2005, 2007; Schusterman *et al.*, 2000; Finneran *et al.*, 2003; Southall et al., 2007). The TTS threshold for pulsed sounds has been indirectly estimated as being a sound exposure level (SEL) of approximately 171 dB re 1 $\mu Pa^2 \cdot s$ (Southall *et al.*, 2007) which would be equivalent to a single pulse with a received level of approximately 181 to 186 dB re 1 µPa (rms), or a series of pulses for which the highest rms values are a few dB lower. The sound level necessary to cause TTS in pinnipeds depends on exposure duration, as in other mammals; with longer exposure, the level necessary to elicit TTS is reduced (Schusterman *et al.*, 2000; Kastak *et al.*, 2005, 2007). For very short exposures (e.g., to a single sound pulse), the level necessary to cause TTS is very high (Finneran *et al.*, 2003).

NMFS has established acoustic thresholds that identify the received sound levels above which hearing impairment or other injury could potentially occur, which are 180 and 190 dB re 1 µPa (rms) for cetaceans and pinnipeds, respectively (NMFS 1995, 2000). The established 180- and 190-dB re 1 µPa (rms) criteria are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before additional TTS measurements for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. Additionally, based on the summary provided here and the fact that modeling indicates the back-propagated source level for the *Kulluk* to be 185 dB re 1 µPa at 1 m (Greene, 1987), TTS is not expected to occur in any ringed or bearded seals that may occur in the proposed drilling area since the source level will not reach levels thought to induce even mild TTS. While the source level of the airgun is higher than the 190-dB threshold level, an animal would have to be in very close proximity to be exposed to such levels. Additionally, the 180- and 190-dB radii for the airgun are 0.8 mi (1.24 km) and 0.3 mi (524 m), respectively, from the source. Because of the short duration that the airguns will be used (no more than 20-28 hours throughout the entire open-water season) and mitigation and monitoring measures described later in this document, it is highly unlikely that any type of hearing impairment to ringed or bearded seals, temporary or permanent, would occur as a result of the exploration drilling activities.

Potential Effects of Vessel Traffic

All vessels produce sound during operation, which when propagated at certain frequencies and intensities can alter the normal behavior of marine mammals, mask their underwater communications and other uses of sound, cause them to avoid noisy areas, and in extreme cases (e.g., high-powered sonar), damage their auditory systems and even cause death (Marine Mammal Commission 2007, Arctic Council 2009, OSPAR Commission 2009). The mere presence and movements of ships in the vicinity of seals can also cause disturbance of their normal behaviors (Jansen et al. 2010) and potentially cause ringed seals to abandon their preferred breeding habitats in areas with high traffic (Smiley and Milne 1979, Mansfield 1983). The timing of the drilling program is such that no disruption of breeding or pupping would occur due to vessel operations. Seals appear quite tolerant of vessels that do not alter course or operate at relatively slope speeds, such as would occur here. As observed in Richardson *et al*., 1995:"In general, evidence about reactions of seals to vessels is meager. The limited data, plus the responses of seals to other noisy human activities, suggest that seals often show considerable tolerance of vessels. In monitoring seismic work in the Beaufort Sea in 2007, the most commonly observed reaction by seals to passing vessels (not active seismic) was no reaction, followed by looking, splashing, and changing direction (Ireland *et al*., 2009). Similar monitoring of seismic work in the Beaufort during 1998 found 252 seals were sighted from the seismic source vessel (98.5% of which were ringed seals). They found the operation of the airgun array affected the distribution of seals within a few hundred meters of the array. However, seals were observed in the general areas where seismic operations were occurring throughout the season (Richardson, 1999). We are not aware of any abandonment of open water habitat by ringed or bearded seals due to vessel activity. Vessel strikes are probably not a threat to ringed seals except in the case of icebreakers. "

Potential Effects from Icebreakers

Ice management activities include the physical pushing or moving of ice to create more open-water in the proposed drilling area and to prevent ice floes from striking the drillship. Icebreaking activities include the physical breaking of ice. Shell does not intend to conduct icebreaking activities. However, should there be a need for icebreaking, it would only be performed in order to safely move the drillship and other vessels off location and to end operations for the season. Ringed and bearded seals are dependent on sea ice for at least part of their life history. Sea ice is important for life functions such as resting, breeding, and molting. These species are dependent on two different types of ice: pack ice and landfast ice. Should ice management/icebreaking activities be necessary during the proposed drilling program, Shell would only manage pack ice in either early to mid-July or mid- to late October. Landfast ice would not be present during Shell's proposed operations.

The ringed seal is the most common pinniped species in the proposed project area. While ringed seals use ice year-round, they do not construct lairs for pupping until late winter/early spring on the landfast ice. Therefore, since Shell plans to conclude drilling on October 31, Shell's activities would not impact ringed seal lairs or habitat needed for breeding and pupping in the Camden Bay area. Ringed seals can be found on the pack ice surface in the late spring and early summer in the Beaufort Sea, the latter part of which may overlap with the start of Shell's proposed drilling activities. If an ice floe is pushed into one that contains hauled out seals, the animals may become startled and enter the water when the two ice floes collide. Bearded seals breed in the Bering and Chukchi Seas, as the Beaufort Sea provides less suitable habitat for the species. Therefore, ice used by bearded seals for life functions such as breeding and molting would not be impacted as a result of Shell's drilling program since these life functions do not occur in the proposed project area. For ringed seals, ice management/icebreaking would occur during a time when life functions such as breeding, pupping, and molting do not occur in the proposed activity area. Additionally, these life functions normally occur on landfast ice, which will not be impacted by Shell's activity.

Potential Effects from Aircraft Traffic

Potential effects to pinnipeds from aircraft activity could involve both acoustic and non-acoustic effects. It is uncertain if the seals react to the sound of the helicopter or to its physical presence flying overhead. Typical reactions of hauled out pinnipeds to aircraft that have been observed include looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water. Ice seals hauled out on the ice have been observed diving into the water when approached by a low-flying aircraft or helicopter (Burns and Harbo, 1972, cited in Richardson *et al.*, 1995a; Burns and Frost, 1979, cited in Richardson *et al.*, 1995a). Richardson *et al.* (1995a) note that responses can vary based on differences in aircraft type, altitude, and flight pattern. Additionally, a study conducted by Born *et al*. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice, as well as time of day and relative wind direction.

Blackwell *et al.* (2004a) observed 12 ringed seals during low-altitude overflights of a Bell 212 helicopter at Northstar in June and July 2000 (9 observations took place concurrent with pipe-driving activities). One seal showed no reaction to the aircraft while the remaining 11 (92%) reacted, either by looking at the helicopter (n=10) or by departing from their basking site (n=1). Blackwell et al. (2004a) concluded that none of the reactions to helicopters were strong or long lasting, and that seals near Northstar in June and July 2000 probably had habituated to industrial sounds and visible activities that had occurred often during the preceding winter and spring. There have been few systematic studies of pinniped reactions to aircraft overflights, and most of the available data concern pinnipeds hauled out on land or ice rather than pinnipeds in the water (Richardson *et al.* 1995a; Born *et al.*, 1999).

Born *et al.* (1999) determined that 49% of ringed seals escaped (i.e., left the ice) as a response to a helicopter flying at 492 ft (150 m) altitude. Seals entered the water when the helicopter was 4,101 ft (1,250 m) away if the seal was in front of the helicopter and at 1,640 ft (500 m) away if the seal was to the side of the helicopter. The authors noted that more seals reacted to helicopters than to fixed-wing aircraft. The study concluded that the risk of scaring ringed seals by small-type helicopters could be substantially reduced if they do not approach closer than 4,921 ft (1,500 m).

Potential Effects from Discharges

Discharge of drilling muds and cuttings is not expected to have any measurable effect on individual seals nor to cause population-level effects, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution/deposition of these materials. Drilling muds and cuttings may cover portions of the seafloor and cause localized pollution. While bearded seals are benthic feeders and could therefore be at risk of ingesting organisms that had been exposed to these discharges, it is doubtful to have any significant impact on individual animals. Bearded seals occur in low numbers in the action area during ice-free seasons, and benthic organisms themselves are mobile and would not necessarily be sufficiently exposed to accumulate body burdens of pollutants from muds and cuttings. Also, the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat.

There is a potential for fuel spills during fuel transfers. A fuel spill would introduce hydrocarbons and temporary toxicity effects to the surface water. The effects of a fuel spill would be limited by required deployment of booming equipment during fuel transfers and automatic shutdown of fuel lines triggered by decreased pressure.

Overall, impacts to water quality in the action area are anticipated to be low given the fact that turbidity will only be increased for a short period of time in close proximity to the actual activities and discharged waste streams would be diluted within close proximity to the vessel. No impacts to ringed or bearded seals are anticipated due to these discharges; although it is possible seals may detect (smell or taste) such releases in the immediate area of the discharge. We have no information on the possible reactions by seals to such discharges.

Potential Effects of Oil Spills from Exploration Activity

Ringed and bearded seals are present in open-water areas during summer and early autumn within the Action area, and could be potentially exposed to oil spills from the drilling activities. Externally oiled phocid seals often survive and become clean, but heavily oiled seal pups and adults may die, depending on the extent of oiling and characteristics of the oil. Prolonged exposure could occur if fuel or crude oil was spilled in or reached nearshore waters, was spilled in a lead used by seals, or was spilled under the ice when seals have limited mobility (NMFS, 2000). Adult seals may suffer some temporary adverse effects, such as eye and skin irritation, with possible infection (MMS, 1996). Such effects may increase stress, which could contribute to the death of some individuals. Ringed and bearded seals may ingest oil-contaminated foods, but there is little evidence that seals will ingest enough oil to cause lethal internal effects. There is a likelihood that newborn seal pups, if contacted by oil, would die from oiling through loss of insulation and resulting hypothermia. These potential effects are addressed in more detail in subsequent paragraphs.

Reports of the effects of oil spills have shown that some mortality of seals may have occurred as a result of oil fouling; however, large scale mortality had not been observed prior to the EVOS (St. Aubin, 1990). Effects of oil on marine mammals were not well studied at most spills because of lack of baseline data and/or the brevity of the post-spill surveys. The largest documented impact of a spill, prior to EVOS, was on young seals in January in the Gulf of St. Lawrence (St. Aubin, 1990). Brownell and Le Boeuf (1971) found no marked effects of oil from the Santa Barbara oil spill on California sea lions or on the mortality rates of newborn pups.

Intensive and long-term studies were conducted after the EVOS in Alaska. There may have been a long-term decline of 36% in numbers of molting harbor seals at oiled haul-out sites in Prince William Sound following EVOS (Frost *et al.*, 1994a). However, in a reanalysis of those data and additional years of surveys, along with an examination of assumptions and biases associated with the original data, Hoover-Miller *et al.* (2001) concluded that the EVOS effect had been overestimated. The decline in attendance at some oiled sites was more likely a continuation of the general decline in harbor seal abundance in Prince William Sound documented since 1984 (Frost *et al.*, 1999) rather than a result of EVOS. The results from Hoover-Miller *et al.* (2001) indicate that the effects of EVOS were largely indistinguishable from natural decline by 1992. However, while Frost *et al.* (2004) concluded that there was no evidence that seals were displaced from oiled sites, they did find that aerial counts indicated 26% fewer pups were produced at oiled locations in 1989 than would have been expected without the oil spill. Harbor seal pup mortality at oiled beaches was 23% to 26%, which may have been higher than natural mortality, although no baseline data for pup mortality existed prior to EVOS (Frost *et al.*, 1994a). There was no conclusive evidence of spill effects on Steller sea lions (Calkins *et al.*, 1994). Oil did not persist on sea lions themselves (as it did on harbor seals), nor did it persist on sea lion haul-out sites and rookeries (Calkins et al., 1994). Sea lion rookeries and haul out sites, unlike those used by harbor seals, have steep sides and are subject to high wave energy (Calkins *et al.*, 1994).

Adult seals rely on a layer of blubber for insulation, and oiling of the external surface does not appear to have adverse thermoregulatory effects (Kooyman et al., 1976, 1977; St. Aubin, 1990). Contact with oil on the external surfaces can potentially cause increased stress and irritation of the eyes of ringed seals (Geraci and Smith, 1976; St. Aubin, 1990). These effects seemed to be temporary and reversible, but continued exposure of eyes to oil could cause permanent damage (St. Aubin, 1990). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976) and in seals in the Antarctic after an oil spill (Lillie, 1954).

Newborn seal pups rely on their fur for insulation. Newborn ringed seal pups in lairs on the ice could be contaminated through contact with oiled mothers. There is the potential that newborn ringed seal pups that were contaminated with oil could die from hypothermia.

Marine mammals can ingest oil if their food is contaminated. Oil can also be absorbed through the respiratory tract (Geraci and Smith, 1976; Engelhardt *et al.*, 1977). Some of the ingested oil is voided in vomit or feces but some is absorbed and could cause toxic effects (Engelhardt, 1981). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt, 1978, 1982, 1985). In addition, seals exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin, 1980, 1982).

Although seals may have the capability to detect and avoid oil, they apparently do so only to a limited extent (St. Aubin, 1990). Seals may abandon the area of an oil spill because of human disturbance associated with cleanup efforts, but they are most likely to remain in the area of the spill. One notable behavioral reaction to oiling is that oiled seals are reluctant to enter the water, even when intense cleanup activities are conducted nearby (St. Aubin, 1990; Frost *et al.*, 1994b, 2004).

Seals that are under natural stress, such as lack of food or a heavy infestation by parasites, could potentially die because of the additional stress of oiling (Geraci and Smith, 1976; St. Aubin, 1990; Spraker *et al.*, 1994). Female seals that are nursing young would be under natural stress, as would molting seals. In both cases, the seals would have reduced food stores and may be less resistant to effects of oil than seals that are not under some type of natural stress. Seals that are not under natural stress (e.g., fasting, molting) would be more likely to survive oiling.
In general, seals do not exhibit large behavioral or physiological reactions to limited surface oiling or incidental exposure to contaminated food or vapors (St. Aubin, 1990; Williams *et al.*, 1994). Effects could be severe if seals surface in heavy oil slicks in leads or if oil accumulates near haul-out sites (St. Aubin, 1990). An oil spill in open-water is less likely to impact seals.

The potential effects to ringed and bearded seals described here do not take into consideration the proposed mitigation measures planned for this drilling program.

Non-auditory Physiological Effects – Stress

Stress may be induced by the proposed drilling actions on the species considered in this opinion. This section provides information on the relative exposure to stress, expected responses, and consequences.

Exposure to the drilling program associated with the issuance of this IHA has the potential to cause certain physiological effects to marine mammals other than those directly impacting their hearing. The combination of both the psychological stressor and the physiological stressor may have detrimental consequences (Wright et al., 2008). Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg, 2000; Sapolsky et al., 2000; Seyle, 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor.

An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress."

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg, 1987; Rivier, 1995), altered metabolism (Elasser *et al.*, 2000), reduced immune competence (Blecha, 2000), and behavioral disturbance.There are times during an animal's life when they have lower reserves and are more vulnerable to impacts from stressors. For example, if a mammal is stressed at the end of a feeding season just prior to a long distance migration, it may have sufficient energy reserves to cope with the stress. If stress occurs at the end of a long migration or fasting period, energy reserves may not be sufficient to adequately cope with the stress (Tyack, 2008; McEwen and Wingfield, 2003; Romano *et al.*, 2004).

Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead one to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as "distress" upon exposure to anthropogenic sounds.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (sensu Seyle, 1950) or "allostatic loading" (sensu McEwen and Wingfield, 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

There is little information available on sound-induced stress in marine mammals or on its potential to affect the long-term health or reproductive success of marine mammals (Fair and Becker, 2000; Hildebrand, 2005; Wright *et al.*, 2007a,b). Potential long-term effects, if they occur, would be mainly associated with chronic noise exposure (Nieukirk *et al.*, 2009). Disruption in feeding, especially within small populations could have impacts on whales, their reproductive success and even the survival of the species (NRC, 2005). However, we are unable to quantify any possible impacts of sound-induced stress on these species based on available information.

V. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 (Interagency Cooperation on the ESA of 1973, as amended): "…those effects of future State or private activities not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation." Reasonable foreseeable future federal actions and potential future federal actions that are unrelated to the proposed action are not considered in the analysis of cumulative effects because they would require separate consultation pursuant to section 7 of the ESA. Cumulative effects are usually viewed as those effects that impact the existing environment and remain to become part of the environment. These effects differ from those that may be attributed to past and ongoing actions within the area since they are considered part of the environmental baseline. Additionally, most structures and major activities within the Chukchi and Beaufort Sea OCS require federal authorizations from one or more agencies, such as the MMS, Army Corps of Engineers, and the Environmental Protection Agency. Such projects must consult under the ESA on their effects to listed species, and are therefore not addressed here as cumulative impacts.

The State of Alaska is currently leasing state-owned portions of the Beaufort Sea for oil and gas exploration and production. State leasing tracts within the Beaufort Sea would be subject to several federal permits and authorizations and therefore not considered in this analysis of cumulative effects. Recent development along the coastline and within nearshore state waters has occurred in the central Beaufort area, often near the Colville River delta. This work is being done from ice islands in relatively shallow waters (< 3m) constructed in early winter and abandoned by the following spring melt. Additional exploration and development of state lands within this region appears likely.

Since offshore oil and gas activities in state waters are generally well shoreward of the bowheads' main migration route, and some of the activities occur inside the barrier islands, the overall effects on bowheads from activities on state leases is likely to be minimal. These impacts could be magnified, however, if construction activity associated with additional development projects were to occur simultaneously, rather than consecutively. For example, construction and drilling noise from multiple drilling sites could result in a long-term, offshore shift in bowhead migration routes. The extra distance and heavier ice encountered could result in slower migration or physiological stress that may noticeably affect the whales. However, the majority of bowhead whales are generally found offshore of state waters.

Similarly, there may be impacts to ringed and bearded seals from these activities on state lands. These effects could include behavioral responses, including local avoidance to noise from aircraft and vessel traffic; seismic surveys; exploratory drilling; construction activities, including dredging; and development drilling and production operations that occur within several miles of the shore. Much of these state tracts would occur near the area of shorefast ice that is important to ringed seals for winter habitat and pupping.

Oil and gas development has occurred in the Eastern Beaufort Sea off the Canadian Mackenzie Delta. This includes seismic surveys, drilling, and infrastructure and support facilities as described for the US OCS. Seismic programs have recently been conducted off the Mackenzie Delta. The main area of industry interest to date has centered around the Mackenzie River Delta and offshore of the Tuktoyaktuk Peninsula. There has been little industry activity in this area in recent years, and we are not aware of any proposed activities. This area comprises a minor portion of the bowhead's summer range, as well as beign within the range of the ringed and bearded seal. Possible disturbance to these species from helicopters, vessels, seismic surveys, and drilling would be as previously described.

Continued development along the North Slope of Alaska would require some equipment and supplies to be transported to the site by barge or sealift. The process modules and permanent living quarters and other equipment and supplies likely would be transported to these sites on seagoing barges during the open-water season. Barge traffic around Point Barrow is likely to be limited to a short period from mid-August through mid-to-late September and should be completed before the bowhead whale migration reaches this area unless it encounters severe ice conditions. Barge traffic continuing into September is likely to disturb seals and some bowheads during their migration. Whales may react briefly by diving in response to low-flying helicopters and they would seek to avoid close approach by vessels. Oil spill probabilities associated with exploration are extremely low. In the event an oil spill occurred on state leases, the effects of an oil spill on bowhead, fin, and humpback whales, and seals would be as described earlier in this document. These effects would be most pronounced whenever whales or seals were confined to an area of freshly spilled oil. Of course, if the spill occurred over a prolonged period of time, more individuals could be contacted. Some individuals could be killed as a result of prolonged contact with freshly spilled oil, particularly if spills were to occur within ice-lead systems.

Activities that are not oil and gas related also affect bowhead whales. Between 1976 and 1992, only three ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al., 1994). The low number of observed ship-strike injuries suggests that bowheads either do not often encounter vessels or they avoid interactions with vessels, or that interactions usually result in the death of the animals. However, there is recent evidence that interaction of bowhead whales with ships and fishing gear may be increasing. There is little information to suggest ship strikes are currently a significant issue for ringed or bearded seals in the Action area.

Subsistence harvest by Alaska Natives is another non-OCS activity that affects the ringed and bearded seals. These harvests have been discussed previously in this opinion, and are considered sustainable at present levels.

Vessel traffic and, perhaps, aircraft activity may be expected to occur in the future in both the Chukchi and Beaufort Seas. The effects of these actions would be the same as that presented for traffic associated with oil and gas actions.

VI. Synthesis and Integration

Bowhead, fin, and humpback whale

NMFS estimates the number of bowhead whales to be exposed to noise levels that may be “taken”, as defined by the ESA, to be fewer than 60, with much lesser numbers of fin and humpback whales (76 FR 69958). The majority of these takes are likely to be by harassment due to acoustic exposure to drilling noise. No injurious or lethal takes are expected. These estimates were derived through density estimates from various sources that may not reflect the actual numbers of whales in these particular areas, sound propagation figures which are derived from models that may differ from actual conditions, and an assumed “take” received sound level of 160 dB, which may be higher or lower than the actual levels that elicit biologically-significant response from the whales. However, the estimates appear reasonable in view of available data.

As discussed earlier, there is concern that received levels below 160dB are detectable by whales and may cause some behavioral reaction. The numbers of animals so affected cannot be determined or estimated, depending on many factors including the specific sound propagation characteristics of the area and the age and sex of the receiving whales. The degree to which whales exposed to these lower received sound levels may react is not known, and may vary with age, sex, and behavior. While there is concern for whales abandoning feeding areas when exposed to seismic noise, it appears that most reaction by whales to these types of acoustic disturbance is localized and temporary, persisting only for 12-24 hours, after which time whales would resume their pre-exposure behavior. We note, however, this is an area requiring further study.

Elevated noise levels in the marine environment could alter the hearing ability of whales, causing temporary or permanent threshold shifts. However, information suggests the continuous and impulsive underwater noise levels associated with this drilling program would be at levels or durations below those expected to injure hearing mechanisms. Nonetheless, marine seismic activities present concerns with respect to hearing, and should be closely conditioned and monitored to avoid these effects. Noise has also been shown to cause avoidance in migrating gray and bowhead whales. Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s had lasting population-level adverse effects on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea.

Research on the effects of offshore seismic exploration in the Beaufort Sea, supported by the testimony of Inupiat hunters based on their own experience, has shown bowhead whales avoid these operations when within 20 km of the source and may begin to deflect at distances up to 35 km (Richardson, 1999a). While drilling noise is expected to be well below seismic levels, Davies (1997) concluded bowheads avoided an active drilling rig at a similar distance. Available data and the literature supports the Chukchi drilling program is likely to result in similar reactions. The proposed Chukchi sites are located within the area of the fall bowhead migration, and the drilling program would coincide with the fall bowhead migration (although the majority of this action would occur prior to the migration). While such deflections during migration may not be injurious to individual animals, concern is warranted for cumulative noise and multiple disturbances; the consequences of which might include long-term shifts in migrational paths or displacement from nearshore feeding habitats. However, it is unlikely that even these impacts would prevent the survival and recovery of the bowhead whale, as only the Western Arctic population would be associated with this action and their the primary feeding habitat is considered to be in the Canadian Beaufort and, perhaps, the Bering Sea. The Alaskan Chukchi Sea certainly provides feeding habitat for bowhead whales, and likely for fin and humpback whales, however current data do not fully identify the importance of the Chukchi Sea for these species (it is known to be important as a migrational corridor for bowheads).

Seismic and drilling operations have occurred in the Beaufort and Chukchi seas throughout the last several decades. NMFS has issued MMPA small take authorizations for many of these programs and has required monitoring, which in some cases has employed acoustic arrays to detect whale vocalizations/locations in addition to the observations of ship based observers and aerial monitors. Thus, our consideration of the proposed Shell drilling activities is informed by the monitoring and research associated with past oil and gas projects, and many aspects of that past work would be similar to that currently being proposed. The monitoring from these efforts indicates varied responses among whales (the large majority of observations have been on bowhead whales), with migrating whales being more responsive to noise and feeding whales less so. Whale calling rates decline in the presence of seismic sounds, and all but a very few whales show localized avoidance of the area near a drilling rig or a seismic source vessel. To our knowledge, no whales or other marine mammals have been killed or injured by these past operations, and the Western Arctic population of bowhead whales continues to increase at an annual rate estimated over 3 percent.

Because the Western Arctic bowhead whale population is approaching its pre-exploitation population size and has been documented to be increasing at a roughly constant rate for over 20 years, the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor (Angliss and Outlaw, 2010). These activities are unlikely to have any effect on the other four stocks of bowhead whales. Similarly, only the western North Pacific stock of humpback whales and the Northeast Pacific stock of fin whales would be potentially affected by these drilling activities. The described work would have no effect on the remaining worldwide stocks of humpback or fin whales. No injury or lethal takes are anticipated from these activities, nor are population-level consequences to the stocks expected. Most impacts would be due to harassment of whales, which may lead to behavioral reactions from which recovery is fairly rapid. Mitigative measures will reduce harassment and the possibility of harm or lethal takes.

Ringed Seal – Arctic Sub-Species, and Bearded Seal – Beringia DPS

The proposed drilling will occur in an area that supports moderate numbers of ringed seals and low numbers of bearded seals during the time of the activity. The most common behavior of these seals within the action area would be foraging, with no breeding, pupping, or molting periods overlapping the drilling period. We expect seals to show little significant reaction to the proposed activities, although localized avoidance of vessels and elevated noise levels is likely.

We have found no indication that these activities would be likely to result in the abandonment of foraging habitat within the Action area, nor to present concern for the energetic budgets of these seals or their ability to fulfill critical life history functions.

Consideration of the potential impacts of oil spills to seals must assess 1) the probabilities for a spill to occur and to make contact with the seals and/or their habitat, 2) the effects of oil spills and spill responses on these seals, and 3) the ability of industry to prevent, control, and recover spilled oil. Should a spill occur, its effects would depend on factors such as the time and location of the spill, the nature of the product spilled, its persistence and toxicity, and the effectiveness of any response measures. The estimated physical and behavioral effects of an oil spill on these seals have been described. While the most likely consequence of exposure to oil would be non-lethal impacts to individual ringed or bearded seals, some seals contacting oil, particularly freshly-spilled oil, could be harmed and possibly killed. Several coincidental events would be necessary for this scenario; the spill would have to occur, the spill would have to contact the seals in these waters, and clean-up or response efforts would have to have been at least partially unsuccessful. The impact of such an event would be significant, yet the statistical probability for the coincident occurrence of these events would be low.

No lethal takes are anticipated because of these activities, nor are population-level consequence expected. Most impact would be due to harassment by noise, which may lead to behavioral reactions from which recovery is rapid. Both ringed and bearded seals currently exist at what are believed to be high levels of abundance; concerns for these seals' survival are based on expected habitat conditions projected over the next century.

Exposure Analysis
NMFS has estimated the number of individuals exposed to sounds recognized as inducing harassment from these exploration drilling activities at fewer than 60 bowhead whales, fewer than 10 fin and humpback whales, up to 814 ringed seals, and fewer than 30 bearded seals (76 FR 69958). These estimates are based on certain acoustic thresholds described earlier in this opinion, and may under-estimate or over-estimate actual levels of exposure. Nonetheless, we believe they provide a reasonable measure of exposure for these animals. We note this exposure, however, would not include those associated with an oil spill. The potential exposure associated with spills has been presented earlier in this opinion.

Response Analysis
A review of the reactions of bowhead, humpback, or fin whales, ringed seals, and bearded seals exposed to continuous, broadband low- frequency industrial noise in the Alaskan Arctic suggests that whales will elicit short-term behavioral responses to the proposed drilling operations, largely due to elevated in-water noise. Such responses are not known to have long-term, adverse consequences for the biology or ecology of the individual whales exposed, although individual whales will may alter their migratory pathways to avoid these sound sources and may reduce their calling rates (Richardson *et al.*1995), although these reactions varied by season and ambient sound levels. Expected exposure would not elicit responses that suggest adverse effects on the ability of bowhead whales, ringed seals, or bearded seals to forage, detect predators, select a mate, or reproduce successfully. We also would not expect these responses to be symptomatic of chronic stress that might depress an animal's immune responses and increase their susceptibility to disease. At received levels between120 and 180 dB re 1µPa, the information available would not lead us to expect bowhead, humpback, or fin whales, ringed seals, or bearded seals to respond in ways that would reduce their reproduction, numbers, or distribution. Based on the past observed reactions of these animals to a sound source and the mitigative measures proposed or applicable to this program, we do not expect any whales or seals to be exposed to injurious noise at received levels equal to or greater than 180 dB re 1µPa.

Risk Analysis
Numerous studies of the ecology of populations have demonstrated the relationship between a population's reproduction (which includes fecundity schedules, age at maturity, and reproductive lifespan), numbers (which includes age- or stage-specific abundance and survival rates), or distribution (which includes the number of populations and sub-populations, immigration rates, and emigration rates), and a population's risk of extinction. In the absence of behavioral responses that reduce a population's reproduction, numbers, or distribution, the information available leads us to conclude that exposure to the Shell Chukchi Sea drilling activities are likely to elicit short-term responses in bowhead, humpback, or fin whales, ringed seals, and bearded seals that are known to have no long-term, adverse consequences for the biology or ecology of the individuals exposed.

We do not expect this exposure to translate into chronic or cumulative reductions in the current or expected future reproductive success of the bowhead, humpback, or fin whale, the Arctic sub-species of ringed seals, or the Beringia DPS of bearded seals. Therefore, the proposed drilling operation is not likely to affect the performance of these species or demographic divisions. By extension, we would not expect the authorization of the proposed IHA for the Shell 2012

Beaufort Sea drilling program to appreciably reduce the their likelihood of surviving and recovering in the wild.

Finally, while we have noted the expected effects of climate change and ocean acidification in this opinion, these effects are not pivotal in our determinations. The effects of ocean acidification are not fully understood and the timeframes by which such changes are occurring not fully known. However, the long term effects of ocean acidification on these species are effectively independent of the effects of this action, and would not be expected to exacerbate the impacts on listed species.

Conclusions

After reviewing the current status of these species, the environmental baseline for the action area, the biological and physical impacts of the proposed action, and cumulative effects, it is NMFS's biological opinion that the authorization of the proposed IHA associated with Shell's 2012 Chukchi Sea drilling program is not likely to jeopardize the continued existence of the endangered bowhead, humpback, and fin whale, the Arctic sub-species of ringed seal, or the Beringia DPS of bearded seal. No critical habitat has been designated for these species, therefore none will be affected.

VIII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the Act 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.

The National Marine Fisheries Service should implement the following measures for these purposes:

1. Upon learning of any unauthorized take of bowhead, fin, or humpback whales or a ringed or bearded seal which occurs as a result of OCS exploratory activity, NMFS should immediately notify the assistant Regional Administrator for Protected Resources at (907) 586-7235 of this taking to determine the appropriate and necessary course of action.

2. NMFS should recommend IHA holders take the following measures during operating to reduce potential interference with listed whales:
   (1) Reducing vessel speed below 9 knots when within 300 yards of whales; and
   (2) Avoiding multiple changes in direction and speed when within 300 yards of whales.

3. NMFS should continue to coordinate research associated with drilling and other OCS actions and the bowhead whale, with emphasis on cumulative impacts of OCS activities.

IX. REINITIATION OF CONSULTATION

This concludes formal consultation on this action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Biological Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Biological Opinion; or (4) a new species is listed or critical habitat designated that may be affected by this action. In circumstances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

X. 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, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the 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 to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

This opinion does not include an incidental take statement at this time. Upon issuance of regulations or authorizations under Section 101(a)(5) of the Marine Mammal Protection Act and/or its 1994 Amendments, NMFS will amend this opinion to include an incidental take statement(s) for the described work.

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