ENDANGERED SPECIES ACT: SECTION 7 CONSULTATION
BIOLOGICAL OPINION

Action Agency:	National Marine Fisheries Service, Permits and Conservation Division
Activity:	The issuance of regulations and a letter of authorization to take marine mammals incidental to offshore oil and gas operations at the Northstar development in the U.S. Beaufort Sea, January 13, 2014-January 14, 2019
Consulting Agency:	National Marine Fisheries Service, Alaska Region
Approved By:	
Date Issued:	2.12.14

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 *et. seq.*) requires that each federal agency shall ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species, or result in the destruction or adverse modification of any critical habitat of such species. When the action by a federal agency may affect a protected species, that agency is required to consult with either National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS), depending upon the protected species that may be affected. Formal consultations on most listed marine species are conducted between the action agency and NMFS. Consultations are concluded after NMFS' issuance of a biological opinion that identifies whether a proposed action is likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its critical habitat. If jeopardy or destruction or adverse modification is found to be likely, the biological opinion must identify the reasonable and prudent alternatives to the action, if any, that would avoid jeopardizing any listed species and avoid destruction or adverse modification to its designated critical habitat. If jeopardy is not likely, the biological opinion may also include an incidental take statement, which specifies the amount or extent of incidental take that is anticipated from the proposed action. Non-discretionary reasonable and prudent measures to minimize the impact of the incidental take are included along with the implementing terms and conditions, and conservation recommendations.

NMFS, Office of Protected Resources, Permits and Conservation Division (NMFS PR1) requested formal consultation on regulations and subsequent Letter of Authorization (LOA) under section 101(a)(5) of the Marine Mammal Protection Act of 1972, as amended (MMPA), for offshore oil and gas facilities operations at the Northstar development in the Beaufort Sea, Alaska. This document constitutes NMFS's biological opinion on the effects of that action on threatened and endangered species in accordance with section 7 of the ESA. Specifically, this biological opinion analyzes the effects of the action on the 1) endangered bowhead whales (*Balaena mysticetus*), and 2) threatened Beringia distinct population segment (DPS) of bearded seals (*Erignathus barbatus nauticus*), and 3) threatened Arctic subspecies of ringed seals (*Phoca hispida hispida*).

In formulating this biological opinion, NMFS used information from the following information sources:

- Request by BP Exploration (Alaska), Inc. (BPXA) for a LOA pursuant to section 101(a)(5) of the MMPA covering “taking of marine mammals incidental to operations of offshore oil and gas facilities in the U.S. Beaufort Sea” (50 C.F.R. Part 216, Subpart R); October 27, 2009
- Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (76 FR 39706, July 6, 2011)
- Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (79 FR 3347, January 21, 2014)
- Status review of the bearded seal (*Erignathus barbatus*) (Cameron et al. 2010)
- Status review of the ringed seal (*Phoca hispida*) (Kelly et al. 2010)
- Endangered Species Act, section 7 consultation biological opinion: Incidental harassment authorization to allow for incidental takes of marine mammals during shallow hazard survey in the Chukchi Sea, Alaska 2011; July 22, 2011
- Taking and importing marine mammals; taking marine mammals incidental to construction and operation of offshore oil and gas facilities in the Beaufort Sea, Alaska (74 FR 31011, June 29, 2009)
- Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
- Published scientific studies
- Unpublished data:
    - International Whaling Commission
    - North Slope Borough
    - Alaska Eskimo Whaling Commission
    - Traditional knowledge of the Alaskan Eskimo communities
    - National Marine Mammal Laboratory

Consultation History

In 1999 and 2004, BPXA petitioned NMFS to issue regulations concerning the potential “taking” of small numbers of whales and seals incidental to oil and gas development and operations in arctic waters of the United States. These two petitions were submitted pursuant to Section 101 (a) 5 of the MMPA, 16 U.S.C. § 1371.101 (a) (5), and 50 C.F.R. § 216, Subpart I. The regulations were promulgated by NMFS on May 25, 2000 and on April 6, 2006 at 50 C.F.R. § 216, subpart R. Those regulations allowed NMFS to issue LOAs for the incidental, but not intentional, “taking” of small numbers of marine mammals in the event that such “taking” occurred during construction and operation of Northstar oil and gas facilities in the Beaufort Sea, offshore from Alaska. The six species were the: bearded seal, ringed seal, spotted seal (*Phoca largha*), bowhead whale, beluga whale (*Delphinapterus leucas*), and gray whale (*Eschrichtius robustus*). To date, five LOAs were issued under the first regulations during 2000-2005; five LOAs were issued under the regulations during 2006-2011; and one LOA for five years has been issued for 2014-2019 (79 FR 3347, January 21, 2014).

The purpose of this request by BPXA is for NMFS to renew the Regulations and issue a new letter of authorization for potential future incidental taking of small numbers of whales and seals during continued oil and gas operations in the arctic waters of the United States. Future LOAs will be requested at later dates, assuming that NMFS renews the regulations at 50 C.F.R. § 216, subpart R, for 2014-2019.

NMFS PR1 initiated consultation on June 13, 2011. We completed a biological opinion on June 22, 2012 that covered 2012 through 2016. This biological opinion updates and replaces the 2012 opinion to cover the revised period of authorization (now 2014-2019) and includes an incidental take statement.

Terms of this Biological Opinion

This biological opinion will be valid upon issuance and remain in force for five years plus 30 days after the date the regulations are published in the Federal Register. Reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained and if: 1) the amount or extent of taking specified in the incidental take statement is exceeded; 2) new information reveals effects of this action may affect listed species in a manner or to an extent not previously considered in this biological opinion; 3) the identified action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or 4) a new species is listed or critical habitat proposed that may be affected by the identified action.

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Presentation of the Analysis in this Biological 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 on the other sections in this biological opinion and the analyses that can be found in each section. Every step of the analytical approach described below will be presented in this biological 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 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. By regulation, the baseline includes the impacts on the species and critical habitat of all past and present actions and future federal actions for which consultation has been completed (except the effects of the proposed action). 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, as required by regulation. 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 biological 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 [designated critical] habitat…*"

Jeopardy Standard
The "jeopardy" standard has been further interpreted in regulation (50 CFR 402.02) as a requirement that federal agencies ensure 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*.[1] 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.

The parameters of productivity, abundance, and population spatial structure are important to consider because they are predictors of extinction risk and recovery potential, 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).

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, including other factors affecting the survival and recovery of the species.

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.,

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[1] For purposes of this opinion, NMFS interprets this definition consistent with the court's opinion in *National Wildlife Federation v. NMFS*, 524 F.3d 917 (9th Cir. 2008). NMFS's jeopardy analysis considers how the proposed action may affect the likelihood of survival of the species and how it may affect the likelihood of recovery of the species.

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.

I. DESCRIPTION OF THE PROPOSED ACTION

Section 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq*.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens engaged in a specified activity (other than commercial fishing) in a specified geographical area, if certain findings are made. Such authorization may be accomplished through regulations and issuance of LOA(s) 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; would not have an unmitigable adverse impact on the availability of the marine mammal for subsistence uses (where relevant); 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 that produce underwater noise capable of harassing marine mammals. Harassment is a form of take, otherwise prohibited by the MMPA and ESA.

This opinion will address the potential effects from NMFS PR1's issuance of regulations and a letter of authorization to BPXA to harass marine mammals, under section 101 (a)(5) of the MMPA, during operations at the Northstar facility in the U. S. Beaufort Sea during a five-year period between 2014 and 2019 . Its purpose is to provide an assessment of those actions on the survival and recovery of the endangered bowhead whales, and the threatened bearded and ringed seals, as well as to provide measures to conserve these species and mitigate impacts. This biological opinion incorporates much of the information provided by NMFS PR1, as well as pertinent research on the whales, ice seals, and matters related to oil exploration. Traditional knowledge and the observations of Inupiat hunters are presented, along with information gained through scientific research. This combined knowledge contributes to a more complete understanding of the effects from the proposed activities.

The specific activities subject to this consultation are described below.

NMFS PR1 has re-issued regulations and an associated LOA to BPXA for the take of marine mammals incidental to operating the Northstar development in the Beaufort Sea, Alaska, during 2014-2019. The likely or possible impacts from continuing operations at Northstar on marine mammals involve both non-acoustic and acoustic effects. BPXA has requested authorization to take individuals of three cetacean and three pinniped species by Level B harassment. They are:

beluga, bowhead, and gray whales; and bearded, ringed, and spotted seals. Further, BPXA requested authorization to annually take five individual ringed seals by injury or mortality during the next five years, in the unlikely event that a ringed seal lair is crushed or flooded as a result of the described activities

Of these six species, the bowhead whale, bearded seal, and ringed seal are listed under the ESA. No critical habitat has been designated for these species.

LOA request

In 1999 and 2004 BPXA petitioned NMFS PR1 to issue regulations concerning the potential "taking" of small numbers of whales and seals incidental to oil and gas development and operations in U.S. arctic waters. These two petitions were submitted pursuant to section 101(a)5 of MMPA, 16 U.S.C. § 1371.101 (a)(5), and 50 C.F.R. § 216, Subpart I. The regulations were promulgated by NMFS on May 25, 2000 and on April 6, 2006 at 50 C.F.R. § 216, subpart R. Those regulations allowed NMFS to issue LOAs for the incidental, but not intentional, "taking" of small numbers of six marine mammals species in the event that such "taking" occurred during construction and operation of the Northstar oil and gas facility in the Beaufort Sea, offshore from Alaska.[2] The six species were the bearded, ringed, and spotted seals; beluga, bowhead, and gray whales. To date, five LOAs were issued under the regulations for 2000-2005, five LOAs were issued under the regulations for 2006-2011, and one LOA for five years has been issued for 2014-2019.

BP requested that NMFS renew the regulations and issue a new LOA, effective immediately, for potential future incidental taking of small numbers of seals and whales during continued oil and gas operations in the Beaufort Sea. Future LOAs will be requested at later dates, assuming that NMFS renews the regulations at 50 C.F.R. § 216, subpart R, immediately for the next five years.

Aside from the aforementioned six species for which "take" authorization is again sought, two other marine mammal species, Pacific walrus (*Odobenus rosmarus*) and polar bear (*Ursus maritimus*), are under the jurisdiction of the USFWS and are thus subject to a separate application to that agency.

BP does not anticipate that the operations at Northstar oil and gas production facilities will result in the "taking" of significant numbers of marine mammals. Moreover, these potential "takes" of small numbers of marine mammals are most likely not lethal (except for the request to take five individual ringed seals by injury or mortality annually during 2014-2019), and any impact on the species would be no more than negligible (Table 1). Although some whales and seals are likely to occur near the planned activities, any disturbance effects that occur are not anticipated to have serious consequences to the populations. Furthermore, there would be no unmitigable adverse impact on the availability of whales or seals for subsistence uses.

[2] The MMPA defines "take" to mean to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." 16 U.S.C. § 1362 (13).

BPXA filed this request for take authorization to ensure that the activities described herein are conducted in compliance with the MMPA, if small numbers of marine mammals are disturbed or otherwise "taken" incidentally and unintentionally during ongoing drilling, maintenance, and production operations.

Operations to be conducted

BP is currently producing oil from an offshore development in the Northstar Unit (Figure 1). This development is the first in the Beaufort Sea that uses a subsea pipeline to transport oil to shore and then into the Trans-Alaska Pipeline System. The Northstar facility was built in State of Alaska waters on the remnants of Seal Island, which was an artificial gravel island constructed for exploration drilling in the 1980s. Northstar facilities, built on the eroded remnants of Seal Island in 2000, are about 9.5 kilometers (km; 6 mi) offshore from Point Storkersen, northwest of the Prudhoe Bay industrial complex; and 5 km (3 mi) seaward of the closest barrier island.

Table 1 The species' population abundance estimates, total annual authorized take (when combining takes from the ice-covered, break-up, and open-water seasons), and percentage of the population that may be taken under this biological opinion**.**

Species	Abundance	Total annual authorized Level B take	Total annual authorized Level A take	Percentage of stock or population
Bearded Seal	1500,000*	5	0	<0.01
Ringed Seal	~250,000*	31	5	0.01
Bowhead Whale	15,232^	15	0	0.10
*Abundance estimate in NMFS 2011 Alaska Stock Assessment Reports (Allen and Angliss 2012). ^ Abundance estimate in George et al. (2004) with annual growth rate of 3.4 percent.				

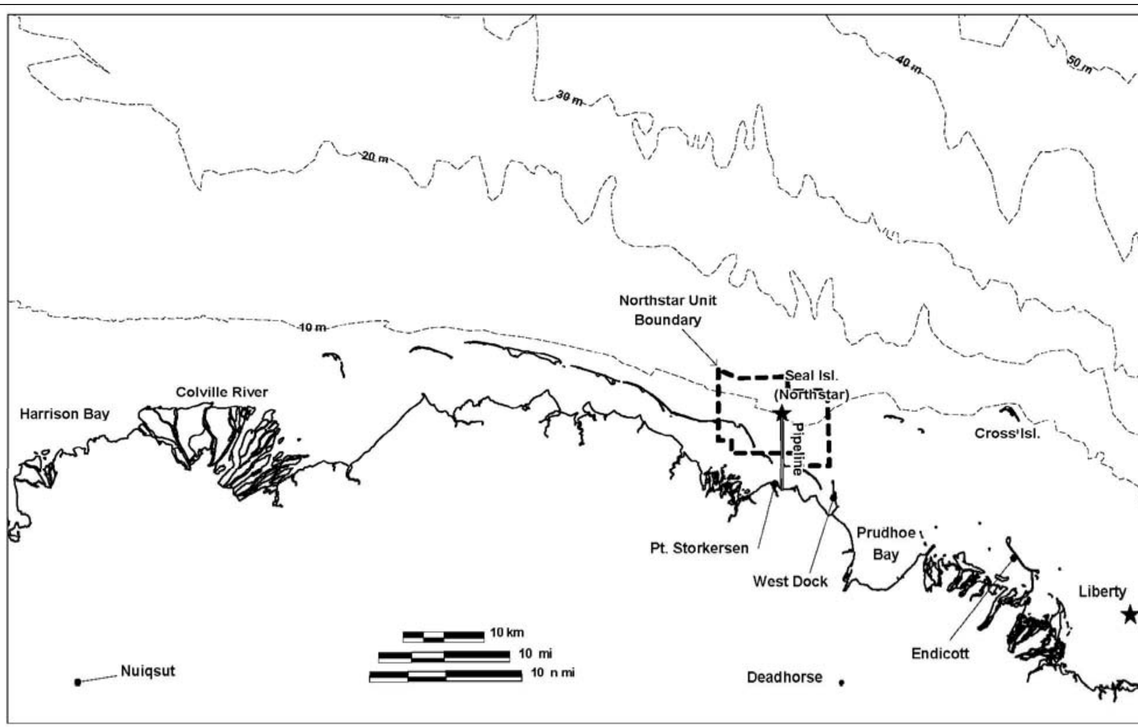

Figure 1 Northstar development, located at Seal Island, in the central Alaskan Beaufort Sea.

The construction and operation of the Northstar development in the Beaufort Sea was approved via other permitting processes. This request for a LOA concerns the potential takes of small numbers of whales and seals associated with BPXA's plans for continued drilling and oil production activities at Northstar. Upon expiry of the LOA recently issued (79 FR 3347, January 21, 2014), BPXA will submit additional requests for LOAs for future operations at Northstar, assuming that regulations regarding incidental take of marine mammals in association with Northstar will be renewed.

Much of what already occurred during Northstar construction, drilling, and production provides a basis for what can be anticipated during the next five years of activity at Northstar. Construction was completed in 2001, and activities with similar intensity are not planned or expected for any date within 2014-2019. Information about the activity levels in prior years, however, is helpful in understanding the varying activity levels that could occur in the future. The following section summarizes past activities at Northstar during the construction period and the subsequent drilling and production periods.[3] The description of Northstar activities from previous years is followed by information about activities expected to occur during the next five year period.

Northstar previous and future activities: construction, drilling, and production

The Northstar Unit is located 3.2 and 12.9 km (2 and 8 mi) offshore from Point Storkersen in the Beaufort Sea. The unit is adjacent to Prudhoe Bay and is approximately 87 km (54 mi) northeast of Nuiqsut, an Inupiat community. The main facilities associated with Northstar include a gravel island work surface for drilling and oil production facilities, and two pipelines that connect the island to the existing infrastructure at Prudhoe Bay. One pipeline transports crude oil to shore, and the second pipeline imports gas from Prudhoe Bay to inject at Northstar. Permanent living quarters and supporting oil production facilities are also located on the island.

During the 2014-2019 ice-covered seasons, an ice-road will be constructed between the Prudhoe Bay facilities at West Dock and Northstar Island to transport personnel, supplies, equipment, and materials. Helicopters and hovercraft will be used for transportation during freeze-up and break-up. During the open-water periods, helicopters and hovercraft will be used for most of the transportation; however, vessels from Alaska Clean Seas (ACS) will be used for personnel and equipment when weather, maintenance, or operational considerations prevent the use of helicopters and hovercraft. Normal oil production, gas injection, and drilling activities will continue during this period, including equipment testing, exercises for spill detection, and emergency escape training. Maintenance activities will occur annually on the protection barrier around Northstar due to the expected ice and storm impacts.

[3] A detailed description of Northstar activities during the period 1999-2004 can be found in Rodrigues and Williams (2006) and for 2005-2008 in the respective annual reports (Richardson 2006, 2007; Aerts and Richardson 2008, 2009).

Northstar previous and future equipment needed during drilling, production, and maintenance operations

Table 2 summarizes the vehicles and machinery used during BPXA's Northstar activities since the development of Northstar Island. Specific vehicles and heavy equipment are mentioned where possible, but in some cases these might be substituted by similar vehicles or heavy equipment.

Although all listed activities are not planned to take place during the 2014-2019operational phase of Northstar, some equipment may be required to repair or replace existing structures or infrastructure on Northstar in the future.

Table 2 Equipment used during activities for Northstar Island since its development.

Activity	Vehicles / Equipment	Description
Ice road Construction	Ice Auger	*Blue Bird Rolligon* augers and pumps are used to bore holes into the sea ice and pump sea water onto the ice-road surface.
	Water Truck	Water trucks are used along ice road corridors to thicken the ice to a sufficient depth to support heavy equipment traffic; and to cap off the offshore roads for durability.
	Grader	*Caterpillar 14G or 16G* graders are used to maintain ice roads, and small snow blowers and front-end loaders with snow blower attachments.
Pipeline Installation	Ditchwitch	*Ditchwitch R100s* are used to cut slots in the ice.
	Backhoe	*Caterpillar 330s* are used to remove ice from the slots; *Hitachi EX-450s* are used for ice block removal from slotting and for pipeline trench excavation.
	Tractor Trailer	Standard tractor trailers are used to haul pipe sections to the trench location.
	Boom Tractor	*Caterpillar 583* side booms are used to lay the pipes into the trench.
Island Maintenance	Dozer	Various *D-3, D-4, D-5, D-8N and D-8K Caterpillars* are used for plowing snow along the ice-road corridors; removing ice rubble from Seal Island; moving gravel on the island; and various other island construction and maintenance related activities.
	Front End Loaders	*Caterpillar 966* and *Volvo 150* loaders are used for island gravel placement, island slope grading, ice block handling, ice road handling, truck loading, snow removal, trench spoils, trench spoils placement, maintenance, and various other island maintenance related activities.
	Heavy Load Truck	*Euclid R-25, Volvo A-30,* and *Euclid B-70* dump trucks are used to haul gravel on grounded ice. *Kenworth Maxihauls* are used to haul gravel on the floating landfast ice.
	Crane	*Manitowoc 888* crane is used to lift and place sheet piles for island reinforcement and pilings for the dock face.
	Vibratory Hammer	*APE 200A* vibratory hammers are used to drive sheet piles, dock piles, thermosiphons, and well casings.
	Impact Hammer	A *DELMAG D62-22 Diesel Impact Hammer* is used to install sheet piles and well casings through frozen surfaces that cannot be penetrated by the vibratory hammer.
Drilling Activities	Drill Rig	Nabors 33e.
Production Operations	Gas Turbines	The turbines (*GE model LM-2500*) operate three *Solar* power generators and two high pressure compressors for gas injection.
	Pumps	Two electrically-powered crude stabilizer pumps and two electrically powered crude sales pumps operate almost continuously. Two electrically-powered water injection pumps operate sporadically.
	Various Equipment	*M777* truck crane, 82-ton link belt truck crane, Polaris six wheeler, Mobile aerial lifting platform, Mechanic box truck, Compactors, Scheuerle trailer model MPEK 5200.

Northstar future transportation of personnel, equipment, and supplies

Transportation needs for the Northstar project will include the ability to safely transport personnel, supplies, and equipment to and from the site during repairs or maintenance, drilling, and operations in an offshore environment. Drilling operations will require the movement of pipe materials, chemicals, and other supplies to the island.

Barges and ACS vessels will be used to transport personnel and equipment from the Prudhoe Bay area to Northstar Island during the open-water season, which extends from mid- to late-July through early- to mid-October. To minimize the potential for conflicts with subsistence users, marine vessels transiting between Prudhoe Bay or West Dock and Northstar Island will travel shoreward of the barrier islands as much as possible, and avoid the Cross Island area during the bowhead hunting season in autumn.

A small hovercraft was first tested in June 2003 for use to transport personnel and supplies to and from Northstar Island during the open-water season; and has been in use since then when weather conditions allowed. The hovercraft will continue to be used to transport personnel and supplies during break-up and freeze-up periods, to reduce helicopter use.

Helicopter access to Northstar Island was an important transportation option during break-up and freeze-up of the sea ice when wind, ice conditions, or other operational considerations prevented or limited hovercraft travel. Helicopters will be used to move personnel and supplies in the fall after freeze-up begins and vessel traffic is not possible, but before ice roads are constructed. Helicopters will also be used in the spring after ice roads are no longer safe for all terrain vehicles, but before enough open water is available for vessel traffic. Helicopters will be available for use throughout the year in emergency situations. Helicopters fly at an altitude of at least 305 m (1,000 ft.), except for take-off, landing, and as dictated for safe aircraft operations, as governed by the Federal Aviation Administration. Designated flight paths are assigned to minimize potential disturbance to wildlife and subsistence users.

Transportation to Northstar Island will continue for the petitioned time period (i.e., January 13, 2017-January 14, 2019) to operate the Northstar facilities. During ongoing field operations equipment and supplies will be transported to the site; island renewal construction may occur and quantities of pipes, vertical support modules, gravel, and a heavy module will be transported to the site.

The future scope of ice-road construction activities during the ongoing production is expected to be similar to the post-construction period (2002-2009). Ice roads allow for the use of standard vehicles such as pick-ups, SUVs, buses, and trucks, to transport personnel and equipment to and from Northstar Island during the ice-covered period. Ice roads are planned to be constructed and used for winter transportation during Northstar operations. The orientation for future ice roads is undetermined, but will not exceed the number of ice roads created during the winter of 2000-2001.

Barges and ACS vessels will be used to transport personnel and equipment from the Prudhoe Bay area to Northstar Island during the open-water season. BPXA intends to continue using the hovercraft in future years. Helicopter access to Northstar Island continues to be an important transportation option during break-up and freeze-up of the sea ice when wind, ice conditions, or other operational considerations prevent or limit hovercraft travel; and during emergencies.

Production operations
The process facilities for the Northstar project are primarily prefabricated sealift modules that were shipped to the island and installed in 2001. The operational aspects of the Northstar production facility include the following: two diesel generators (designated emergency generators); three turbine generators for the power plant, operating at 50 percent duty cycle (i.e., only two operate at any one time); two high pressure turbine compressors; one low pressure flare; and one high pressure flare. Both flares are located on the 66 m (215 ft.) flare tower. Modules for the facility include permanent living quarters (i.e., housing, kitchen/dining, lavatories, medical, recreation, office, and laundry space), utility module (i.e., desalinization plant, emergency power, and wastewater treatment plant), shop/ warehouse module, communications module, diesel storage, potable water storage, and chemical storage. The operational phase of Northstar began with initial drilling in late 2000. Oil production began on October 31, 2001. Operations have been continuing since that time and are expected to continue beyond 2019.

Drilling operations
The drilling rig and associated equipment was moved by barge to Northstar Island from Prudhoe Bay during the open-water season in 2000. Drilling began in December 2000 using power supplied by the installed gas line. The first well drilled was the Underground Injection Control well, which was commissioned for disposal of permitted muds and cuttings in January 2001. After Northstar facilities were commissioned, drilling above reservoir depth resumed, while drilling below that depth is allowed only during the ice covered period. Although future drilling is not specifically planned, drilling additional wells or well work-over may be required at some time during 2014-2019, and it may be necessary to move a drilling rig to and/or from the island during those years.

Pipeline design, inspection, and maintenance
Northstar pipelines have been designed, installed, and monitored to assure safety and leak prevention. Pipeline monitoring and surveillance activities have been conducted since oil production began and BPXA will continue to monitor the pipeline system to assure design integrity and to detect any potential problems through the life of Northstar development. The program will include visual inspections/aerial surveillance and pig inspections.

The Northstar pipelines include the following measures to assure safety and leak prevention:

- Under the pipeline design specifications, the tops of the pipes are 1.8-2.4 m (6-8 ft.) below the original seabed (this is two times the deepest measured ice gouge).
- The oil pipeline uses higher yield steel than required by design codes as applied to internal pressure (by a factor of more than 2.5 times). This adds weight and makes the pipe stronger. The 10-inch diameter Northstar oil pipeline has thicker walls than the 48-inch diameter Trans-Alaska Pipeline.

- The pipelines are designed to bend without leaking in the event of ice keel impingement or the maximum predicted subsidence from permafrost thaw.
- The pipelines are coated on the outside and protected with anodes to prevent corrosion.
- The shore transition is buried to protect against storms, ice pile-up, and coastal erosion. The shore transition valve pad is elevated and set back from the shoreline.

A best-available-technology leak detection system is being used during operations to monitor for any potential leaks. The Northstar pipeline incorporates two independent, computational leak detection systems: 1) the Pressure Point Analysis (PPA) system, which detects a sudden loss of pressure in the pipeline; and 2) the mass balance leak detection system, which supplements the PPA. Furthermore, an independent hydrocarbon sensor, the leak and location system (LEOS) detection method, located between the two pipelines, can detect hydrocarbon vapors and further supplements the other systems.

- Intelligent inspection pigs are used during operations to monitor pipe conditions and measure any changes.
- The elevated overland pipeline section is composed of conventional, proven North Slope design.
- The line is constructed with no flanges, valves, or fittings in the subsea section to reduce the likelihood of equipment failure.

During operations, BPXA conducts aerial forward looking infrared (FLIR) surveillance along the offshore and onshore pipeline corridors at least once per week (when conditions allow), to detect pipeline leaks. Pipeline isolation valves are inspected on a regular basis. In addition to FLIR observations/inspections, BPXA conducts a regular oil pipeline pig inspection program to assess continuing pipeline integrity. The LEOS leak detection system is used continuously to detect under-ice releases during the ice covered period.

The pipelines are also monitored annually to determine any potential sources of damage along the pipeline route. The monitoring work has been conducted in two phases: 1) a helicopter-based reconnaissance of strudel drainage features in early June, and 2) a vessel-based survey program in late July and early August. During the vessel-based surveys, multi-beam sonar, single-beam sonar, and side scan sonar are used. These determine the locations and characteristics of ice gouges and strudel scour depressions in the sea bottom along the pipeline route, and at additional selected sites where strudel drainage features have been observed. If strudal scour depressions are identified, additional gravel fill is placed during the open water season to maintain the sea bottom to original pipeline construction depth.

Routine repair and maintenance
Various routine repair and maintenance activities have occurred since the construction of Northstar. Some activities, such as repairs to the island slope protection berm, could be major repairs that involved using barges and heavy equipment; while other activities will be smaller-scale repairs that involved small pieces of equipment and hand operated tools. The berm surrounding the island is designed to break waves and ice movement before they contact the island work surface, and is subjected to regular eroding action from these forces. The berm and sheet pile walls will require regular surveys and maintenance in the future. Potential repair and

maintenance activities that may be expected to occur at Northstar during 2014-2019include: pile driving, traffic, gravel transport, diving, dock construction and maintenance, and other activities similar to those that have occurred in the past.

Emergency and oil spill response training

Emergency and oil spill response training activities will occur at various times throughout the year at Northstar. Oil spill drill exercises will be conducted by ACS during both the ice-covered and open-water periods. During the ice-covered periods, exercises will be conducted to contain oil in water and detect oil under ice. These spill drills will mostly be on bottom-fast ice and will require snow machines and all-terrain vehicles. The spill drill includes using various types of equipment to cut ice slots or drill holes through the floating sea ice. Typically, the snow is cleared from the ice surface with a Bobcat loader and snow blower that allows access to the ice. Two portable generators are used to power light plants at the drill site. The locations and frequency for future spill drills or exercises will vary depending on the sea ice condition and training needs.

ACS conducts spill response training activities during the open-water season during late July through early October. Vessels used as part of this training typically include Zodiacs, Kiwi Noreens, and Bay-class boats that range in length from 3.7-13.7 m (12-45 ft.). Future exercises could include other vessels and equipment.

ARKTOS amphibious emergency escape vehicles are stationed on Northstar Island. Each ARKTOS is capable of carrying 52 people. Training exercises with the ARKTOS are conducted monthly during the ice-covered period. ARKTOS training exercises are not conducted during the summer.

Equipment and techniques used during oil spill response exercises are continually updated, and some variations relative to the activities described here are to be expected.

Northstar abandonment

Detailed plans to decommission Northstar will be prepared near the end of field life, which will not occur during the period addressed here (2014-2019). Decommissioning will be conducted in accordance with provisions from Federal, State, and local laws, regulations, and permit conditions. In general, the applicable laws and regulations provide for discretion with respect to rehabilitation requirements. This flexibility allows BPXA to consider the environmental effects from decommissioning Northstar, relative to leaving certain facilities in place and other site-specific factors.

Decommissioning may involve removal and salvage of offshore and onshore surface facilities and equipment. Subsurface pipelines may be purged, plugged, and left in place. The gravel island may be abandoned in place with some slope protection removed to allow erosion, or all slope protection kept in place to maintain low sediment release into the surrounding marine environment. The actual method for abandonment will be determined, in association with the responsible agencies, through an assessment of the environmental effects of the alternatives as judged at the future date when these decisions must be made.

Action area

Federal regulations implementing the ESA (50 C.F.R. §402.02) define the action areas 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(s) for the proposed action, there must be some basic understanding of the area over which direct and indirect effects from this action might occur. Based on literature on effects from oil and gas production on migrating bowhead whales, these whales may react to noise as low as 120 decibel (dB). Southall et al. (2007) reviewed literature describing responses of pinnipeds to non-pulsed sound and reported that the limited data suggest exposures between approximately 90-140 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. The action area, for purposes of this biological opinion, is defined as the Alaskan Beaufort Sea that extends from Point Barrow to Demarcation Point and from the Alaska coastline to the edge of the continental shelf. The direct and indirect effects of this action on the endangered bowhead whale, and the threatened bearded and ringed seals, are expected to be confined to the action area.

II. STATUS OF THE SPECIES

NMFS has determined that the endangered bowhead whale and the threatened bearded and ringed seals 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 3).

Table 3 Listing status and critical habitat designation for marine mammal species considered in this opinion.

Species	Stock	Status	Listing	Critical Habitat
Balaena mysticetus	Bowhead whale	Endangered	NMFS 1970, 35 FR 18319	Not designated
Erignathus barbatus nauticus	Beringia DPS of the Pacific Bearded Seal	Threatened	December 28, 2012 77 FR 76740	Not yet proposed
Phoca hispida hispida	Arctic Subspecies of Ringed Seal,	Threatened	December 28, 2012 77 FR 76706	Not yet proposed

This biological opinion will consider the potential effects of these actions on these species. However, the ringed seal is most likely to be affected by BPXA's Northstar operations because this species is regularly found close to Northstar Island, and therefore, subject to noise and disturbance more than bearded seals and bowhead whales. BPXA requested authorization to take five individual ringed seals by injury or mortality annually during the next five years, in the unlikely event that a ringed seal lair is crushed or flooded.

Critical habitat
Critical habitat has not been designated for any of the listed species considered under this opinion. 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 opinion.

Bowhead whale
Information in this section provides updates and, in some cases, summarizes information from previous consultation documents (e.g., NMFS 2010, 2011) and supplements this information with more recent information on the Western Arctic bowhead whale. Key studies include:

1. Bowhead Whale Aerial Survey Project (BWASP)
2. BOwhead Whale Feeding Ecology STudy (BOWFEST), multi-year, multi-disciplinary study
3. Chukchi Offshore Monitoring In Drilling Area (COMIDA), multi-year broad scale aerial survey for marine mammals in Chukchi Sea planning area
4. Bowhead whale satellite tag studies
5. Industry funded studies
6. Stock structure

Documents that summarize current information on bowhead whales:

1. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
2. Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (76 FR 39706, July 6, 2011)
3. Request for Letter of Authorization pursuant to section 101(a)(5) of the MMPA covering 'taking of marine mammals incidental to operations of offshore oil and gas facilities in the U.S. Beaufort Sea (50 C.F.R. Part 216, Subpart R)
4. Biological opinion on the issuance of annual quotas authorizing the harvest of bowhead whales to the Alaska Eskimo Whaling Commission for the period 2008 through 2012 (NMFS 2008)
5. BWASP reports
6. BOWFEST reports
7. COMIDA reports

The International Whaling Commission (IWC) Scientific Committee (SC) has reviewed and critically evaluated new information available on large whales, including the bowhead whales (http://iwcoffice.org/index.htm).

The IWC SC conducted an in-depth status assessment on the bowhead whale population (IWC 2004a, b). In recent years, a considerable amount of research has been conducted on bowhead stock structure as requested by the IWC SC during its 2004 meeting. Results from this research were summarized in George et al. (2009) who wrote that:

> Collectively, these studies have resulted in over 80 research papers and contributed new information on BCB stock structure, but particularly the genetic structure of the BCB bowhead whale population. It should be recognized that these studies add to the baseline of over 30 years of research (resulting in more than 300 IWC SC submitted papers), including an intensive program in the 1970-80s when a similar suite of studies (e.g., aerial and ship based surveys, analysis of commercial whaling records, abundance estimation, harvest documentation, local knowledge, etc.)…was undertaken.

NMFS has reviewed and considered information in these documents and other available information in our evaluation of potential environmental impacts.

NMFS has considered traditional knowledge (also called traditional ecological knowledge or TEK) in preparing this biological opinion. "Observations that form traditional knowledge and scientific observations are independent sources of information that when combined, can increase our depth of knowledge" (Huntington et al. 2004). The knowledge that Alaska Native bowhead whale hunters have about bowhead whale population status, habitat use, behavior, and response to anthropogenic activities is well documented and highly valuable. Thus, NMFS believes traditional knowledge is an essential component that 1) allows for a full understanding about the bowhead whale status in this area and 2) identifies ways that bowhead whales may be affected by the proposed action.

<u>ESA listing history, and status</u>

The bowhead whale was listed as an endangered species under the Endangered Species Conservation Act, the predecessor to the ESA (35 FR 8495, June 2, 1970). The species was then listed as endangered under the ESA in 1973. On February 22, 2000, NMFS received a petition requesting that portions of the U.S. Beaufort and Chukchi seas be designated as critical habitat for the Western Arctic stock (Bering Sea stock) of bowhead whales. On August 30, 2002, NMFS made a determination not to designate critical habitat for this bowhead whale population (67 FR 55767) because: 1) the population decline was due to overexploitation by commercial whaling and habitat issues were not a factor in the decline; 2) the population is abundant and increasing; 3) there is no indication that habitat degradation is having any negative impact on the increasing population; and 4) existing laws and practices adequately protect the species and its habitat.

While five bowhead whale stocks are recognized, the Western Arctic population is the only stock known to occur in the action area. Except as otherwise noted, all further references to bowhead whales in this document concern only the Western Arctic population.

Population and stock structure

The bowhead whale was historically found in all arctic waters of the northern hemisphere. Five populations are currently recognized by the IWC (but see Heide-Jørgensen et al. 2006: and references cited therein, who argued that bowhead whales that summer in eastern Canada and winter in West Greenland, considered the Hudson Bay and Davis Strait stocks, consist of a single population). Three bowhead whale populations are found in the North Atlantic and two populations are in the North Pacific, some or all of which may be reproductively isolated (Shelden and Rugh 1995). The Spitsbergen population is found in the North Atlantic east of Greenland, in the Greenland, Kara, and Barents seas. Once thought to have been the most numerous of bowhead whale populations, Woodby and Botkin (1993) estimate the unexploited population at 24,000 animals; it is now severely depleted, possibly in the tens of animals (Shelden and Rugh 1995).

The Davis Strait population is found in Davis Strait, Baffin Bay, and along the Canadian Arctic Archipelago. This population is separated from the Bering Sea population by the heavy ice found along the Northwest Passage (Moore and Reeves 1993). The population was estimated to have originally numbered more than 11,700 animals (Woodby and Botkin 1993), but was significantly reduced by commercial whaling during 1719-1915. The population is now estimated at 350 animals (Zeh et al. 1993) and recovery is described as "at best, exceedingly slow" (Davis and Koski 1980).

The Hudson Bay population, also found in Foxe Basin, is differentiated from the Davis Strait population by their summer distribution, rather than genetic or morphological differences (Reeves et al. 1983). No reliable estimate exists for this population; however, a conservative population is estimated at 100 animals or less. More recently, estimates of 256-284 whales have been presented for the whale population within Foxe Basin. There has been no appreciable recovery of this population.

The Okhotsk Sea population occurs in the North Pacific, off the west coast of Siberia near the Kamchatka Peninsula. The pre-exploitation size of this population may have been 3,000-6,500 animals (Shelden and Rugh 1995); and may now range 300-400 animals, 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 Western Arctic bowhead whale has the largest population of all surviving bowhead populations and is the only stock that inhabits U.S. waters. Many other stocks are likely small. Thus, available data indicate the viability of bowhead whales in the Western Arctic stock is highly important to the long term future of the biological species as a whole.

While all questions regarding genetic distinctions have not been resolved, the best available information indicates that bowhead whales that may occur in the Bering, Chukchi, and Beaufort seas, including in the action area, are probably part of a single population of Western Arctic stock bowhead whales. Hence, it is likely that a single bowhead whale population is affected by the proposed action.

Abundance and trends

Woodby and Botkin (1993) estimated the historic population abundance for bowhead whales in the Western Arctic stock was 10,400-23,000 whales in 1848, before commercial whaling severely depleted the whales. They estimated that 1,000-3,000 animals remained in 1914 near the end of the commercial whaling period.

Based on both survey data and the incorporation of acoustic data, the current Western Arctic bowhead whale abundance was estimated at 11,836 whales (95 percent CI; 6,795- 20,618 whales), an estimate that is consistent with trends in abundance estimates made from ice-based counts (Allen and Angliss 2011). George et al. (2004) reported that the Western Arctic bowhead whale stock has increased at a rate of 3.4 percent (95 percent CI; 1.7-5 percent) from 1978-2001, during which time abundance doubled from approximately 5,000-10,000 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. The increase in the estimated population size most likely is due to a combination of improved data and better census techniques, along with an actual increase in the population.

This steady recovery is likely due to low anthropogenic mortality, a relatively pristine habitat, and a well-managed subsistence hunt (George et al. 2004). Based on capture-recapture statistical analysis, with the "capture" of 4,894 putative individuals obtained from 10 years of photographic surveys conducted during the spring migration period past Barrow, the yearly growth rate was derived as 3.2 percent. Attempts to count migrating whales near Point Barrow in 2009 and 2010 were unsuccessful due to sea ice conditions, resulting in no new estimates of abundance. The most recent abundance estimate, based on surveys conducted in 2001, is 10,545 (CV = 0.128) (Allen and Angliss, 2011), similar to previous estimates.

The Western Arctic bowhead whale abundance was based on photo-identification data collected in 2003-2005 for use in capture-recapture analyses, with accounting in the analyses for unmarked whales. This work was reviewed by the IWC SC Subcommittee on bowhead, gray, and right whales in 2009. This subcommittee agreed the 2004 abundance estimate for Western Arctic bowhead whale stock was 11,800 whales (95 percent CI; 7,200-19,300 whales; CV = 0.255), an acceptable estimate for the Western Arctic stock abundance; and was suitable to use in the bowhead whale Strike Limit Algorithm applied in setting acceptable harvest levels.

As discussed above, all available information indicates that the Western Arctic bowhead whale population is currently increasing and may have reached the lower limit of the population size estimate that existed prior to intensive commercial whaling.

Reproduction, survival, and sources of mortality

Information gained from the various approaches to age the Western Arctic bowhead whales and estimate their survival rates all suggest that bowhead whales are slow growing, late maturing, long lived animals, with survival rates that are currently high (Zeh et al. 1993).

Female bowhead whales probably become sexually mature at an age exceeding 15 years, from their late teens to mid-20's (Koski et al. 1993) and about 20 years (Schell and Saupe 1993). Their size at sexual maturity is about 12.5-14.0 m (41-46 ft.) long, probably at an age exceeding 15 years or 17-29 years (IWC 2004b). Most males probably become sexually mature at about 17-27 years (IWC 2004b). Schell and Saupe (1993) looked at baleen plates as a means to determine the bowhead whale age and concluded that bowhead whales are slow growing, taking about 20 years to reach breeding size. Based on population structure and dynamics, Zeh et al. (1993) also concluded that the bowhead is a late maturing, long lived animal (George et al. 1999), with fairly low mortality. Photographic recaptures by Koski et al. (1993) also suggested advanced age at sexual maturity, into late teens to mid-twenties.

Mating may start as early as January and February, but was reported as late as September and early October (Koski et al. 1993). The model by Reese et al. (2001) indicated that conception likely occurs in early March to early April, which suggests that breeding occurs in the Bering Sea. Gestation has been estimated to range between 13-14 months (Nerini et al. 1984; Reese et al. 2001) and between 12-16 months (Koski et al. 1993, IWC 2004b). Reese et al. (2001) developed a nonlinear model for fetal growth in bowhead whales to estimate the length of gestation, with the model indicating an average length of gestation at 13.9 months. Data indicate most calving occurs during the spring migration when whales are in the Chukchi Sea. Some calving likely occurs in the Beaufort spring lead system. Koski et al. (1993) reported that calving occurs from March to early August, with the peak probably occurring between early April and late May (Koski et al. 1993). The conception date and gestation suggests that calving is likely to occur in mid-May to mid-June, when whales are between the Bering Strait and Point Barrow (Chukchi Sea). Reese et al. (2001) said this is consistent with other observations in the region, including: 1) relatively few cow-neonate pairs reported by whalers at Saint Lawrence Island; 2) many neonates seen during the whale census in late May; 3) relatively few term females taken at Barrow; 4) harvested females with term pregnancies appeared close to parturition; and 5) most bowhead whales are believed to have migrated past Barrow by late May. Females give birth to a single calf, probably every 3-4 years.

There is little information regarding causes of mortality for Western Arctic bowhead whales. Bowhead whales have no known predators except, perhaps, killer whales and subsistence whalers. The frequency of killer whale attacks probably is low (George et al. 1994). Bowhead whales have been hunted by humans for millennia and remain a fundamental subsistence resource for many northern coastal hunters and communities. The number of bowhead whales landed at each village varies greatly from year to year as success is influenced by village size; and ice and wind conditions, which impact hunter access to the whales. Alaska Native subsistence hunters take approximately 0.1-0.5 percent of the population per year, primarily from ten Alaska communities; where the number of kills ranged between 14-72 animals per year (Allen and Angliss 2011).

A relatively small number of whales likely die because they are entrapped in ice (Philo et al. 1993). Little is known about the effects of microbial or viral agents on natural mortality. Several cases of rope or net entanglements have been reported from whales taken in the subsistence harvest, but the average annual entanglement rate in the U.S. commercial fisheries is currently unknown (Allen and Angliss 2011).

The discovery of traditional whaling tools recovered from five bowhead whales landed since 1981 (George et al. 1995) and age estimates using aspartic acid racemization techniques (George et al. 1999) both suggest bowhead whales can live a very long time, in some instances more than 100 years. The oldest harvested females, whose ages were estimated using corpora albicans accumulation to estimate female age, were more than 100 years old (George et al. 2004). Five whales out of 84 whales landed were aged using aspartic acid racemization and exceeded 100 years old. The oldest whale was estimated to be 178 years old. Discussion in the IWC (2004b) indicated that neither lifespan nor age at sexual maturity is certain. Lifespan may be greater than the largest estimate.

Using aerial photographs from naturally marked bowhead whales collected in 1981-1998, Zeh et al. (2002) estimated "the posterior mean for bowhead survival rate…is 0.984, and 95 percent of the posterior probability lies between 0.948 and 1." They noted that a high estimated survival rate is consistent with other bowhead life history data.

<u>Migration, distribution, and habitat use</u>

The Western Arctic bowhead whales generally occur north of 60° N. and south of 75° N. latitude (Allen and Angliss 2011) 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.

Winter

Bowhead whales from 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 feeding amount in the Bering Strait during the fall (Richardson and Thomson 2002). Previously, Moore and Reeves (1993) concluded that, in the Bering Sea, bowhead whales 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 Saint Matthew Island, and near Saint Lawrence Island. Bowhead whales congregate in these polynyas before migrating north (Moore and Reeves 1993). However, recent satellite tag data (ADFG unpublished data) also show whales in ice covered habitats, in locations distant from major polynyas.

Observations by Mel'nikov et al. (1997) from shore based observations of waters adjacent to the Chukotka Peninsula in 1994-1995 indicate that bowhead whales spend winter in the Bering Sea along leads and polynyas adjacent to the Asian coastline. Mel'nikov et al. (1997) summarized that in years when there is little winter ice; bowhead whales inhabit the Bering Strait, and potentially inhabit southern portions of the Chukchi Sea.

Spring

Some, or nearly all (see stock discussion above), bowhead whales 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, depends on the ice conditions) and early May. It is thought to happen after the peak breeding season, which is believed to occur in March-April (IWC 2004b). Based on shore based surveys in 1999-2001, Mel'nikov et al. (2004) observed that the start of the spring migration from the Gulf of Anadyr varies between cold and mild years by up to 30 days, but in both instances, continues at least until 20 June. Mel'nikov et al. (2004) also reported that weather influenced migration, with migration seeming to stop when there were storms or high winds in the western Bering Strait or at the exit from the Gulf of Anadyr. Bowhead whales migrate up both the eastern and western Bering Strait in the spring (Mel'nikov et al. 1997; Mel'nikov et al. 2004). They pass through the Bering Strait and eastern Chukchi Sea from late March to mid-June through newly opened leads in the shear zone, between the shore fast ice and the offshore pack ice. During spring aerial surveys in the late 1980s, bowhead whales were observed migrating in shore fast leads and polynyas up the coast of northwestern Alaska (Mel'nikov et al. 1997).

Alaska Native whaling captains from Wainwright reported that "In the past, bowhead whales first arrived at Wainwright in late April, but . . . now they appear in the area in early April and at times even in March. Most whales have passed by in early June" (Quakenbush and Huntington 2010). In spring 2010, the first bowhead of the season was observed near Barrow on March 24, 2010; and a few whales continued to be seen the first week of April.[4] Hunters reported that ice conditions determined local distribution and when leads near Wainwright are closed, whales travel farther offshore. They reported that whales often follow the shore fast ice edge, but they may also stay farther offshore and travel directly between Icy Cape and Point Belcher areas. Areas between Icy Cape and Point Franklin were identified by whaling captains as areas where feeding, calving, and mating have been observed (Quakenbush and Huntington 2010).

Whaling captains from Wainwright also reported that bowhead whales have occasionally been observed in June and July after shore fast ice, near Wainwright, has broken up. In 2007, a large whale was spotted near Point Franklin in June, and many large whales were seen in July. Observations from about 35 years ago report three very large bowhead whales near the mouth of the Kuk River in July, which suggests that such occurrence is not a brand new phenomenon, but may be the normal range of variability in habitat use for this area.

Several studies on acoustical and visual comparisons from the bowhead's spring migration off Barrow indicate that bowhead whales may also migrate under ice within several kilometers of the leads. Data from several observers indicate that bowhead whales migrate underneath ice and can break through ice 14-18 cm (5.5-7 in) thick to breathe (George et al. 1989; Clark et al.1986). Bowhead whales may use cues from ambient light and echoes from their calls to navigate under ice and to distinguish thin ice from thick ice (multiyear floes). After passing by Barrow from April through mid-June, the whales move easterly through or near offshore leads. East of Point Barrow, the lead systems divide into many branches that vary in location and extent from year to year. The spring migration route is offshore of the barrier islands in the central Beaufort Sea. The route follows a corridor centered at 71º30'N latitude, and broadly occurring between latitude 71º20'N and 71º45'N (Ljungblad et al. 1983; Braham et al. 1984; Richardson et al. 1995a). No bowhead whales are expected to occur within 75 km (46 mi) of Northstar during the spring migration period.

[4] J.C. George, North Slope Borough, personal communication, 2010.

The migration past Barrow occurs in pulses in some years (e.g., in 2004) but not in other years (e.g., 2003) (IWC 2004b), with temporal segregation by size class (Angliss and Outlaw 2005; Quakenbush and Huntington 2010). At Barrow, the first migratory pulse is typically dominated by subadults. This pattern changes and by the migration's end, adults constitute most bowhead whales passing Barrow. The last whales to pass Barrow tend to be females that are accompanied by calves (Angliss and Outlaw 2005; Koski and Miller 2009; NSB unpublished data).

Wainwright whaling captains reported that young and mid-sized whales require open leads or ponds and that, if leads close up, whales may delay migration. They reported that bowhead whales may congregate in pools as they wait for better conditions. These captains reported that the third wave, which consists of the largest whales and female and calf pairs, occurs in the last half of May and early June. They reported that these whales can push through young ice (to approximately 45 cm (18 in)) and are able to migrate when leads are closed. Wainwright whaling captains reported that "[w]hales in the third wave may also be found in cracks and openings far out in the pack ice" (Quakenbush and Huntington 2010).

Traditional ecological knowledge and satellite tag data both indicate that near shore lead areas are very important migration areas and that some near shore areas are used for feeding and calving (Quakenbush and Huntington 2010).

Summer

Satellite tag studies, data from small boat surveys near Barrow, and other new data suggest the paradigm that underlay previous management that thought all bowhead whales round the corner at Point Barrow, swim east across the leads to Canadian waters, and stay there until "a fall migration begins" from the Canadian Beaufort (around September 1); which oversimplified a more complex and varied pattern. For example, tag data demonstrate that bowhead whales may be in the ice leads northeast of Barrow in mid-June to mid-July, transit to the Camden Bay area and Canadian Border from the east and west in late July, move from mid-Beaufort halfway across the Chukchi in mid-August. Data from the Barrow based boat surveys showed that bowhead whales 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 with large numbers of feeding whales east of Point Barrow later in August into September. These new data add to previous observations of bowhead whales near Barrow, in the central Beaufort Sea, or in the Chukchi Sea during the summer.

Bowhead whales were observed in the Barrow area during the middle of summer, when hunters were hunting bearded seals along the ice edge. The 2002 monitoring program conducted while towing the single steel drilling caisson to the McCovey Prospect location recorded five bowhead whales off Point Barrow on July 21, 2002.

Some biologists conclude that almost the entire Bering Sea bowhead whale population migrates to the Beaufort Sea each spring and that few whales, if any, summer in the Chukchi Sea. However, incidental sightings suggest that bowhead whales may occupy the Chukchi Sea in the summer more regularly than commonly believed. Moore (1992) summarized bowhead whale observations in the northeastern Chukchi Sea in late summer. Other scientists maintain that a few bowhead whales swim northwest along the Chukotka coast in late spring and summer in the Chukchi Sea. Natives living along the coast of Russia and other observers have long reported bowhead whale observations during the summer along the Chukotka Peninsula. Current data are not available to estimate abundance, typify spatial and temporal patterns of use, or determine if individual bowhead whales show strong site fidelity to this area.

While sample sizes from the tagging study are insufficient to draw broad conclusions about relative distribution, it is clear from all data sources that bowhead whales may be in the U.S. Beaufort and the Chukchi seas during spring, summer, and fall. They may also occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore 1992).

Autumn
The bowhead whales that feed during the summer in the Canadian Beaufort Sea begin moving westward into Alaskan waters in August and September. Although few bowhead whales are seen in Alaskan waters until the major portion of the migration takes place (typically mid-September to mid-October), in some years bowhead whales are present in substantial numbers in early September (Greene and McLennan 2001; Treacy 1998). Treacy (1998) observed 170 bowhead whales, including six calves, between Cross Island and Kaktovik on September 3, 1997 on a survey flight. A large concentration of bowhead whales was observed between Barrow and Cape Halkett in mid-September 1997 (Treacy 1998). Bowhead whales were still present in large numbers between Dease Inlet and Barrow in early October 1997, although they may not have been the same individuals (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 during the fall migration (Moore and Reeves 1993).

Inupiat whalers estimate that bowhead whales take about two days to travel from Kaktovik to Cross Island, reaching the Prudhoe Bay area in the central Beaufort Sea by late September; and five days to travel from Cross Island to Point Barrow (NMFS 1999).

Bowhead whales are capable of traveling rapidly. Based on tagging data, Heide-Jørgensen et al. (2006) showed that, at least in the Atlantic, bowhead whales travel long distances (more than 1,000 km (621 mi)) in relatively short periods of time (7-10 days). Mate et al. (2000) tagged 12 juvenile bowhead whales with satellite monitored radio tags in the Canadian Beaufort Sea. The whale with the longest record traveled about 3,886 km (2,415 mi) from Canada, across the Alaskan Beaufort Sea, to the Chukchi Sea off Russia, and averaged 5.0 km/hour (3.1 mi/hour). The whale's speed was faster, though not significantly faster, in heavy ice than in open water.

Oceanographic conditions can vary during the fall migration from open water to more than nine-tenths ice coverage. The extent of ice cover may influence the fall migration's timing or duration. Miller et al. (1996) observed that whales within the Northstar region (147°-150° W. longitude) migrate closer to shore in light and moderate ice years, and farther offshore in heavy ice years, with median distances offshore at 30-40 km (19-25 mi) in both light and moderate ice years, and 60-70 km (37-43 mi) in heavy ice years. Moore et al. (2000) looked at bowhead whale distribution and habitat selection in heavy, moderate, and light ice conditions in data collected during autumn 1982-1991. This study concluded that bowhead whales select shallow inner shelf waters during moderate and light ice conditions, and deeper slope habitat in heavy ice conditions. During the summer, bowhead whales selected continental slope waters and moderate ice conditions (Moore et al. 2000). Inter-seasonal depth and ice cover habitats were significantly different for bowhead whales. Ljungblad et al. (1988) observed in the years 1979-1986 that: 1) the fall migration extended during a longer period; 2) higher whale densities were estimated; and 3) daily sighting rates were higher and peaked later in the season in light ice years as compared to heavy ice years.

Aerial surveys near the Liberty development project in 1997 (BPXA 1998) showed that the primary fall migration route was offshore of the barrier islands, outside the development area. Some bowhead whales may swim inside the barrier islands during fall migration. For example, there was a report that whales were seen inside the barrier islands near Cross Island nearly every year, and are sometimes observed between Seal Island and West Dock (USACE 1999). A relatively small number of bowhead whales have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; Greene 1997a; Greene et al. 1999; Blackwell et al. 2009), with most bowhead whales passing by Northstar Island in September. Consistent with this, Nuiqsut whalers have stated that the earliest arriving bowhead whales have apparently reached the Cross Island area earlier in recent years than formerly.

While factors such as prey concentrations, seismic activities, and localized vessel traffic may have dominating effects on site specific distributions, broad-area fall distributions of bowhead whale sightings in the central Beaufort Sea may be driven by overall sea ice severity (Treacy 2001). Treacy (2002) concluded that:

> Bowhead whales occur farther offshore in heavy-ice years during fall migrations across the Central Alaskan Beaufort Sea (142° W to 155° W longitudes). Bowheads generally occupy nearshore waters in years of light sea-ice severity, somewhat more offshore waters in moderate ice years, and are even farther offshore in heavy ice years. While other factors . . . may have localized effects on site-specific distributions, broad-area distributions of bowhead whale sightings in the central Alaskan Beaufort Sea are related to overall sea-ice severity.

Data are limited on the bowhead whale fall migration through the Chukchi Sea before the whales move south into the Bering Sea. IWC (2004b) reported that bowhead whales pass through the Bering Strait into the Bering Sea during October and November on their way to overwintering areas in the Bering Sea. Whaling captains from Wainwright reported that bowhead whales do not typically follow the Alaska coast southward in the autumn, but they have been seen a few times near Wainwright in October. Bowhead whales are commonly seen from the coast to about 150 km (93 mi) offshore between Point Barrow and Icy Cape, suggesting that most bowhead whales disperse southwest after passing Point Barrow and cross the central Chukchi Sea, near Herald Shoal, to the northern coast of the Chukotka Peninsula.

Sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. Mel'nikov et al. (1997) argued that data suggest that after rounding Point Barrow, some bowhead whales head for the northwestern coast of the Chukotka Peninsula, while others proceed primarily in the direction of the Bering Strait and into the Bering Sea. It was reported that abundance increased along northern Chukotka in September, as whales come from the north (Mel'nikov et al. 1997). More whales are seen along the Chukotka coast in October. The timing, duration, and location of the fall migration along the Chukotka Peninsula are highly variable and are linked to freeze up (Mel'nikov et al. 1997). Whales migrate in "one short pulse over a month" in years with early freeze up, but when ice formation is late, whales migrate during a 1.5-2 month period in two pulses (Mel'nikov et al. 1997).

During their southward migration in the autumn, bowhead whales pass through the Bering Strait in late October through early November, or later (e.g., tag data indicate some may linger into January; ADFG unpublished data), on their way to overwinter in the Bering Sea.

Foraging ecology

Bowhead whales filter prey from the water through baleen fibers in their mouth. They apparently 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 and conversely may occur in coordinated echelons with more than a dozen animals (Würsig et al. 1989). Prey items most commonly found in the stomachs from harvested bowhead whales include euphausiids, copepods, mysids, and amphipods. Euphausiids and copepods are thought to be their primary prey. Lowry et al. (2004) documented that other crustaceans and fish also were eaten, but were minor components in samples consisting mostly of copepods or euphausiids.

It is likely that bowhead whales continue to feed opportunistically where prey is available as they move through or about the Alaskan Beaufort Sea. Feeding is more prevalent or at least better documented during summers in the Canadian Beaufort, and in the autumn (Lowry et al. 2004), than in the spring.

Observations from the 1980s documented that some feeding occurs during the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (Ljungblad et al. 1988; Carroll et al. 1987). Stomach contents from bowhead whales harvested between Saint Lawrence Island and Point Barrow during April into June indicated it is likely that some whales feed during the spring migration (Carroll et al. 1987; Shelden and Rugh 1995). Carroll et al. (1987) reported that the region west of Point Barrow seems to be particularly important for feeding, at least in some years, but whales feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant prey. Lowry (1993) reported that the stomachs of 13 out of 36 (36 percent) spring migrating bowhead whales harvested near Point Barrow between 1979-1988 contained prey items. Lowry estimated total volumes of stomach contents ranged from less than 1-60 liters (L), with an average of 12.2 L in eight specimens. Shelden and Rugh (1995) concluded that "[i]n years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring" (Carroll et al. 1987). Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring.

Lee at al. (2005) published data on isotope ratio analyses from bowhead whales, where all but one whale was harvested in autumn 1997. Results from these samples were compared to data from baleen collected in past studies from both spring (predominantly) and autumn whales in 1986-1988 (Lee et al. 2005). Lee et al. (2005) concluded that the new data continue to indicate that "bowhead whale population acquires the bulk of its annual food intake from the Bering-Chukchi system . . . . Our data indicate that they acquire only a minority of their annual diet from the eastern and central Beaufort Sea . . . although subadult bowheads apparently feed there somewhat more often than do adults."

One source of uncertainty that affected the analyses related to bowhead whale energetics is that the amount of feeding in the Chukchi Sea and Bering Strait in the autumn is unknown, as is the amount of feeding in the Bering Sea in the winter (Richardson and Thomson 2002). In mid to late fall, at least some bowhead whales feed in the southwest Chukchi Sea. Detailed feeding studies have not been conducted in the Bering Sea during the winter.

Thomson et al. (2002) offered a feeding scenario, parts of which are speculative, that might be consistent with new data. In this scenario, feeding occurs commonly in the Beaufort Sea during summer and early autumn, where bowhead whales gain energy stores. However, zooplankton availability is not as high in the Beaufort Sea during summer as in the Chukchi and northern Bering seas during autumn. Also, feeding in the western Beaufort in autumn effectively may be on Chukchi prey advected to that area. Thus, bowhead whales might acquire more energy from Bering and Chukchi seas prey in autumn, than from eastern and central Beaufort Sea prey in summer and early autumn. Given this, plus an assumed low turnover rate of body components, the overall body composition for bowhead whales may be dominated by components from the Bering and Chukchi seas system, even at the end of the summer when they leave the Beaufort Sea. Energy gained in the Beaufort and Chukchi seas during summer and fall presumably is used during winter when prey availability is low, resulting in reduced girth and energy stores when returning to the Beaufort Sea in spring.

Richardson and Thomson (2002) pointed out that the isotopic, behavioral, and stomach content data might not be in conflict, if prey availability in the Chukchi and/or Bering seas were "notably better" than in the eastern Beaufort Sea. However, they also point out that: "it is difficult to understand why bowhead whales would migrate from the Bering and Chukchi seas area to the Beaufort Sea, if feeding in the Beaufort Sea were unimportant." Richardson and Thomson (2002) noted that while the study has provided many new data about bowhead whale feeding ecology and related biology, "there are still numerous approximations, assumptions, data gaps, and variations of opinion regarding the interpretation of data. This is inevitable . . . . The authors do not claim that the project has resolved all uncertainty about the importance of the eastern Alaskan Beaufort Sea for feeding by bowhead whales . . . ."

Vocalizations and hearing

Bowhead whales are believed to be most sensitive to lower frequency sound. It may be reasonable that whales are most sensitive to noise at the frequencies at which they vocalize. Most bowhead calls are at 50-400 Hz, although components may reach as low as 35 Hz or as high as 5 kHz (Burns et al. 1993). Bowhead produce various types of vocalizations, described as: frequency modulated tonal calls in the 50-300 Hz range; complex calls that include pulsed sounds, squeals, and growl type sounds with abundant harmonic content; and call sequences. Bowhead whales are known to sing during spring migrations. Source levels for bowhead whale calls have been estimated as high as 180-189 dB. In addition to communicating with others, bowhead whales may use vocalizations to maintain cohesion in migrations or to locate ice in order to migrate through the spring leads in the Chukchi and Beaufort seas. Bowhead whale vocalizations and hearing remain poorly understood, although call duration, frequency, and type appear dependent on the whale's life history, age, gender, behavior, time of year, and outside stimuli, such as industrial noise.

No studies have directly measured the sound sensitivity for bowhead whales. In a study on the morphology of the mysticete auditory apparatus, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing. Southall et al. (2007) assigned bowhead whales to the low frequency cetacean functional hearing group. This group has an estimated auditory bandwidth at 7 Hz-22 kHz. As is the case for all mysticetes, direct data on bowhead whale hearing sensitivity is not available, and so it has been estimated based on: behavioral responses to sounds at various frequencies; favored vocalization frequencies; body size; ambient noise levels at favored frequencies; and cochlear morphometry.

Since the start of construction and initial operations at BPXA's Northstar facilities in 2000, acoustic monitoring methods have been used to characterize the late summer/early autumn migration of bowhead whales past Northstar Island. An array of bottom-mounted acoustic recorders with direction-finding capability has been deployed 6-22 km (4-14 mi) seaward of Northstar Island in 2001-2004 (Greene et al. 2004; Blackwell et al. 2006). These recorders have determined the locations of large numbers of calling whales during the late summer/early autumn seasons in 2000-2004. The offshore distribution for these calling bowhead whales has been analyzed in relation to the variable level of underwater sound emanating from Northstar itself and (especially) it's supporting vessels (Richardson et al. 2008a, McDonald et al. 2008). A confounding factor in using calling bowhead whales to determine changes in distribution in relation to sounds from Northstar is that any apparent displacement effect may be partly or wholly an effect to changes in calling behavior, rather than an actual change in distribution. To the extent that there is offshore displacement of bowhead whales as a result of Northstar Island, it is challenging to detect and involves only a small proportion of the passing bowhead whales. Acoustic monitoring has continued since 2005, with increasing call detection rates during years with lower ice conditions because whales migrate closer to shore (Richardson 2007, 2008a; Aerts and Richardson 2008, 2009).

Bearded seal

This section provides information on the threatened Beringia DPS of the bearded seal. Key reports include:

1. Status review of the bearded seal (*Erignathus barbatus*) (Cameron et al. 2010)
2. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
3. Request for Letter of Authorization pursuant to section 101(a)(5) of the MMPA covering 'taking of marine mammals incidental to operations of offshore oil and gas facilities in the U.S. Beaufort Sea (50 C.F.R. Part 216, Subpart R)
4. Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (76 FR 39706, July 6, 2011)
5. Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (79 FR 3347, January 21, 2014)
6. Industry funded studies

ESA listing history and status

NMFS received a petition to list bearded seals (*Erignathus barbatus)* as threatened or endangered under the ESA (73 FR 51615, September 4, 2008). Based on the findings from the status review report and consideration of the factors affecting these subspecies, we concluded that *Erignathus barbatus nauticus* consists of two distinct population segments (DPSs): 1) Beringia DPS, which are found in Alaska waters; and 2) Okhotsk DPS, which are found in Russian waters. On December 10, 2010 NMFS proposed to list the two subspecies of bearded seals as threatened under the ESA (75 FR 77496). On December 28, 2012 NMFS listed both the Beringia and Okhotsk DPS bearded seal as threatened under the ESA (77 FR 76740).

Population and stock structure

Early estimates of the Bering and Chukchi seas bearded seal population range from 250,000-300,000 seals (Popov 1976, Burns 1981). Surveys flown from Shishmaref to Barrow during May and June 1999 and 2000 resulted in an average density of 0.07 seals/km^2 (0.03 mi^2) and 0.14 seals/km^2 (0.05 mi^2) respectively, with consistently high densities along the coast to the south of Kivalina (Bengtson et al. 2005). These densities cannot be used to develop an abundance estimate because no correction factor is available. The Alaska stock of bearded seals, which occupy the Bering, Chukchi, and Beaufort seas, may consist of approximately 155,000 individuals (Cameron 2010). No reliable estimate of bearded seal abundance is available for the Beaufort Sea (Angliss and Allen 2011).

Reproduction, survival, and sources of mortality

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). Bearded seals vocalize during the breeding season, with a peak in calling during and after pup rearing (Cameron et al. 2010). Building evidence, especially from new acoustic technologies and captive studies, indicates these calls originate only from males (Cameron et al. 2010). 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 (19 mi), are up to 60 seconds in duration, and are usually associated with stereotyped dive displays (Cameron et al. 2010). Male vocalizations are believed to advertise mate quality to females, signal competing males of a claim on a female, or proclaim a territory.

Recent studies in the shore leads in the Chukchi Sea, Alaska have suggested site fidelity of males within and between years supporting earlier claims that males defend aquatic territories (Cameron et al. 2010). Males that exhibit territoriality maintain a single core area (less than 12 km^2 (4.6 mi^2)), a strategy that is contrasted by males that “roam” and call across several larger core areas (Van Parijs et al. 2003, Van Parijs et al. 2004, Van Parijs and Clark 2006, Risch et al. 2007). The efficacy of territorial versus roaming strategies is thought to be related to differences in ice regimes, as shown by inter-annual differences at Svalbard Archipelago and when comparing Svalbard with the Chukchi Sea. At the Svalbard Archipelago, more predictable ice conditions favor territorial males (71 percent), whereas in the coastal Chukchi Sea, less stable ice favors roaming males (66 percent) (Van Parijs et al. 2004, Van Parijs and Clark 2006). Males with a higher proportion of “moving territories” were also noted in the Bering Strait (Burns 1967). Hence, largely unstable and seasonally-dynamic ice habitat, in concert with highly mobile females in estrus, may support alternative mating systems in bearded seals (Van Parijs 2003). Serial monogamy would be favored where sea ice is more predictable, allowing a territorial male to pair-bond with a female (on the ice and/or by claiming the water around the female), mate, and then find another female. At Svalbard Archipelago, only territorial males (i.e., no roamers) were present when there was more than 60 percent land-fast ice (Van Parijs et al. 2004), and promiscuity in both males and females would be more common when unstable ice favors a roaming strategy (Van Parijs and Clark 2006). 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).

During the winter and spring, as sea ice begins to break up, perinatal females find broken pack ice over shallow areas on which to whelp, nurse young, and molt (Burns 1981). Although parturition has been reported by Eskimo hunters to occur occasionally in the water (Vibe 1950, Burns 1967), bearded seals are considered to use ice as their birthing platform (Reeves et al. 1992, Kovacs et al. 1996). A suitable ice platform is likely a prerequisite to whelping, nursing, and rearing young (Cameron et al. 2010). Despite descriptions of pups occurring throughout the species’ range, the timing and relative importance of specific areas for whelping (and subsequent nursing, breeding, and molting) is poorly known because quantitative surveys are lacking.

In the eastern Canadian Arctic, the winter and pre-whelping distribution of bearded seals is largely associated with the location of polynyas and shore leads (Stirling et al. 1981). These wintering grounds are presumed to represent staging areas for females prior to whelping, because these locations host mothers with dependent pups in the spring.

After a female is fertilized, the blastocyst stays dormant for approximately 2-2.5 months until June to mid-August when implantation occurs (Chapskii 1938, McLaren 1958b, Burns 1967, Burns 1981). In phocids, blastocyst implantation occurs during molting. A female’s nutritional and molting status may affect the levels of hormones (e.g., estrogen) required to reactivate the embryo (Ling 1970, Reijnders 1990, Atkinson 1997). Gestation lasts nine months. At parturition, female bearded seals have expended about a third of the anticipated total investment in a weaned pup, which is average for ice-associated species in the North Atlantic (Lydersen and Kovacs 1999).

There is little information regarding causes of mortality for bearded seals in Alaska. Bearded seals are preyed upon by polar bears, possibly killer whales, and subsistence hunters. Although polar bears frequently capture bearded seals, the frequency of killer whale attacks probably is low. Bearded seals have been hunted by humans for millennia and remain a fundamental subsistence resource for many northern coastal hunters and communities. 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 bearded seal subsistence harvest is 6,788 seals (Allen and Angliss 2011). Although subsistence harvest of the Arctic subspecies is currently substantial in some regions, harvest levels appear to be sustainable.

Little is known about the effects of microbial or viral agents on natural mortality. During 2007-2009 there were several cases of fisheries entanglements that resulted in serious injuries and mortalities of bearded seal in the Bering Sea/Aleutian Island pollock trawl and the Bering Sea/Aleutian Island flatfish trawl fisheries. The estimated minimum mortality rate incidental to commercial fisheries is 2.70 (CV = 0.21) bearded seals per year, based exclusively on observer data (Allen and Angliss 2011).

Distribution and habitat use

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently, bearded seals are less abundant during winter. From mid-April to June, as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During summer, they are found near the widely fragmented margin of multi-year ice that covers the continental shelf of the Chukchi Sea, and in nearshore areas of the central and western Beaufort Sea. In the Beaufort Sea, bearded seals rarely use coastal haul outs. In some areas, bearded seals are associated with the ice year-round; however, because they are primarily benthic feeders, they usually move shoreward into open water areas when the pack ice retreats to areas with water depths greater than 200 m (656 ft.). During the summer, when the Bering Sea is ice-free, the most favorable bearded seal habitat is found in the central or northern Chukchi Sea along the margin of the pack ice. Suitable habitat is more limited in the Beaufort Sea where the continental shelf is narrower, and the pack ice edge frequently occurs seaward of the shelf and over water too deep for feeding. The preferred habitat in the western and central Beaufort Sea during the open water period is the continental shelf seaward of the scour zone.

During the late winter/spring period, the Northstar area is covered by landfast ice, which bearded seals tend to avoid, as they prefer areas of moving ice and open water in depths of less than 200 m (656 ft.) (Mansfield 1967; Burns and Harbo 1972). However, bearded seals have been observed maintaining breathing holes in annual ice and have even been observed hauling out from the same holes as ringed seals (Mansfield 1967; Stirling and Smith 1977). Small numbers of bearded seals have been reported in the Northstar area. The number of bearded seals that were seen in the landfast ice around Northstar during spring aerial surveys from 1997-2002 ranged from 0-15 animals (Moulton et al. 2003b).

Foraging ecology

The bearded seal is the largest in size of the northern phocids. The diving behavior for 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). Unlike walrus that “root” in the soft sediment for benthic organisms, bearded seals are believed to “scan” the surface of the seafloor with their highly sensitive whiskers, burrowing only in the pursuit of prey (Marshall et al. 2006). Bearded seals prefer areas of water no deeper than 200 m (656 ft.), although adult dives have been recorded up to 300 m (984 ft.) and young-of-the-year have been recorded diving down to almost 500 m (1,640 ft.) (Gjertz 2000). Bearded seals have occasionally been reported to maintain breathing holes in the sea ice and they do occupy areas with pack ice, particularly if the water depth is more than 200 m (656 ft.). Bearded seals apparently also feed on ice associated organisms when they are present, and this allows a few bearded seals to live in areas considerably deeper than 200 m (656 ft.).

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 (Reeves et al. 1992; Cameron et al. 2010). They primarily feed on or near the bottom, diving is typically to depths of less than 100 m. 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 percent 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 amphipods, decapods, isopods, and mysids. 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 in this study.

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 seconds 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 can hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz-16 kHz (Richardson et al. 1995a). A more recent review suggests that the functional auditory bandwidth for pinnipeds in water is between 75 Hz-75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz (Southall et al. 2007). Masking 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.

Ringed seal
This section provides information on the threatened ringed seals. Key reports include:

1. Status review of the ringed seal (*Phoca hispida*) (Kelly et al. 2010)
2. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
3. Request for Letter of Authorization pursuant to section 101(a)(5) of the MMPA covering 'taking of marine mammals incidental to operations of offshore oil and gas facilities in the U.S. Beaufort Sea (50 C.F.R. Part 216, Subpart R)
4. Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (76 FR 39706, July 6, 2011)
5. Taking and importing marine mammals; taking marine mammals incidental to operation of offshore oil and gas facilities in the U.S. Beaufort Sea (79 FR 3347, January 21, 2014)
6. Industry funded studies

ESA listing history, and status
NMFS received a petition to list ringed seals as threatened or endangered under the ESA (73 FR 51615, September 4, 2008). On December 10, 2010 NMFS proposed to list four subspecies of ringed seals as threatened under the ESA (75 FR 77476):

Arctic:	(*Phoca hispida hispida*)
Okhotsk:	(*Phoca hispida ochotensis*)
Baltic:	(*Phoca hispida botnica*)
Ladoga:	(*Phoca hispida ladogensis*)

On December 28, 2012 NMFS listed the Ladoga subspecies of the ringed seal as endangered and the other three subspecies of ringed seals as threatened under the ESA (77 FR 76706).

Population and stock structure
Ringed seals are year-round residents in the Beaufort Sea and will be the most frequently encountered seal species in the project area. During winter and early spring, ringed seals will be the only seals encountered near the development area within the landfast ice zone. Ringed seal population estimates in the Bering, Chukchi, and Beaufort seas ranged from 1-1.5 million (Frost 1985) to 3.3-3.6 million (Frost et al. 1988). Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter. Although current reliable population estimates for ringed seals are not available, Frost et al. (2002) reported a trend analysis suggested a marginally significant decline of 31 percent from 1980-1987 to 1996-1999; however this decline may be due to differences in survey timing rather than reflect an actual decline in abundance.

In 1997, BPXA began an intensive seal survey program in the Northstar/Prudhoe Bay area. The purpose was to establish a baseline prior to development at Northstar; and to continue the surveys during Northstar construction and initial operations to compare with the baseline data. Seal counts through springtime aerial surveys, conducted prior to Northstar construction during 1997-1999 in Prudhoe Bay and Foggy Island Bay area, reported (uncorrected) ringed seal densities of 0.43, 0.39, and 0.63 seals/km^2(seals/0.4 mi^2) respectively, in water more than 3 m (9.8 ft.) in depth (Moulton et al. 2002). Similar surveys in the Prudhoe Bay area conducted during the years 1997-1999 estimated higher densities of seals (0.73 versus 0.43 seals/km^2 (seals/0.4 mi^2) in 1997; 0.64 vs. 0.39 seals/ km^2 (seals/0.4 mi^2) in 1998 and 0.87 vs. 0.63 seals/ km^2 (seals/0.4 mi^2) in 1999 (Frost et al. 2002, 2004). There are many natural factors that can contribute to variations in reported seal densities, e.g., time of year, time of day, snow conditions, air temperature, and cloud cover (Moulton et al. 2002). Early in the season a higher proportion of seals are still using their lairs and are unavailable to be counted by aerial surveyors, resulting in a lower estimated density (Kelly et al. 2004). However, it is not clear why such different results were obtained from similar surveys with considerable overlap in timing and methods. Ringed seal densities (uncorrected) on landfast ice during Northstar construction in the period 2000, 2001, and 2002 were 0.47, 0.54, and 0.83 seals/km^2 (seals/0.4 mi^2), respectively (Moulton et al. 2005).

Although aerial surveys during spring are the standard method for documenting ringed seal densities and distribution, the densities of seals estimated with this method underestimate actual seal densities. Not all seals are hauled out on the ice at any one time, and aerial surveyors, even under the best survey conditions, miss some seals that are on the ice. Thus, the average density figures quoted above are minimum estimates.

Reproduction, survival, and sources of mortality

Based on ringed seals studies in Alaska and the Canadian High Arctic, ringed seals use a series of breathing holes as soon as ice begins to form in late fall/early winter (Smith and Stirling 1975; Williams et al. 2002). As snow accumulates around these breathing holes, areas around some breathing holes become lairs, which afford protection from predators and weather (Smith and Stirling 1975; Frost and Burns 1989; Kelly and Quakenbush 1990). Ringed seals breed annually, and males in the Arctic populations rut from late March to mid-May, occasionally to mid-June, and rarely even later (McLaren 1958a). Arctic females ovulate in May and early June (Johnson et al. 1966, Smith 1973, Smith 1987). Mating is thought to take place under the ice in the vicinity of the pupping lair (Kelly 2010). Fertilization is followed by 3-3.5 months of arrested development before the blastocyst implants (McLaren 1958a, Fedoseev 1975, Smith 1987). Following implantation, active gestation lasts approximately 8 months. Ringed seals give birth in lairs from mid-March through April, nurse their pups in the lairs for 5-8 weeks, and mate in late April and May (Smith 1973; Hammill et al. 1991; Lydersen and Hammill 1993). They maintain some of the same breathing holes and lairs throughout the ice-covered period, but some are abandoned during the winter period even in the absence of human activities (Frost and Burns 1989; Hammill and Smith 1990). Williams et al. (2002) reported similar densities of structures (both abandoned and active) out to 3.5 km (2.2 mi) from Northstar Island and the ice road, and found that new structures were created by ringed seals throughout the ice-covered season. The area used by a single ringed seal may cover a relatively large area. Kelly and Quakenbush (1990) reported that mean distance between lairs was 2.0 km (1.2 mi) for male and 0.6 km (0.4 mi) for female ringed seals (maximum distance between two lairs was 3.4 km (2.1 mi)). Individual seals had as many as four lairs. Pups may use more holes than adults (mean 8.7; Lydersen and Hammill 1993), but these holes are closer together (maximum distance apart was 900 m (559 mi)).

Distribution and habitat use

During winter, ringed seals occupy landfast ice and offshore pack ice in the Bering, Chukchi, and Beaufort seas. In winter and spring, the highest densities for ringed seals are found on stable landfast ice. However, in some areas where there is limited landfast ice but wide expanses of pack ice (including the Beaufort Sea, Chukchi Sea, and Baffin Bay), total numbers of ringed seals on pack ice may exceed those on shore fast ice (Burns 1970; Stirling et al. 1982; Finley et al. 1983).

During summer, ringed seals are found dispersed throughout open water areas, although in some regions they move into coastal areas (Smith 1987; Harwood and Stirling 1992). During the open water period, ringed seals in the eastern Beaufort Sea are widely dispersed as single animals or small groups (Harwood and Stirling 1992). Marine mammal monitoring in the nearshore central Beaufort Sea confirms these generalities (Moulton and Lawson 2002; Williams et al. 2006a). Many groups with more than five ringed seals were seen in September 1997 offshore from the Northstar area (Harris et al. 1998). These seal groups were in water 50-2,000 m (164-6,562 ft.) deep, well offshore from the planned development area. A group of about five ringed seals was encountered about 15 nm (17 mi) offshore of Northstar Island mid/end September in waters 25 m (82 ft.) deep. Large concentrations of ringed seals are not expected to be encountered near Northstar Island during the summer season.

Foraging ecology

Ringed seals eat a wide variety of prey spanning several trophic levels. Their diet has been well documented, especially in the marine environment (Kelly et al. 2010). Most ringed seal prey is small, and preferred prey tends to be schooling species that form dense aggregations (Kovacs 2007). The most common prey size is 5-10 cm (2-4 in) for fish and 2-6 cm (0.8-2.4 in) for crustaceans, with a maximal size typically about 20 cm (8 in) (Węsławski et al. 1994). Estimated prey size may be biased if ringed seals do not consume the hard and identifiable parts (e.g., bones and otoliths) of larger prey (Smith 1977). Ringed seals rarely prey upon more than 10-15 species in any one area, and not more than 2-4 species are considered as important prey (Węsławski et al. 1994).

Despite some regional and seasonal variations in the diet of ringed seals, gadid fishes tend to dominate the diet from late autumn through early spring in many areas (Kovacs 2007). Arctic cod (*Boreogadus saida*) is often reported to be among the most important prey species, especially during the ice-covered periods of the year (Kelly 2010). Other fish reported to be locally important to ringed seals include sculpin (Cottidae) in the Chukchi Sea (Johnson et al. 1966).

Invertebrates appear to become more important to ringed seals in many areas during the open-water season, and are often found to dominate the diets of young seals (Kelly et al. 2010). Large amphipods (e.g., *Themisto libellula*), mysids (e.g., *Mysis oculata*), euphausiids (e.g., *Thysanoessa* spp.), shrimps (e.g., *Eualus*, *Lebbeus*, and *Pandalus* spp.), and squid (e.g., *Gonatus* sp.) are all commonly found in the diet of ringed seals and can be very important in some regions, at least seasonally (Kelly et al. 2010).

Vocalizations and hearing

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

III. ENVIRONMENTAL BASELINE

By regulation, the environmental baseline for biological opinions includes the past and present impacts of all state, Federal, or private actions and other human activities in the action area, the anticipated impacts from all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this biological opinion includes the effects of several activities that affect the survival and recovery of the endangered and threatened species in the action area.

The following factors, other than the proposed action, have had or are having potential effects on the endangered bowhead whale and the threatened bearded and ringed seals:

- Historic commercial whaling and sealing
- Subsistence hunting
- Oil and gas related activities
- Non-oil and gas industrial development
- Research activities
- Marine vessel traffic and commercial fishing
- Pollution and contaminants
- Climate change

Bowhead whale

There are no data available to indicate that, other than historic commercial whaling, any previous human activity had a significant adverse effect at the population level on the Western Arctic bowhead whale or their recovery. The uncertainty of the stock structure adds some uncertainty to the bowhead whale population status that may be affected by the proposed actions. However, current available information indicates that at the population level, bowhead whales using the Beaufort Sea are resilient, at least to the human caused mortality and disturbance that currently exists within their range.

Data indicate that at least some bowhead whales are extremely long lived (100 years or more). Thus, many individuals in this population may already have been exposed to many disturbance events in their lifetimes. Currently, the primary anthropogenic cause of mortality in bowhead whales is the regulated subsistence hunt by Alaska Natives, which occurs during spring and autumn throughout the coastal portions of their range. The bowhead whale harvest has focused Native, local, state, federal, international, and industry research and monitoring attention on this stock. Mitigation measures were developed, which are intended to ensure that the stock will continue to support a level of subsistence take that is sustainable and adequate to meet the needs of the bowhead hunting Native communities. Since the take level is directly linked to the population's abundance and status, protecting the whales' availability for subsistence take is linked to protection needed to ensure the population's long term viability. Whether there are long lasting behavioral effects from this subsistence activity is unknown, but overall habitat use appears to be relatively unaffected.

Historical commercial whaling

It is clear that commercial whaling that occurred during 1848-1915 was the human activity that had the greatest adverse effect on this population. Commercial whaling severely depleted bowhead whales. Woodby and Botkin (1993) estimated the historic bowhead whale abundance for this population ranged between 10,400-23,000 whales in 1848, before commercial whaling started. Woodby and Botkin (1993) estimated that 1,000-3,000 animals remained by 1914, around the time commercial whaling ended. Commercial whaling may have caused the extinction of some bowhead whale subpopulations and temporary changes in distribution. Following protection from commercial whaling, this population (but not all bowhead whale populations) has shown marked progress toward recovery. Thus current population size is within the lower bounds of historic population size estimates.

Subsistence hunting

Indigenous peoples of the arctic and subarctic regions 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, prior to commercial whaling, that subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal whale hunting 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 to co-manage the subsistence hunt by Alaska Natives is shared with the Alaska Eskimo Whaling Commission (AEWC) through a cooperative agreement between the AEWC and the U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

The sustainable harvest of bowhead whales by indigenous hunters represents the largest known human related mortality for this population at the present time. Available information suggests that it is likely to remain thus, for the foreseeable future. While there are other anthropogenic factors that 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 to confirm any other sources of common human related mortality. Subsistence take, which all available evidence indicates is sustainable when monitored, managed, and regulated, helps to determine the resilience of the population to other impacts that could potentially cause lethal takes.

Currently, Alaska Native hunters from 10 villages harvest bowhead whales for subsistence and cultural purposes under a quota authorized by the IWC. Chukotka Native whalers, from Russia, also are authorized to harvest bowhead whales under the same authorized quota. The population status is closely monitored and these activities are closely regulated. Strike limits are established by the IWC and set at a five year quota at 280 landings (NMFS 2008). The sustained growth of the Western Arctic bowhead whale population indicates the subsistence harvest level has been sustainable. Because the quota for the hunt is tied to the population size and population parameters, it is unlikely this mortality method will contribute to a significant adverse effect on the population's recovery and long term viability.

There are adverse impacts from bowhead whale hunting, in addition to the death of animals that are successfully hunted and the serious injury to animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes: 1) disturbance to other whales; 2) changes whale behavior; and 3) sometimes temporarily effects habitat use, including migration paths. Modern subsistence hunting represents a noise source and disturbance to the whales. Whales near a struck whale could be disturbed by: 1) sound of the explosive used in the hunt; 2) boat motors; and 3) 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 (ex., noise from vessels and/or bombs) can propagate in areas where hunting typically occurs, but it 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.[5] However, disturbances to migration as a result of a strike are temporary, 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.[6]

Because evidence indicates that bowhead whales are long lived, some bowhead whales may have been in the area when hunting occurred 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 activities. To the extent such activities occur in habitats during 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 to indicate long term habitat avoidance with present activity levels. Additionally, if whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions, during 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.

<u>Pollution and contaminants</u>

[5] E. Brower. Barrow, Alaska. Personal communication.
[6] E. Brower. Barrow, Alaska. Personal communication.

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. Becker (2000) noted that chlorinated hydrocarbon concentration levels 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 whale being a baleen whale feeding on copepods and euphausiids, with the beluga whale being a toothed whale feeding at a level higher in the food web. The total mercury concentration in the liver is also much higher in beluga whales than in bowhead whales.

Bratton et al. (1993) measured organic arsenic in the liver tissue from one bowhead whale and found that about 98 percent 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 bowhead whales harvested from 1983-1990. They observed considerable variation in tissue metal concentration among the whales tested. Evaluated metal concentrations did not appear to increase over time during 1983-1990. Based on metal levels reported in the literature for other baleen whales, the metal levels observed in all bowhead whale tissues 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 kidneys from large bowhead whales, pending further evaluation.

Cooper et al. (2000) analyzed anthropogenic radioisotopes in the epidermis, blubber, kidney, liver, and muscle from marine mammals harvested for subsistence food in northern Alaska and Resolute, Canada. The majority of analyzed samples had detectable levels of the radioactive isotope of Cesium (^{137}Cs). Among all marine mammal tissues analyzed, ^{137}Cs was almost always undetectable in the blubber, and significantly higher in epidermis and muscle tissue than in the kidney and liver tissues. The anthropogenic radioisotopes levels 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.

Demographic threats

The Western Arctic bowhead whale is not believed to be currently at risk from the effects of demographic stochasticity, inbreeding, loss of genetic diversity, or depensation.

Bearded seal

NMFS listed the Beringia DPS of the bearded seal as a threatened species under the ESA. This DPS is found in waters near the action area. We present information in this biological opinion related to the status of the Beringia DPS of the bearded seal.

Historical commercial sealing

By about the late 19th century, bearded seals were harvested commercially in large numbers causing local depletions. Commercial operations were primarily interested in seal oil and skins, but have been prohibited in U.S. waters since 1972 by the MMPA.

Subsistence hunting

Evidence of seal hunting by Native villages in the Arctic goes back at least 5,000 years (Riewe 1991). Bearded seals have been an important subsistence resource for Alaska Native communities along the coasts of the eastern Bering, eastern Chukchi, and Beaufort seas; and today they remain a central nutritional and cultural resource for many northern communities (Hart and Amos 2004, ACIA 2005, Hovelsrud et al. 2008). 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 (mukluks), 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 at least 1,700 bearded seals annually from 1966-1979, with reported takes remaining fairly constant, except in 1977 when an estimated 4,750-6,308 seals 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). Under more comprehensive subsistence monitoring, the estimated harvest peaked from 1990-1998 at mean levels of 6,788 bearded seals per year (Allen and Angliss 2010). In 2003, bearded seal subsistence harvest in the North Slope Borough villages estimates a minimum of 1,545 seals were 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 seals' availability and hunter success in retrieving seals that have been shot, which can range from 50-75 percent success in the ice to as low as 30 percent success in open water (Cameron 2010). Using the mean annual harvest reported from 1990-1998, assuming 25-50 percent of seals struck were lost, the total annual hunt by Alaska Natives would range from 8,485-10,182 bearded seals.

Pollution and contaminants

Research on contaminants and bearded seals is limited compared to the extensive information available for ringed seals. Research has only been conducted in a few areas, particularly throughout Arctic environments where bearded seals are an important prey of polar bears and an important diet item in coastal communities (Norheim et al. 1992, Muir et al. 1999, Fisk et al. 2005). However, it is likely that the temporal trend data for contaminants in other Canadian Arctic wildlife (Muir et al. 1999, Fisk et al. 2001, Fisk et al. 2005) also apply to bearded seals.

Pollutants such as organochlorine compounds (OC) and heavy metals have been found in most bearded seal populations (Cameron 2010). The variety and sources of the contaminants vary across the bearded seal's range, but these compounds appear to be ubiquitous in the Arctic marine food chain (Wiberg et al. 2000, Kovacs 2007). 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 (Borgå et al. 2005). A subset of OCs is persistent organochlorine pollutants (POPs), including dichloro-diphenyl-trichloroethane (DDTs), polychlorinated biphenyl (PCBs), and perfluorinated contaminant (PFCs) (Powley et al. 2008).

In pinnipeds specifically, DDT and PCB exposure have been linked to endocrine disruption, reproductive disorders, and reproductive failure (reviewed by Gregory and Cyr 2003). Kovacs (2007) noted that until late in the 20th century the Arctic was perceived to be one of the last pristine wilderness areas in the world; thus, the presence of POPs and other contaminants was a surprise. Concentrations of DDT and related residues generally are much lower among pinnipeds in the Beaufort and Bering seas than in other regions (Kelly 1988). Bearded seals had the highest concentrations (0.33 ppm) of six marine mammals tested in Alaska. Dieldrin and lindane levels were less than half the concentration of DDT (Galster and Burns 1972). Average PCB concentrations were similar (1.78 ppm) among five pinniped species, including bearded seals, in the Beaufort and Bering seas (Galster and Burns 1972). Organochlorine contaminants are of particular concern because they are lipophilic compounds that have potential detrimental effects on health and reproduction (O'Shea 1999, Gregory and Cyr 2003). Cytochrome P450s, a class of hemoproteins induced by exposure to contaminants and pharmaceuticals, are used as biomarkers for exposure to certain contaminants, including organochlorines (Assunção and Ross 2001, Fujita et al. 2001). The accumulation of persistent lipophilic contaminants in marine mammals is generally related to an individual's size and gender (O'Shea 1999, Aguilar et al. 2002, Hoekstra et al. 2003b), but Hoekstra et al. (2003b) noted that biases associated with sample collections, such as geographical location or the type of tissue examined, may influence these findings. Muir et al. (2003) showed that ΣPCBs and ΣDDTs from the blubber of male bearded seals from the White Sea were approximately 10 times higher than levels reported for male bearded seals from Kongsfjorden in Svalbard (Bang et al. 2001). Male bearded seals from Barrow, Alaska (Chukchi-Beaufort seas) also had low ΣPCB levels (Hoekstra 2002). Quakenbush et al. (2010), studying bearded seals harvested in Alaska from 2003-2007, indicated that OC concentrations in blubber were an order of magnitude higher than concentrations in the liver.

PFCs, such as perfluorooctane sulfonate (PFOS) and related synthetic compounds have been detected in bearded seals in the western Arctic (Powley et al. 2008). These compounds bind to proteins rather than lipids and negatively affect cellular function.

The spatial distribution of organochlorines in pinnipeds appears to be consistent with levels found in the environment described by de Wit et al. (2006). Organochlorine levels in regions surrounding the Arctic are expected to continue to rise (de Wit et al. 2006). Addison et al. (2005) suggested that the distribution of PCB congeners in the Arctic between the 1980s and the 1990s was consistent with atmospheric transport processes becoming increasingly important. Climate change also has the potential to increase the transport of pollutants into the marine environment through freshwater runoff (Tynan and DeMaster 1997), highlighting the importance of continuing to monitor bearded seal contaminant levels.

Mercury, cadmium, lead, selenium, arsenic, and nickel are the most commonly reported heavy metals in Arctic marine mammals (Kovacs 2007, Dietz 2008). Bearded seals bio accumulate mercury in vital tissues, (e.g., liver, kidney, muscle) and accumulation levels of this metal have been studied in some bearded seal populations (Cameron 2010). There is a strong correlation between mercury and selenium levels and, in the Canadian Arctic, metal levels generally showed a positive correlation with bearded seal age or size (Freeman and Horne 1973, Smith and Armstrong 1978). Smith and Armstrong (1978) also reported that rates of accumulation appear to be somewhat higher in bearded seals as compared to ringed seals, and that the input of mercury from natural sources to fresh waters is increasing.

Butyltin (BT) compounds are used as antifouling agents in ship bottom paints and aquaculture nets (Iwata et al. 1997). They are retained in all tissues, although they are more concentrated in the liver rather than the blubber, where PCBs and DDT also accumulate (Iwata et al. 1997). These compounds have been detected in marine mammal species in North Pacific, Asian, and California coastal waters (Iwata et al. 1997, Tanabe et al. 1998). Tanabe et al. (1998) reported that "BT accumulation in pinnipeds was lower than in cetaceans, confirming earlier notion that pinnipeds have greater capacity to degrade Tributyltin in the liver and excrete BTs through molting." Less is known about the toxicity of polybrominated diphenyl ethers (PBDEs), which are flame retardants widely used in plastics, textiles, electronic equipment, and other materials (Rigét et al. 2006). PBDEs have not yet been found in bearded seals, but they are ubiquitous in the environment. They are found in air, water, fish, birds, marine mammals, and humans; and detected levels have increased exponentially during the past 30 years (Hites 2004). Studies have shown that they adversely affect thyroid function and neurodevelopment in mammals (Darnerud 2003, Viberg et al. 2004). Sources of PBDEs in the Arctic include western Europe, eastern North America, highly populated local areas, and southern regions through long-range atmospheric transport (de Wit et al. 2006).

Parasites and disease

A variety of diseases and parasites have been documented to occur in bearded seals. The seals have likely coevolved with many of these and the observed prevalence is typical and similar to other seal specie. However, since July 2011, more than 100 sick or dead ice seals have been reported in Alaska. The cause of the arctic seal disease remains unknown.

Demographic threats

The Beringia DPS for bearded seals 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).

Ringed seal

NMFS listed the arctic subspecies of ringed seals as a threatened species under the ESA. The arctic subspecies of ringed seals is found in waters near the action area. We present information in this biological opinion related to the status of the arctic subspecies of the ringed seal.

Historical commercial sealing

Ringed seals were harvested commercially in large numbers during the 20th century, which lead to the depletion of their stocks in many parts of their range. Commercial operations were primarily interested in seal oil and skins, and have been prohibited in U.S. waters since 1972 by the MMPA.

Subsistence hunting

Ringed seals have been hunted by humans for millennia and remain a fundamental subsistence resource for many northern coastal communities today, including many Alaska Native communities along the coasts of the northern Bering, Chukchi, and Beaufort seas. Ringed seal meat has been used as food for people, sled dogs, and livestock; their skins sold for cash, traded for goods, or used for clothing, crafts, and other household items; their blubber rendered into oil for food and fuel; and their flippers, bones, and viscera used for many household, industrial, and medicinal purposes (Kelly et al. 2010). However, their harvest levels decreased during the 1970s, likely due to changes in the Natives' lifestyle and the enactment of the MMPA in 1972 (Frost 1985). The annual harvest in Alaska dropped from 7,000-15,000 ringed seals per year during 1962-1972 to 3,000-6,000 during 1973-1977, and to 2,000-3,000 by 1979 (Frost 1985). Based on limited data from two villages on St. Lawrence Island, Kelly (1988) suggested that the annual take in Alaska likely exceeded 3,000 ringed seals during the mid-1980s.

A report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably between years (Coffing et al. 1998). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. As of August 2000, an estimated 9,500 ringed seals were harvested for subsistence use in Alaska per year, considerably higher than the previous minimum estimate (Allen and Angliss 2011). Measures of error were not available for this estimate. Currently, there is no comprehensive effort to quantify harvest levels of seals in Alaska (Allen and Angliss 2010).

Pollution and contaminants

Contaminant loads in ringed seals have been investigated in most parts of the species' range, reflecting the ringed seal's importance in the diets of polar bears and coastal people (Kelly et al. 2010). Pollutants such as OC and heavy metals have been found in all ringed seal populations (Kelly et al. 2010). The variety, sources, and transport mechanisms of the contaminants vary across the seal's range (Addison et al. 2009). Many compounds are imbedded in the Arctic marine food chain (Kelly 2010). Borgå et al. (2005) noted that OC contamination is greater in the European Arctic than in the Canadian or U.S. Arctic.

Heavy metals such as mercury, cadmium, lead, selenium, arsenic, and nickel accumulate in ringed seal vital organs, including the liver and kidneys, as well as in their central nervous system (Kelly et al. 2010). Heavy metal burdens in Arctic ringed seals have been reported during the last several decades (Kelly et al. 2010). Smith and Armstrong (1978) examined mercury and selenium levels in ringed seal tissues from seven locations across the Canadian Arctic. Their findings confirmed prior reports of high total mercury levels in liver and muscle, and they found no significant regional differences. Mercury and selenium were positively correlated with age, and the ratio of the two elements was linear (1:1). Toxic effects were not detected from these naturally occurring elements, which suggested that marine mammals have developed mechanisms (Koeman et al. 1975) to cope with high mercury levels in their diet. Rigét et al. (2005) compared concentrations of mercury and cadmium in ringed seal liver and kidneys from 11 locations across the Arctic, including: Alaska; Canada; Greenland; Svalbard; and the White Sea. They found that concentrations differed significantly among the studied locations. Ringed seals in the western Canadian Arctic had the highest mercury concentrations in the liver, while cadmium in liver was highest in the eastern Canadian Arctic and West Greenland.

Concentrations in liver and kidney were also significantly higher in adult ringed seals as compared to subadults, and the circumpolar patterns were most pronounced in adult ringed seals. The authors suggested that the distribution of mercury and cadmium in ringed seals reflected natural and geological differences in the distribution of the metals. They noted that mercury and cadmium in the environment are derived from both natural and anthropogenic sources. Gaden et al. (2009) examined mercury levels in ringed seals from the western Canadian Arctic from 1973-2007. They detected no temporal trends in total mercury levels in muscle tissue, but a curvilinear relationship existed with the length of the ice-free periods. Total mercury levels were higher in both short (two month) and long (five month) ice-free seasons. They suggested that during ice-free periods the seals will eat more Arctic cod (and mercury). The authors also found that total mercury levels increased with age for both genders, which is similar to Dehn et al.'s (2005) findings near Barrow, Alaska.

Cadmium and mercury levels were associated with age and sampling locations. Mercury accumulated throughout life, whereas cadmium levels peaked in the 5-10 year age groups then declined significantly. Zinc concentrations in liver and kidney tissues showed some differences among sampling areas, but there was no correlation with age. Selenium levels exhibited the same patterns as cadmium and mercury. As reported in other studies, selenium and mercury levels were strongly correlated in the liver (1:1). Further, cadmium and mercury were correlated in all tissues, whereas cadmium, selenium, mercury, and zinc were only correlated in kidneys and liver. High cadmium levels in adults from some regions were linked to their prey (e.g., Arctic cod). The authors also noted that average cadmium levels from Greenland were similar to levels reported by Wagemann et al. (1996) for the eastern Canadian Arctic; levels from western Greenland were much higher than levels reported for the Gulf of Bothnia in the Baltic Sea. Dietz et al. (1998) also summarized previous findings of mercury levels in Arctic ringed seals. They cited Zeisler et al.'s (1993) findings of high mercury levels in 1 and 2 year old seals in Alaskan waters and noted that those levels corresponded to concentrations reported from western Canadian Arctic and eastern Greenland samples. Further, Dietz et al. (1998) noted that mercury levels in samples analyzed from the eastern Canadian Arctic, West Greenland, Svalbard, and northern Norway were three times lower (Kelly et al. 2010). Sonne-Hansen et al. (2002) investigated the effect on the skeletal system on the high cadmium concentrations in the kidneys from ringed seals from northwestern Greenland. Despite the high levels of cadmium, no seals exhibited signs of cadmium-induced nephropathy or osteodystrophy. They noted that the ringed seals' diet contains high levels of vitamin D, calcium, phosphorus, zinc, selenium, and protein, which would counteract the effects of cadmium.

Parasites and disease

A variety of diseases and parasites have been documented to occur in bearded seals. The seals have likely coevolved with many of these and the observed prevalence is typical and similar to other seal specie. However, since July 2011, more than 100 sick or dead ice seals have been reported in Alaska. Although NMFS declared the current ringed seal disease event an unusual mortality event, the cause of this arctic seal disease remains unknown.

Demographic threats

The Arctic subspecies of ringed seals 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.

Bowhead whale, bearded seal, and ringed seal

Research

Large research ships that are active in the bowhead whale, bearded seal, and ringed seal range when these marine mammals are present, have the potential to cause noise disturbance to them, potentially altering their movement patterns or other behaviors. However, available evidence does not indicate such disturbance will have a significant effect on their population during the next five years, which is the approximate life of the regulations and LOA; even when added to the effects of other stressors. The Western Arctic bowhead whale, bearded seal, and ringed seal have been the focus of research activities that could, in some instances, cause minor temporary disturbance to the whales and seals. During research on these animals themselves, their reactions are generally closely monitored to minimize potential adverse effects. Additionally, research conducted primarily for reasons other than the bowhead whale, bearded seal, and ringed seal studies has also occurred within their Beaufort Sea ranges. In some cases, such research has the potential to adversely affect the whales and seals through the introduction of additional noise, disturbance, and low levels of pollution into their environment.

Marine vessel traffic

The extraordinary reduction in Arctic sea ice that has occurred in recent years has renewed interest in broadening the use of the Arctic Ocean as a waterway for coastal, regional, and trans-Arctic marine operations (Brigham and Ellis 2004). Declines in sea-ice extent and thickness have provided greater access to marine navigation routes, especially along the margins of the Arctic Basin, which historically have been ice-covered for most or all of the year (ACIA 2004). Climate models predict that the warming trend in the Arctic will accelerate: 1) causing the sea ice to begin melting earlier in the spring, 2) retreat farther away from most Arctic landmasses, and 2) get thinner during the summer; and resume freezing later in the fall, resulting in an expansion of potential shipping routes and lengthening the potential navigation season, on an increasingly frequent basis (ACIA 2004, Howell and Yackel 2004, Howell et al. 2009, Khon et al. 2010). This reduction in sea ice "is very likely to increase marine transport and access to resources" in the Arctic during this century (ACIA 2004). A comprehensive review and analysis of current (2004) and future (2020) marine shipping activities in the Arctic was presented in the Arctic Marine Shipping Assessment (AMSA) 2009 Report (Arctic Council 2009). Much of the following information was incorporated from this report.

According to the AMSA report (Arctic Council 2009), the term “shipping” refers to the various uses of all types of ships (except naval vessels), including tankers, bulk carriers, offshore supply vessels, passenger ships, tug-barge combinations, fishing vessels, ferries, research vessels, and icebreakers. These ships may travel to or from destinations within the Arctic (destinational shipping) or may use the Arctic Ocean as a marine link between the Atlantic and Pacific Oceans (trans-Arctic shipping). At present, the two main navigation routes crossing the Arctic are the Northwest Passage and Northern Sea Route (NSR). A proposed new route termed the Central Arctic Ocean Route (CAOR), which would cross a significant portion of the Arctic Basin, could be navigable at least intermittently and be economically feasible by mid-century (Holland et al. 2006, Ellis 2008). Compared to the NSR, the CAOR would reduce the distance between Russian ports by 10-15 percent.

The NSR, which is actually the central portion of a longer trans-Arctic route called the Northeast Passage, traverses the Russian Arctic along the northern coast of Eurasia from the Barents Sea in the west to the Bering Sea in the east. For ships travelling between northern Europe and Far East Asia or Alaska, the NSR represents a savings of 35-60 percent in distance when compared to the normal shipping routes through the Suez or Panama Canals (Arctic Council 2009). This shallow, seasonally ice-covered route has been maintained year-round in its western portion by Russian icebreakers since 1979 and has been open to international marine traffic since 1991 (ACIA 2004).

Marine vessel traffic, in general, can pose a threat to bowhead whales, bearded seals, and ringed seals because of the ship strike risk. Shipping and vessel traffic is expected to increase in the Arctic if warming temperatures continue. Additionally, noise associated with ships or other boats potentially could cause these marine mammals 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 whale and pinnipeds risk of exposure to contaminants and disease vectors. The observation frequency of vessel inflicted injuries suggests that the incidence for ship collisions with 1) bowhead whales is low but may be increasing; and 2) bearded and ringed seals remains low. During 1976-1992, only three ship strike injuries were documented out of 236 bowhead whales (0.01 percent) examined from the Alaskan subsistence harvest (George et al. 1994). The low number of ship strike injuries observed suggests the bowhead whale: 1) does not often encounter vessels, or 2) avoid interactions with vessels, or 3) interactions usually result in the animals’ death.

<u>Offshore oil and gas related activities and other industrial activities</u>
Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska Outer Continental Shelf (OSC) in the Beaufort and Chukchi seas as a result of previous lease sales since 1979. Available information does not indicate that oil and gas related activities (or any recent activity) have had detectable long term adverse population level effects on the overall health, current status, or recovery of the Western Arctic bowhead whale population, or the bearded and ringed seals. Data indicate the Western Arctic

bowhead whale population has continued to increase during the timeframe that oil and gas activities occurred and 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 whale high use areas. Northstar Island (an oil production facility) is at the southern end of the migratory corridor and Endicott (a near shore oil facility) is within the barrier islands.

A Minerals Management Service (MMS) study (MMS 2002) in the Beaufort Sea provided a compilation of available data on the location, timing, and nature of oil and gas related activities from 1979-1999. It was intended to provide a "database to address concerns expressed by subsistence hunters and others living within . . . villages of the Beaufort Sea about the possible effects that oil and gas activity, particularly seismic activity, drilling, and oil and gas support vessel activities may have on the behavior of . . . especially the bowhead whale." However, "[S]uch an analysis requires an adequate level of detail[,] there are significant gaps in the data for the period 1979-1989," (Wainwright 2002) and "very limited information was obtained on ice management" (Wainwright 2002). Thus, while data on the bowhead whale status are adequate to determine that the Western Arctic population apparently continued to recover during the periods when past and current levels of oil and gas activities were occurring, we cannot adequately assess potential effects on patterns or durations of bowhead whale habitat use.

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 during the past 30 years, because the data is incomplete for many types of activities, even for the 1990s, we cannot evaluate the totality of past effects on bowhead whales, bearded seals, or ringed seals, 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 borehole drilling, aircraft surveys, and hunting).

Climate change

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and 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 of three, 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. 2007). 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).

The Intergovernmental Panel on Climate Change (IPCC) concluded in its synthesis report (IPCC 2007a), as part of its Fourth Assessment Report (IPCC 2007b) that:

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.
- Global GHG [greenhouse gas] emissions due to human activities have grown since pre-industrial times, with an increase of 70 percent during 1970 and 2004.
- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.
- There is now higher confidence than in the Third Assessment Report in projected patterns for warming and other regional scale features, including changes in wind patterns, precipitation, and some aspects of extremes in sea ice.

IPCC (2007b) reports that warming will be greatest over land and at high northern latitudes. They also predict recent observed trends to continue, such as: 1) contraction of snow cover area, 2) increases in thaw depth over most permafrost regions, and 3) decrease in sea ice extent. Projected surface temperature changes along the North Slope of Alaska may increase 6.0-6.5 ºC for the late 21st century (2090-2099), relative to the period 1980-1999 (IPCC 2007b).

The IPCC's projections used the Special Reports on Emissions Scenarios. Emissions scenarios in a range of climate models result in an increase in globally averaged surface temperature at 1.4-5.8 ºC during 1990-2100 (IPCC 2007a). This is about 2-10 times larger than the central value of observed warming during the 20th century, and the projected rate of warming is very likely to be without precedent during at least the last 10,000 years, based on paleoclimate data.

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. Arctic ice thickness is decreasing. Ice distribution 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.

Future predictions in sea ice extent, using several climate models and taking the mean of all the models, estimates the Arctic will be ice free during summer in the latter part of the 21st century (IPCC 2007a). There is considerable uncertainty in the estimates for summer sea ice in these climate models, with some predicting 40-60 percent summer ice loss by the middle of the 21st century (Holland et al. 2006). Using a suite of models, a 40 percent loss is estimated for the Beaufort and Chukchi seas by 2050 (Overland and Wang 2007). Some investigators, citing the current rate of decline in summer sea ice extent believe it may be sooner than predicted by the models, and may be as soon as 2013 (Stroeve et al. 2007). Other investigators suggest that variability at the local and regional level is very important for making estimates in future changes.

McBeath and Shepro (2007) recorded a hunter's experience:

> The sea ice was gone; there's no main ice pack anymore. All of its just floating ice. There are just small pieces of ice. When I first went out whaling, I saw big icebergs, but not now. The ice is too far out to see it. In the 1970s and 1980s the ice was close. You didn't have to go far to see it. Now you don't see any glacier ice at all.

While changes in the reduction of summer sea ice extent are apparent, the cause(s) for such changes are not fully established. Evidence suggests it may be a combination of oceanic and atmospheric conditions that cause(s) the change. Incremental solar heating and ocean heat flux, longwave radiation fluxes, changes in surface circulation, and less multiyear sea ice all may play a role.

These changes are resulting, or are expected to result, in changes to the biological environment, causing shifts, expansion, or retraction of home range, changes in behavior, and changes in population parameters for plant and animal species. Much research in recent years has focused on the effects from naturally occurring or man induced global climate regime shifts; and the potential for these shifts to cause changes in habitat structure over large areas. Although many 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 increased faster than in other areas of the world as evidenced by glacial retreat and melting sea ice (Table 4). Threats posed by the direct and indirect effects from global climatic change are or will be common to northern species. These threats will be most pronounced for ice obligate species such as the bearded seal, ringed seals, polar bear, and walrus.

Table 4 Phenomena associated with projections of global climate change including the confidence levels associated with each projections (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

Sea ice and other climatic conditions that influence bearded seal and ringed seal habitats are quite different between Arctic and the seasonal ice zones. In the Arctic, sea ice loss is a summer feature with a delay in freeze up occurring into the following fall. Sea ice will always persist from late fall through mid-summer due to cold and dark winter conditions.

Sea ice variability is primarily determined by radiation and melting processes during the summer season. The seasonal ice zones are free of sea ice during summer. The variability in extent, thickness, and other sea ice characteristics important to marine mammals are determined primarily by changes in the number, intensity and track of winter and spring storms in the sub-Arctic. 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, which are behaving differently than the Arctic. For example, the Bering Sea has had four years of colder than normal winter and spring conditions from 2007-2010, with near record sea-ice extents, rivaling the sea ice maximum in the mid-1970s, despite record retreats during summer in the Arctic.

There are no reliable time series of ice thickness for the sub-Arctic regions (ex., Bering Sea) that form only annual ice. Shorter ice forming seasons in all areas in the future may produce thinner ice *in situ* than in the past, but a broad range of floe thicknesses would still be expected due to rafting and ridging processes (Parmerter 1975). Much of the sea ice in the eastern and northern Bering and Chukchi seas during spring is very densely compacted and heavily ridged, such that bearded seals are not found there in significant numbers during the breeding season. A decline in ice concentration and thickness in such areas could conceivably result in new breeding habitat in the future, perhaps mitigating losses of previously-used habitat, though we are not aware of specific examples in which similar mitigative shifts in habitat have occurred during rapid climatic changes. Bearded seals' ability to effectively use thinner annual ice for their life history needs, and their apparent lack of preference about the type and quality of ice in which they are observed (Fay 1974), suggest that it is mostly the presence of ice that may be of consequence; and that a decline in ice thickness alone may not be a significant concern to bearded seals throughout their range.

Ringed seals, especially newborns, depend also on snow cover for protection from cold temperatures and predators. Occupation in subnivean lairs is especially critical when pups are nursed in late March-June. Reduced snowfall results in less snow accumulation next to pressure ridges, and pups in lairs with thin snow cover are more vulnerable to predation than pups in lairs with thick cover (Hammill and Smith 1989, Ferguson et al. 2005). 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 percent of the pups died from predation (Kelly et al. 2010).

More recently, telemetric monitoring of Arctic ringed seals and satellite measurements of snow melt, using passive microwave emissions, showed that the seals' emergence from lairs was related to structural failure of the snow pack (Kelly et al. 2006). Warmer temperatures will continue to have negative effects on ringed seal pup survival. Increased rain-on-snow events during the late winter also will negatively impact ringed seal recruitment by damaging or eliminating snow-covered pupping lairs, increasing exposure and the risk of hypothermia, and facilitating predation by polar bears, arctic foxes (*Vulpes lagopus*), gulls, ravens (*Corvus corax*), and other predators (Stirling and Smith 2004). Stirling and Smith (2004) documented the collapse of subnivean lairs during unseasonal rains near southeastern Baffin Island and the subsequent exposure of ringed seals to hypothermia. They surmised that most pups that survived exposure to cold were eventually killed by polar bears (Stirling and Archibald 1977), Arctic foxes (Smith 1976), or gulls (Lydersen and Smith 1989). Stirling and Smith (2004) postulated that should early season rain become regular and widespread in the future, mortality of ringed seal pups will increase, especially in more southerly parts of their range.

However, not all arctic species are likely to be adversely influenced by global climate change. Conceptual models by Moore and Laidre (2006) suggested that, overall; reductions in sea ice cover should increase the Western Arctic bowhead whale prey availability. This theory may be substantiated by the steady increase in the Western Arctic population during the nearly 20 years the sea ice reduced (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) reported a high probability that bowhead whale abundance will increase under a warming global climate. NMFS National Marine Mammal Laboratory stated that data is insufficient to reliably predict the effects of Arctic climate change on bowhead whales (Angliss and Outlaw 2008).

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 one-third of the total emissions for the past 200 years. When anthropogenic CO2 is absorbed by seawater, chemical reactions occur that reduce both seawater pH and the concentration of carbonate ions in a process known as "ocean acidification" (Cameron et al. 2010). 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 from ocean acidification are uncertain. The NRC (2010) concluded that, while direct biological effects from 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 carbon dioxide 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 key effect that is predicted to occur from increasing ocean acidification derives from observations that acidifying seawater negatively affects the ability for species to form and maintain shells and skeletons made of calcium carbonate. This observation indicates that there will likely be adverse effects to organisms, such as calcareous phytoplankton and zooplankton, key elements in many food webs, including bowhead whales (plankton), bearded seals (benthic organisms), and ringed seals (schooling species). The nature and timing of such impacts are extremely uncertain (Cameron et al. 2010). Changes in prey, anticipated in response to ocean warming and loss of sea ice, have the potential for negative impacts, but the possibilities are complex (Cameron et al. 2010). Ecosystem responses may have very long lags as they propagate through trophic webs. Because there is some apparent dietary flexibility, this threat may be of less immediate concern (Cameron et al. 2010).

IV. EFFECTS OF THE ACTION

The primary concern, associated with the impacts from the proposed actions on the endangered bowhead whale and threatened bearded and ringed seals, has to do with potential impacts due to noise. Exposure to anthropogenic noise may affect these whales by impacting their hearing (temporary threshold shifts or permanent threshold shifts indicating mechanical damage to the ear structure), by masking communications, or affecting their behavior (harassment).

There is still uncertainty about the potential impacts from sound on baleen whales and pinnipeds, on the factors that determine response and effects, and especially, on the long term cumulative consequences of increasing noise in the world's oceans from multiple sources (e.g., NRC 2003, 2005). The NRC (2005) Committee on Characterizing Biologically Significant Marine Mammal Behavior concluded that it is unknown how or in what cases baleen whale responses to anthropogenic sound rise to the levels of biologically significant effects.

Available evidence indicates that behavioral reaction to sound, even within a species, may depend on the listener's: gender and reproductive status; possibly age and/or accumulated hearing damage; type of activity engaged in at the time; or, in some cases, group size. For example, reaction to sound may vary depending on whether females have calves accompanying them, and whether individuals are feeding or migrating. Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the impacts from sound on a species or on classes of individuals within a species.

While there is some general information available, evaluation of the noise impacts on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by whales and seals for different functions (Richardson et al. 1995a; Gordon et al. 1998; NRC 2003, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of large whales or the impacts from sound on them, especially physical effects. While research in this area is increasing, it is likely there will continue to be great uncertainty about physiological effects on baleen whales because of the difficulties in studying them.

Baleen whale hearing has not been studied directly. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al. 1995a). Thus, predictions about probable impact on baleen whales generally are based on assumptions about their hearing rather than actual studies on their hearing (Richardson et al. 1995a; Gordon et al. 1998; Ketten 1998).

Ketten (1998) summarized that vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz, but the frequency range in bowhead songs can approach 4 kHz (Richardson et al. 1995a). Most calls emitted by bowhead whales are in the frequency range of 50-400 Hz, with a few extending to 1,200 Hz. Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson et al. 1995a).

Some or all baleen whales may hear infrasound, sounds at frequencies well below those detectable by humans. Functional models indicate that functional hearing of baleen whales extends to 20 Hz, with an upper range at 30 Hz. Even if the sensitive hearing range does not extend below 20-50 Hz, whales may hear strong infrasound at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasound at 5 Hz might be detected (Richardson et al. 1995a). Bowhead whales are predicted to hear at frequencies as low as 10-15 Hertz. McDonald et al. (1995) summarized that many baleen whales produce loud low frequency sounds underwater a significant part of the time. Thus, species that are likely to be impacted by low frequency sound include bowhead whales.

Most species also have the ability to hear beyond their peak range. This broader hearing range probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Ketten (1998) summarized that “The consensus of the data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 500 Hertz or higher. This statement refers solely to the probable potential for marine mammal species to hear sounds of various frequencies. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect. Other factors, such as sound intensity, will determine whether the specific sound reaches the ears of any given marine mammal.” Little data are available about how most marine mammal species, especially large cetaceans, respond either behaviorally or physically to intense sound and to long term increases in ambient noise levels, especially during the long term. Large cetaceans cannot be easily examined after exposure to a particular sound source.

Whales often continue a certain activity (ex., feeding) even in the presence of air gun, drilling, or vessel sounds. Such continuous activity does not confirm that the sound is not harmful to the cetacean. In many or all cases, this may be true; it may not be harmful. However, this type of interpretation is speculative. Whales, and even humans, sometimes continue with important behaviors even in the presence of noise or other potentially harmful factors. Whales often fast for long time periods during the winter. The need to feed or to transit to feeding areas, for example, is possibly so great they continue with the activity despite being harmed or harassed by noise. For example, Native hunters reported to Huntington (2000) that beluga whales often ignore the hunters approach when feeding, but at other times will attempt to avoid hunters’ boats.

Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear’s tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss could result in the inability to communicate effectively with other members of its species, detect approaching predators or vessels, or echolocate (in the case of the toothed whales). Some studies have shown that following exposure to a sufficiently intense sound, baleen whales may exhibit an increased hearing threshold, a threshold shift, after the sound has ceased (Nachtigall et al. 2004; Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002). Thus, a threshold shift indicates that sound exposure resulted in hearing loss causing decreased sensitivity. This type of hearing loss is called a temporary threshold shift, if the individual recovers its pre-exposure sensitivity of hearing over time, or a permanent threshold shift, if it does not.

Ketten (1998) reported that whether or not a temporary threshold shift or a permanent threshold shift occurs will be determined primarily based on the extent of inner ear damage the received sound and the received sound level causes. In general, whether a given species will tend to be damaged by a given sound depends on the frequency sensitivity to the species. There are no data on which to determine the kinds or intensities of sound that could cause a temporary threshold shift in a baleen whale.

Permanent threshold shifts are less species dependent and more dependent on the1) length of time the peak pressure lasts and 2) signal rise time. Usually, if exposure time is short, hearing sensitivity is recoverable. Noise can also modify the animal’s behavior (ex., approach or avoidance behavior, or startle).

Long-term impacts from seismic survey noise on the hearing abilities of individual baleen whales are unknown. Information about the hearing capabilities of large baleen whales is mostly lacking. The assumption is that the area of greatest hearing sensitivity is at frequencies known to be used for intraspecific communication. However, because real knowledge about sound sensitivity is lacking, we assume in our analyses that sensitivities shown by one baleen whale species also could apply to another. This assumption is conservative, especially when using studies on a species such as the humpback whale, which uses a large sound repertoire in intraspecific communication, to infer possible impacts on other species such as the bowhead whale.

When noise interferes with sounds used by baleen whales (ex., interferes with their communication or echolocation), it is said to “mask” the sound (ex., a call to another whale might be masked by an icebreaker operating at a certain distance away). Noises can mask sounds that whales need to hear to function (Erbe et al. 1999). In a given environment, the impact from a noise on cetacean detection of signals likely would be influenced by the noise’s frequency and temporal characteristics: its signal-to-noise ratio, and by the same characteristics from other sounds occurring in the same vicinity (ex., a sound could be intermittent but contribute to masking if many intermittent noises were occurring). It is not known whether (or which) marine mammals can (Erbe and Farmer 1998) and do adapt their vocalizations to background noise.

Because of the wide variability in individual marine mammals’ response to noise, and following recommendations in McCauley et al. (2000), we attempt to take a conservative approach in our analyses and base conclusions about potential impacts on potential effects on the most sensitive members of a population. In addition, we evaluate the potential for effects on bowhead whales by making the implicit assumptions that sound may travel the maximums observed, rather than minimum distances; and that whales engaged in a particular activity may respond at the maximum, not the minimum, distances observed in studies to date. These assumptions overestimate potential effect in many cases.

Potential exposure of whales and pinnipeds to Northstar operations

Bowhead whales, bearded seals, and ringed seals use portions of the Beaufort Sea for: spring and fall migration; feeding; calving/pupping; resting; and breeding. Bowhead whales, bearded seals, and ringed seals have a demonstrated sensitivity to some noise and disturbance.

Operational sounds

Drilling operations started in December 2000 and were the first sound-producing activities associated with the operational phase at Northstar. The four principal operations that occur during drilling are: drilling per se, tripping (extracting and lowering the drill string), cleaning, and well logging (lowering instruments on a cable down the hole). Drilling activities can be categorized as non-continuous sounds, i.e., they contribute to Northstar sounds intermittently. Other noncontinuous sounds are those from heavy equipment operation for snow removal, berm maintenance, and island surface maintenance. Sounds from occasional movements of a "pig" through the pipeline may also propagate into the marine or nearshore environment.

Sounds from generators, process operations (e.g., flaring, seawater treatment, oil processing, gas injection), and island lighting are more continuous and contribute to the operational sounds from Northstar. Drilling and operational sounds underwater, in air, and of ice-borne vibrations were obtained at Northstar Island and summarized below (Blackwell et al. 2004b; Blackwell and Greene 2006).

Drilling

During the ice covered seasons from 1999-2002, drilling sounds were measured and readily identifiable underwater, with a marked increase in received levels at 60-250 Hz and 700-1400 Hz relative to no-drilling times. The higher-frequency peak, which was distinct enough to be used as a drilling "signature", was clearly detectible 5 km (3.1 mi) from the drill rig, but had fallen to background values by 9.4 km (5.8 mi). Distances at which background levels were reached were defined as the distance beyond which broadband levels remained constant with increasing distance from the source. Beyond that distance, measured levels were dominated by natural (or at least non-Northstar) sound or vibration. On a windy day, recorded levels would diminish to background levels closer to Northstar than on a calm day. This method defines the distance at which broadband levels from the measured sound source equal background levels, but certain tones from the sound source may still be audible to greater distances. The lower-frequency peak straddled the range of frequencies involved in power generation on the island, which have been common in recordings since the beginning of construction at Northstar. It is reasonable that, during drilling, an increase in the level of sound and vibration would occur from any equipment that is required to work harder, such as the machinery for power generation or drilling. Sound pressure density levels of island production with and without drilling activities measured at about 500 m (1,640 ft.) from Northstar are similar, with most of the sound energy below 100 Hz. The broadband (10-10,000 Hz) level was about 2 dB higher during drilling than without, but relatively low in both cases (99 vs. 97 dB re 1µPa; Blackwell and Greene 2006).

In air, drilling sounds were not distinguishable from overall island sounds based on spectral characteristics or on broadband levels (Blackwell et al. 2004b). A similar result was found for recordings from geophones: broadband levels of iceborne vibrations with or without drilling were indistinguishable (Blackwell et al. 2004b). Thus, airborne sounds and iceborne vibrations were not strong enough during drilling to have much influence on overall Northstar sound, in contrast to underwater sounds, which were higher during drilling (Blackwell and Greene 2006).

Richardson et al. (1995b) summarized then-available data and stated that sounds associated with drilling activities vary considerably, depending on the nature of the ongoing operations and the type of drilling platform (island, ship, etc.). Underwater sound associated with drilling from natural barrier islands or an artificial island built mainly of gravel is generally weak and is inaudible at ranges beyond several kilometers. The results from the Northstar monitoring work in more recent years are generally consistent with the earlier evidence.

Other operational sounds
Ice-covered season

Both with and without drilling, underwater broadband levels recorded north of the island during the ice-covered season were similar with and without production (Blackwell et al. 2004b). Although the broadband underwater levels did not seem to be affected appreciably by production activities, a peak at 125-160 Hz could be related to production. This peak was no longer detectable 5 km (3.1 mi) from the island, either with or without simultaneous drilling (Blackwell et al. 2004b). Thus, oil production at Northstar during the ice-covered season did not appear to cause any substantial increase in overall levels of underwater sound relative to the levels with the island present but without active oil production. However, production probably caused a change in frequency composition. This is to be expected for two reasons: 1) “no production” recordings were obtained while diesel generators provided the island’s power source (2001), whereas “production” recordings were obtained after the island had shifted to gas turbines (2002); and 2) production implies the use of compressors, which were a new sound source. The transition did not seem to result in detectable changes in broadband levels of island sounds in the water or in the ice, although the in-air levels might have increased by a few dB (Blackwell et al. 2004b).

Open-water season

Underwater and in-air production sounds from Northstar Island were recorded and characterized during nine open-water seasons from 2000-2008 (Blackwell and Greene 2006; Blackwell et al. 2009). Data on underwater sounds were obtained during the fall whale migration (late August-early October) via:

1. Boat-based recordings 0.3-37 km (0.2-23 mi) from the island (2000-2003)
2. Cabled hydrophone (2000-2003) and autonomous directional seafloor acoustic recorders (DASARs; 2003-2008) deployed about 450 m (0.3 mi) north of Northstar
3. DASARs deployed within a range of 6.5-38.5 km (4-24 mi) north of Northstar

Island activity sounds recorded during 2003-2008 island activities mainly consisted of production related sounds and maintenance activities on the protection barrier, similar to what is expected for 2014-2019. During the open water season, vessels were the main contributors to the underwater sound field at Northstar (Blackwell and Greene 2006).

During the drilling and production phase, island sounds underwater reached background values at distances of 2-4 km (1.2-2.5 mi; Blackwell and Greene 2006). For each year, percentile levels of broadband sound (maximum, 95^{th}, 50^{th}, and 5^{th} percentile, and minimum) were computed over the entire field season. The range of broadband levels recorded during 2001-2008 for all percentiles is 80.8-141 dB re 1 μPa. The maximum levels are mainly determined by the presence of vessels and can be governed by one specific event. The 95th percentile represents the sound level generated at Northstar during 95 percent of the time. From 2004-2008, these levels ranged from 110-119.5 dB re 1 μPa at about 450 m (0.3 mi) from Northstar. Much of the variation in received levels was dependent on sea state, which is correlated with wind speed. The lowest sound levels in the time series are indicative of the quietest times in the water near the island, and generally correspond to times with low wind speeds. Conversely, high wind speed usually corresponds to increased broadband levels in the DASAR record (Blackwell et al. 2009).

Percentile distributions of one-third octave band levels and spectral density levels were calculated to characterize the frequency composition of sounds near Northstar. Overall, the spectra for Northstar are very similar between years. For example, peaks were present at 30 Hz and 60 Hz. These peaks have been present every year of monitoring and are associated with generation of 60 Hz power. There was also a peak at 87 Hz, which has been present since 2003 and which we attribute to the LP compressor of compressor Module L1 (Spence 2006).

Airborne sounds were recorded concurrently with the boat-based recordings in 2000-2003 (Blackwell and Greene 2006). The strongest broadband airborne sounds were recorded about 300 m (1,000 ft.) from Northstar Island in the presence of vessels, and reached 61-62 dBA re 20μPa. These values are expressed as A-weighted levels on the scale normally used for in-air sounds. In-air sounds generally reached a minimum 1-4 km (0.6-2.5 mi) from the island, with or without the presence of boats.

Transportation sounds

During Northstar operations from 2000-2002, underwater sound from vehicles traveling along the ice road diminished to background levels at distances ranging from 4.6-9.5 km (2.9-5.9 mi). In-air sound levels of these activities reached background levels at distances ranging from 100-600 m (328-1,969 ft.; Table 4).

Sounds and vibrations from vehicles traveling along an ice-road constructed across the grounded sea ice and along Flaxman Island (a barrier Island east of Prudhoe Bay) were recorded in air and within artificially constructed polar bear dens in March 2002 (MacGillivray et al. 2003). Underwater recordings were not made. Sounds from vehicles traveling along the ice-road were attenuated strongly by the snow cover of the artificial dens; broadband vehicle traffic noise was reduced by 30-42 dB. Sound also diminished with increasing distance from the station. Most vehicle noise was indistinguishable from background (ambient) noise at 500 m (1,640 ft.), although some vehicles were detectable to more than 2,000 m (1.2 mi). Ground vibrations (measured as velocity) were undetectable for most vehicles at a distance of 100 m (328 ft.), but were detectable to 200 m (656 ft.) for a Hägglunds tracked vehicle (MacGillivray et al. 2003).

Helicopters will be used for personnel and equipment transport to and from Northstar during the unstable ice periods in spring and autumn. Helicopters flying to and from Northstar generally maintain straight-line routes at altitudes of 300 m (1,000 ft.), thereby limiting the received levels at and below the surface. 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 about 300 m (1,000 ft.), which is the minimum allowed altitude for the Northstar helicopter under normal operating conditions, varied between 106-111 dB re 1µPa at 9 and 18 m (30 and 59 ft.) 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).

Under calm conditions, rotor and engine sounds are coupled into the water within a 26º cone beneath the aircraft. Some of the sound transmits beyond the immediate area, and some sound enters the water outside the 26º cone when the sea surface is rough. However, scattering and absorption limit lateral propagation in shallow water. For these reasons, helicopter and fixed-wing aircraft flyovers are not heard underwater for very long, especially when compared to how long they are heard in air as the aircraft approaches, passes, and moves away from an observer. Tones from helicopter traffic were detected underwater at a horizontal distance about 450 m (1,476 ft.) from Northstar, but only during helicopter departures from Northstar (Blackwell et al. 2009). The duration of the detectable tones, when present, was short (20-50 s) and received sound levels were weak, sometimes barely detectable. The lack of detectable tones during 65 percent of the investigated helicopter departures and arrivals supports the importance of the aircraft's path in determining whether tones will be detectable underwater. Helicopter tones were not detectable underwater at the most southern DASAR location, about 6.5 km (4 mi) north of Northstar.

Vessels

Principally the crew boat, tugs, and self-propelled barges will be the main contributors to the underwater sound field at Northstar during 2014-2019 (Blackwell and Greene 2006). Vessel sounds are a concern due to the potential disturbance to marine mammals (Richardson et al. 1995b). Characteristics of underwater sounds from boats and vessels have been reported extensively, including specific measurements near Northstar (Greene and Moore 1995; Blackwell and Greene 2006). Broadband source levels for most small ships (lengths about 55-85 m (180-279 ft.)) are around 160-180 dB re 1 µPa. Both the crew boat and the tugs produced substantial broadband sound in the 50-2000 Hz range, which could, in part, be accounted for by propeller cavitation (Ross 1976). Several tones were also apparent in the vessel sounds, including one at 17.5 Hz, corresponding to the propeller blade rate of Ocean Class tugs. Two tones were identified for the crew boat: one at 52-55 Hz, which corresponds to the blade rate, and one at 22-26 Hz, which correspond to a harmonic of the shaft rate.

The presence of boats considerably expanded the distances to which Northstar-related sound was detectable, therefore, BPXA looked into options to reduce vessel use. A small, diesel-powered hovercraft (a Griffon 2000TD) was tested to transport crew and supplies between the mainland and Northstar Island. Acoustic measurements showed the hovercraft was considerably quieter underwater than similar sized conventional vessels (Blackwell and Greene 2005). Received underwater broadband sound levels at 6.5 m (21.3 ft.) from the hovercraft reached 133 and 131 dB re 1 µPa for hydrophone depths 1 m and 7 m (3 ft. and 23 ft.), respectively. In-air unweighted and A-weighted broadband (10-10,000 Hz) levels reached 104 and 97 dB re 20 μPa, respectively. Hovercraft use for Northstar transport resulted in a decreased number of elevated vessel noise ("vessel spikes") events in the acoustic records of the near-island DASARs (Blackwell et al. 2009).

Sound propagation

Underwater propagation

Overall sound levels at Northstar during the open-water season were highly influenced by the presence or absence of vessels (Blackwell and Greene 2006). With vessels, received levels continued to decrease until the farthest distance sampled, about 30 km (18.6 mi), indicating that background levels were not reached at that distance. Northstar sounds during the ice-covered season reached background levels underwater by 9.4 km (5.8 mi) with drilling and 3-4 km (1.9-2.5 mi) without drilling. At times with higher background noise (e.g., windy periods) Northstar sounds disappeared below ambient levels at closer distances, as expected.

In-air propagation

The strongest broadband airborne sounds were recorded about 300 m (1,000 ft.) from Northstar Island in the presence of vessels, and reached 61-62 dBA re 20 μPa. In-air sounds generally reached a minimum 1-4 km (0.6-2.5 mi) from the island, with or without the presence of boats. Beyond those distances, in-air sounds were principally affected by wind.

During the ice-covered season the strongest broadband airborne sounds were 74 and 80 dBA re 20 μPa during production without and with drilling, respectively, as recorded 470 m and 220 m (1,541 ft. and 722 ft.) from the island, respectively. Airborne sounds diminished to background levels at 5 km (3.1 mi) and 9.4 km (5.8 mi) without and with drilling, respectively.

Ambient Noise

Ambient noise is the background sound of physical and biological origin, excluding sounds from specific identifiable sources. Marine mammals are unable to detect industrial noise and sounds from other mammals if these signals are much weaker than the ambient noise levels at corresponding frequencies. Natural ambient noise can mask weak sound signals from natural or human origins. Marine mammals must be adapted to the natural ambient noise levels that prevail in their environment. Ambient levels are thus important for understanding the natural environmental constraints on an animal's ability to detect mammal calls, anthropogenic sounds, and other relevant sounds.

Ambient noise levels in air over the Beaufort Sea are expected to be dominated by wind noise during the ice-covered and broken ice season, and by noise from wind and breaking waves during the open water season. However, there has been no specific effort to measure in-air ambient noise in this region.

Primary sources of underwater ambient noise near the Northstar area are wind and waves, ice, and sounds from biological origins (e.g., bearded seals, bowhead whales, and to a much lesser extent ringed seals and beluga whales). Of these sources, wind is the primary influence on ambient noise level in the absence of human activities, directly and through its effects on ice and waves. In spring, bearded seal calls are also a prominent contributor to ambient noise at many times, and bowhead whale calls are common in late summer and autumn. During winter and spring, when the Northstar area is covered by landfast ice, natural ambient noise levels below the ice are low. Levels in these conditions are often below those typical of calm conditions in open water (Greene and Buck 1964; Milne and Ganton 1964).

Ambient noise data were collected in the Prudhoe Bay region during the open water seasons of 1995-1998. Sonobuoy data from August 1995 showed 5th, 50th, and 95th percentile ambient levels in the 20-1000 Hz band of 77, 95, and 104 dB re 1 μPa (LGL and Greeneridge 1996a). At low frequencies (20-100 Hz), median levels of natural ambient noise measured in these shallow waters were similar to the levels expected in deep waters of the North Atlantic and North Pacific oceans.

Marine mammals inhabiting the Northstar area are likely accustomed to a range of natural sound levels. In the absence of boats, underwater sounds from Northstar Island (during drilling and production) were at background values at distances beyond 2-4 km (1.2-2.5 mi) away from Northstar in low to moderate wind conditions (Blackwell and Greene 2006). However, when vessels were present at Northstar Island, received levels within at least 20-30 km (12.4-18.6 mi) of the island were above background levels (Blackwell and Greene 2006).

Potential impacts on cetaceans

The only endangered cetacean species that occurs in the Northstar/Prudhoe Bay area and has the potential to be impacted by Northstar related activities is the bowhead whale. Production activities, aircraft and vessel traffic, and oil spills can potentially have an effect on cetacean behavior, lead to disturbance, or (in the case of oil spills) physically affect whales.

Sound effects on cetaceans

The possible categories of noise effects on marine mammals that are relevant here are behavioral disturbance, associated habituation effects, masking, and possible effects on hearing sensitivity. To assess the potential sound effects on cetaceans it is important to understand the sound characteristics produced by the different industrial activities, and the hearing abilities of the receiver, in this case the bowhead whale occurring in the area. Hearing abilities have not been measured directly in many cetaceans (e.g., for any baleen whale), and in these cases understanding the call characteristics is relevant in assessing the likely frequency range for best hearing. Also, the characteristics of marine mammal calls are relevant in assessing the potential masking effects of man-made sounds.

<u>Cetacean hearing abilities and sound production</u>

Cetacean hearing has been studied in relatively few species and individuals. Based on current knowledge of functional hearing in marine mammals, three distinct, functional hearing categories were defined for cetacean species (Southall et al. 2007): 1) low-frequency cetaceans (baleen whales); 2) “mid”-frequency cetaceans (most odontocetes, including beluga whale), and 3) high frequency cetaceans (most small odontocetes, e.g., porpoises, river dolphins, pygmy sperm whale).

The auditory sensitivity of bowhead whales and other baleen whales has not been measured, but relevant anatomical and behavioral evidence is available. These whales appear to be specialized for low frequency hearing, with some directional hearing ability (Richardson et al. 1995b; Ketten 2000). Their auditory bandwidth (estimated lower to upper frequency hearing cut-off) is believed to range from 7 Hz-22 kHz (Southall et al. 2007), or perhaps higher in the minke whale (Berta et al. 2009). This means that their optimum hearing overlaps broadly with the low frequency range where production activities and associated vessel traffic emit most of their energy.

Call characteristics of cetaceans provide some limited information on their hearing abilities, although the auditory range often extends beyond the range of frequencies contained in the calls. Also, understanding the frequencies at which different marine mammal species communicate is relevant for the assessment of potential impacts from manmade sounds.

Most bowhead whale calls are tonal, frequency-modulated sounds at frequencies of 50 Hz and 400 Hz. These calls overlap broadly in frequency with the underwater sounds emitted by many operational activities (Richardson et al. 1995b). Some bowhead calls contain energy up to 1,200 Hz (Clark and Johnson 1984; Würsig and Clark 1993), but most of the energy is below 500 Hz. Bowhead "songs" occur in late winter and spring but have not been reported in late summer or autumn. Functions of bowhead whale calls are not positively known, but are believed to: 1) maintain contact among widely separated individuals, 2) mother-calf interactions, and 3) various other social functions. Calls may be especially important during migration through ice. Source levels are quite variable, with the stronger calls having source levels up to about 180 dB re 1 μPa-m. Some bowhead whale calls are detectable more than 20 km (12.5 mi) away, but the ability to detect calls at long range diminishes with increasing background noise level (Greene et al. 2004).

Possible effects on hearing sensitivity

Temporary or permanent hearing impairment is a possibility (although rarely demonstrated) when marine mammals are exposed to very strong sounds. There are no data on received sound levels necessary to cause temporary threshold shift in baleen whales. For toothed whales, there are data concerning temporary threshold shifts for the common bottlenose dolphins (*Tursiops truncatus*) and beluga whales exposed to a single short noise pulse (Schlundt et al. 2000, 2006; Finneran et al. 2002, 2005, 2007) as well as dolphins exposed to more prolonged sounds (Nachtigall et al. 2003, 2004). The lowest received level that elicited a mild temporary threshold shift was 192 dB re 1 μPa for a 1-s pulse, and about 175 dB for a prolonged (about 55 min) exposure. Permanent hearing impairment would not be expected in beluga whales unless sound levels were substantially higher than those required to induce temporary threshold shift (Southall et al. 2007). Such exposures will not occur near Northstar, given the empirical data on sound levels near the operations. Cetaceans will not occur near Northstar during the ice-covered season.

Pressure pulses from explosions can cause permanent auditory damage and, if the cetacean is close to the blast, other injuries or death (Todd et al. 1996). However, explosions are not planned to occur as part of the ongoing Northstar operations.

Overall, temporary threshold shifts and permanent hearing damage are not expected to occur in cetaceans during the drilling and production activities at Northstar.

Masking

No masking effects on bowhead whales will occur during the ice-covered seasons because these whales will not occur near Northstar during that time. The sounds from oil production and any drilling activities are not expected to be detectable beyond several kilometers from the source (Greene 1983; Blackwell et al. 2004b; Blackwell and Greene 2006; Blackwell and Greene 2005). Sounds from vessel activity, however, were detectable to distances as far as about 30 km (18.6 mi) from Northstar (Blackwell and Greene 2006). Because of the transient nature of vessel noise, it will not cause significant masking effects. However, vessels under power to maintain position can be a significant source of continuous noise (Blackwell et al. 2004b; Blackwell and Greene 2006), with potential to cause some degree of masking.

Although some bowhead whales are found in the Chukchi and Bering seas in summer, the majority of the Western Arctic bowhead whale migrates annually from winter areas in the northern Bering Sea, through the Chukchi Sea (April through May), to the Beaufort Sea (June through August), before returning to the Bering Sea (August through December) to overwinter (Moore and Reeves 1993, Quakenbush et al. 2010a). With nearly the entire Western Arctic bowhead whale population migrating through the waters offshore of the Northstar facility, a small number of bowhead whales could be present near Northstar during the open-water season. We would expect that relatively few bowhead whales would enter within the area where vessel noise may cause masking. Almost all energy in the sounds emitted by drilling and other operational activities is at low frequencies, predominantly below 250 Hz, with another peak centered around 1,000 Hz. Most energy in the sounds from the vessels and aircraft to be used during this project is below 1 kHz (Moore et al. 1984; Greene and Moore 1995; Blackwell et al. 2004b; Blackwell and Greene 2006). These frequencies are mainly used by mysticetus, like bowhead whales.

An industrial sound source will reduce the effective communication or echolocation distance only if its frequency is close to that of the cetacean signal, and if it's received level is appreciably above the then-prevailing ambient noise level. If little or no overlap occurs between the industrial noise and the frequencies used, communication and echo location are not expected to be disrupted. Furthermore, the relatively low effective source levels and rapid attenuation of drilling and production sounds from artificial islands in shallow water makes significant masking effects unlikely, even for mysticetes that are within several kilometers of Northstar Island.

Certain cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, or possibly to shift their peak frequencies in response to strong ambient signals (Dahlheim 1987; Au 1993; Lesage et al. 1993, 1999; Parks et al. 2009). These adaptations, along with directional hearing, pre-adaptation to tolerate some masking by natural sounds, and the brief periods when most individual whales occur near Northstar, would all reduce the potential impacts from masking. Overall, masking effects from underwater sounds associated with project activities will have negligible effects on the bowhead whale's abilities to hear other sounds.

Behavioral reactions to noise and disturbance

Disturbance is the main concern in this project. Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as:

> Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

When the received noise level exceeds some behavioral reaction threshold, cetaceans will show disturbance reactions. The levels, frequencies, and types of noise that elicit a response vary among and within species, individuals, locations, and seasons. Behavioral changes may be subtle alterations in surface-respiration-dive cycles, while more conspicuous responses may be changes in activity or aerial displays, movement away from the sound source, or (at least in theory) complete avoidance of the area. The reaction threshold and degree of response are related to the animal's activity at the time of the disturbance. Whales engaged in active behaviors such as feeding, socializing, or mating are less likely than resting animals to show overt behavioral reactions. However, they may do so if the received noise level is high or the source of disturbance is directly threatening.

Behavioral reactions do not occur throughout the zone ensonified by industrial activity. In most cases that have been studied, including work on bowhead whales, the actual radius of effect is considerably smaller than the radius of detectability (Richardson et al. 1995b; Southall et al. 2007).

Effects from drilling and production

Bowhead whale spring migration through the western and central Beaufort Sea occurs during April-June. Their spring migration corridors are far north of the barrier islands and the Northstar project area. Bowhead whales will not be within the Northstar project area during winter or spring. In addition, industrial sounds from Northstar are unlikely to be detectable far enough offshore to be heard by spring-migrating bowhead whales. In rare cases, where these sounds might be audible to cetaceans in spring, the received levels would be weak and very unlikely to elicit behavioral reactions. Consequently, noise from operational activities at Northstar during the ice-covered seasons would have no effects on whales.

During the open-water season, sound propagation from sources on the island is reduced because of poor coupling of sound through the gravel island into the shallow waters. In the absence of boats, underwater sounds from Northstar Island during construction, drilling, and production reached background values 2-4 km (1.2-2.5 mi) away in quiet conditions (Blackwell and Greene 2006). However, when Northstar-related vessels were present, levels were higher and faint vessel sound was often still evident 20-30 km (12.4-18.6 mi) away.

Information is limited on cetacean reactions to heavy equipment activity on artificial (or natural) islands (Richardson et al. 1995b). Richardson et al. (1990) showed that, at least in summer, bowhead whales generally tolerated playbacks of low-frequency construction and dredging noise at received broadband levels, up to about 115 dB re 1 μPa. At received levels higher than about 115 dB, some avoidance reactions were observed. Bowhead whales apparently reacted in only a limited and localized way (if at all) to construction of Seal Island, the precursor to Northstar Island (Hickie and Davis 1983).

There are no specific data on bowhead whale reactions to noise from drilling on an artificial island. However, playback studies have shown that they begin to show overt behavioral responses to various low-frequency industrial sounds when received levels exceed 115-120 dB re 1 μPa (Richardson et al. 1990, 1995a, 1995b). The overall received level of drilling sound from Northstar Island generally diminished to 115 dB within 1 km (0.62 mi; Blackwell et al. 2004b). Any reactions by bowhead whales to drilling at Northstar were, therefore, expected to be highly localized and would involve few whales.

Prior to construction of Northstar, it was expected (based on early data mentioned above) that some bowhead whales would avoid areas where noise levels exceeded 115 dB re 1 μPa (Richardson et al. 1990). It was expected that, during most autumn migration seasons, few bowhead whales would come close enough to shore to receive sound levels that high from Northstar. Thus disturbance effects from continuous operational noise were expected to be limited to the closest whales and at times with the highest sound emissions.

In 2000-2004, bowhead whales were monitored acoustically to determine the number of whales that might have been exposed to Northstar related sounds. Data from 2001-2004 were useable for this purpose. The results showed that during late summer and early autumn in 2001, a small number of bowhead whales in the southern part of the migration corridor (closest to Northstar) were apparently affected by vessel or Northstar operations. At these times, most "Northstar sound" was from maneuvering vessels, not the island itself. The distribution of calling whales was analyzed and the results indicated that the apparent southern (proximal) edge of the call distribution was significantly associated with the level of industrial sound output each year, with the southern edge of the call distribution varying by 0.76-2.35 km (0.47-1.46 mi; depending on year) farther offshore when underwater sound levels from Northstar and associated vessels were above average (Richardson et al. 2008a). It is possible that the apparent deflection effect was, at least in part, attributable to a change in calling behavior rather than actual deflection. In either case, there was a change in the behavior of some bowhead whales.

Migrating bowhead whales whose paths are deflected offshore by no more than a few kilometers would not, in most cases, incur biologically significant effects. A deflection by (at most) a few kilometers is well within the range of normal variability in the offshore distances of migrating bowhead whales. Given that, no significant effects on individual health and overall population would be expected.

Effects from aircraft activity

Helicopters are the only aircraft associated with Northstar drilling and oil production operations for crew transfer, and supply and support. Helicopter traffic occurs during late spring/summer and fall/early winter when travel by ice roads, hovercraft, or vessels is not possible. Twin otters are used for routine pipeline inspections.

Low passes by aircraft over a cetacean, including a bowhead whale, result in short-term responses or no discernible reaction. Responses can include sudden dives or rapidly swimming away from the aircraft track (Richardson et al. 1995b; Patenaude et al. 2002). The activity of the animal during an over flight tends to be related to the "severity" of the reaction, with feeding or socializing animals the least likely to respond. Responses range from no overt reaction to a dramatic disruption in activities. Known or suspected reasons for this variation include aircraft altitude, engine setting changes, aircraft type, weather conditions, and whale activity at the time. Whales appear less disturbed by quiet aircraft flying at slow speeds and reduced engine power. Single over flights may elicit a sudden dive, which probably represents a startle reaction to the visual appearance or sudden noise of the aircraft. Reactions tend to be more common when aircraft altitude is low (e.g., 75-150 m (250-500 ft.)) and infrequent when higher (300-450 m (1,000-1,500 ft.)), but there is much variability. Continued disturbance by an aircraft, such as prolonged circling overhead at low altitude, often results in dispersal of the individuals and departure from the area.

There is little likelihood of project-related helicopter and aircraft traffic over bowhead whales during the fall migration. Helicopter and aircraft traffic is between the shore and Northstar Island. Almost all bowhead whales migrate west in waters farther north. Helicopters maintain an altitude of 305 m (1,000 ft.) above sea level while traveling over water to and from Northstar, whenever weather conditions allow. It is unlikely that there will be any need for helicopters or aircraft to circle or hover over the open water, other than when landing or taking off. Even if several bowhead whales did react to a single helicopter or an aircraft overflight, the whales' reaction would be brief and of no long-term consequence to the population.

Effects from vessel activity
Reactions of cetaceans to vessels often include changes in general activity (e.g., from resting or feeding to active avoidance), changes in surfacing-respiration-dive cycles, and changes in speed and direction. As with aircraft, responses to vessel approaches tend to be reduced if the animals are actively involved in a specific activity such as feeding or socializing (Richardson et al. 1995b). The animals' past experiences with vessels are important to determine the degree and response type elicited from a whale-vessel encounter.

Whales react most noticeably to erratically moving vessels with varying engine speeds and gear changes, and to vessels in active pursuit. Avoidance reactions by bowhead whales sometimes begin as subtle alterations in whale activity, speed, and heading, as far as 4 km (2.5 mi) from the vessel. Consequently, the closest point of approach is farther from the vessel than if the cetacean had not altered course. Bowhead whales sometimes begin to swim actively away from approaching vessels when they come within 2-4 km (1.2-2.5 mi). If the vessel approaches to within several hundred meters, the response becomes more noticeable; and whales sometimes change direction to swim perpendicularly away from the vessel path (Richardson et al. 1985, 1995b; Richardson and Malme 1993).

During the drilling and oil production phase of the Northstar development, most vessel traffic involves slow-moving tugs and barges, and smaller faster-moving vessels providing local transport of equipment, supplies, and personnel. Much of this traffic will occur during August and early September, before many whales are in the area. Some vessel traffic during the broken ice periods in the spring and fall may also occur. Alternatively, small hovercraft may be used during the spring and fall when the ice is too thin to allow safe passage by large vehicles over the ice road.

Whale reactions to slow-moving vessels are less dramatic than are their reactions to faster and/or erratic vessel movements. Bowhead whales often tolerate the approach of slow-moving vessels within several hundred meters. This is especially so when the vessel is not directed toward the whale, and when there are no sudden changes in direction or engine speed (Wartzok et al. 1989; Richardson et al. 1995b; Heide-Jørgensen et al. 2003).

Most vessel traffic associated with Northstar will be inshore of the bowhead whale migration corridor, and/or prior to their migration season. Underwater sounds from the hovercraft are generally lower than sounds for standard vessel; since the sound is generated in air, rather than underwater. If vessels or hovercraft do approach whales, a small number of individual bowhead whales may show short-term avoidance reactions. These will be of no long-term significance to individuals and the population.

The highest levels of underwater sound produced by routine Northstar operations are generally associated with Northstar-related vessel operations. These vessel operations around Northstar sometimes result in sound levels high enough that a small number of bowhead whales in the southern part of the migration corridor appear to be deflected slightly offshore. To the extent that offshore deflection occurs as a result of Northstar, it is mainly attributable to Northstar-related vessel operations.

Migrating bowheads whose paths are deflected offshore by no more than a few kilometers would not, in most cases, incur biologically significant effects. A deflection by (at most) a few kilometers is well within the range of normal variability in the offshore distances of migrating bowheads. This deflection is expected to involve few whales and generally small deflections, and is unlikely to have important consequences for individual bowhead whales or the population.

Most vessel traffic associated with Northstar will be south and west of Cross Island. The vessel traffic is not expected to affect subsistence activities at Cross Island.

Effects from oil on cetaceans

The specific effects from an oil spill on bowhead whales are not well known. Direct mortality is unlikely. However, exposure to spilled oil potentially leads to skin irritation; baleen fouling, which might reduce feeding efficiency; respiratory distress, from inhaling hydrocarbon vapors; feeding on contaminated prey items; and temporary displacement from contaminated feeding areas. Geraci and St. Aubin (1990) summarize oil effects on marine mammals, and Bratton et al. (1993) provides a synthesis of knowledge of oil effects on bowhead whales. The number of whales that might be contacted by a spill would depend on the spill's size, timing, and duration. Whales may not avoid oil spills, and some have been observed feeding within oil slicks.

In the case of an oil spill occurring during migration periods, disturbance to the migrating cetaceans from cleanup activities may have more of an impact than the oil itself. Human activity associated with cleanup efforts could deflect whales away from the path of the oil. However, noise created from cleanup activities likely will be short term and localized, with no long-term consequences for individuals or populations. In fact, whale avoidance of clean-up activities may benefit whales by displacing them from the oil spill area.

There is no concrete evidence that oil spills, including the much studied Santa Barbara Channel and Exxon Valdez spills, have caused the death of cetaceans (Brownell 1971; Geraci 1990; Harvey and Dahlheim 1994). It is suspected that some individually identified killer whales that disappeared from Prince William Sound during the time of the Exxon Valdez spill were casualties of that spill. However, no clear cause and effect relationship between the spill and the disappearance could be established (Dahlheim and Matkin 1994). The AT-1 pod of transient killer whales that sometimes inhabits Prince William Sound has continued to decline after the Exxon Valdez oil spill (EVOS), and has been designated depleted under the MMPA (69 FR 31321, June 3, 2004). No effects on humpback whales in Prince William Sound were evident after the EVOS (von Ziegesar et al. 1994). There was some temporary displacement of humpback whales out of Prince William Sound, but this could have been caused by oil contamination, displacement of prey sources, boat and aircraft disturbance, or other causes.

Migrating gray whales were apparently not greatly affected by the Santa Barbara oil spill. There appeared to be no relationship between the spill and marine mammal mortalities. The higher than usual reports of dead marine mammals after the spill represented an increased survey effort (Brownell 1971; Geraci 1990). The conclusion was that whales were either able to detect the oil and avoid it, or were unaffected by it (Geraci 1990).

Oiling of external surfaces

Whales rely on a layer of blubber for insulation, so oil would have little if any effect on thermoregulation by whales. Oiling effects on cetacean skin appear to be minor and of little significance to the animal's heath (Geraci 1990). It can be assumed that if oil contacted the eyes, effects would be similar to those observed in ringed seals; while continued exposure of the eyes to oil could cause permanent damage (St. Aubin 1990).

Ingestion

Whales could ingest oil through contaminated prey, or oil could be absorbed through the respiratory tract. Some ingested oil is voided in vomit or feces, but some is absorbed and can cause toxic effects (Geraci 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982). Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982) and this kind of damage has not been reported (Geraci 1990).

Fouling of baleen

If a bowhead whale encountered spilled oil, baleen hairs might be fouled, which would reduce a whale's filtration efficiency during feeding. Lambertsen et al. (2005) concluded that because previous "(E)xperimental assessment of the effects of baleen function...thus far has considered exclusively the role of hydraulic pressure in powering baleen function..." but "...our present results indicate that more subtle hydrodynamic pressure may play a critical role in the function of the baleen in the... balaenids...the current state of knowledge of how oil would affect the function of the mouth of right whales and bowhead whales can be considered poor, despite considerable past research on the effects of oil on cetaceans."

Lambertsen et al. (2005) contended that oil could be efficiently ingested if globules of oil behave like prey inside the mouth. They point out that if oil is of low viscosity and does not behave like prey, only small amounts would be ingested. Lambertsen et al. (2005) characterize these two conditions as being of "questionable validity" and note that if, on the other hand, the resistance of the baleen is significantly increased by oil fouling, as experimental evidence on the baleen of other mysticetes indicates it may be, the most likely adverse effect "...would be a substantial reduction in capture of larger, more actively mobile species, that is euphausiids, with possible reductions in capture of copepods and other prey" (Lambertsen et al. 2005). They concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

Avoidance

Some cetaceans can detect oil and sometimes avoid it, but others enter and swim through slicks without apparent effects (Geraci 1990; Harvey and Dahlheim 1994). Bottlenose dolphins apparently could detect and avoid slicks and mousse, but did not avoid light sheens on the surface (Smultea and Würsig 1995). After the *Regal Sword* spill, various species of baleen and toothed whales were observed swimming and feeding in areas containing spilled oil southeast of Cape Cod, MA (Goodale et al. 1981).

<u>Factors affecting the severity of effects</u>

Oil effects on whales in open water are likely to be negligible, but there could be effects on whales where both the oil and the whales are at least partly confined in leads or at ice edges (Geraci 1990). In spring, bowhead whales migrate through leads in the ice. At this time, the migration can be concentrated in narrow corridors defined by the leads. However, given the probable alongshore trajectory of oil spilled from Northstar in relation to the whale migration route through offshore waters, interactions between oil slicks and whales are unlikely in spring.

In fall, the bowhead whale migration route can be close to shore (Blackwell et al. 2009). If fall migrants were moving through leads in the pack ice, or were concentrated in nearshore waters, some bowhead whales might not be able to avoid oil slicks and could be subject to prolonged contamination. However, the autumn migration past the Northstar area extends over several weeks and most whales travel along routes well north of Northstar. Thus, only a small minority of bowhead whales are likely to approach the spilled oil. Additionally, vessel activity associated with spill cleanup efforts may deflect any whales traveling nearshore farther offshore, and thereby reduce the likelihood of contact with spilled oil. Also, during years when spilled oil and whale migrations might be partially confined by ice, the bowhead migration corridor tends to be farther offshore (Treacy 1997; LGL and Greeneridge 1996a; Moore 2000).

Effects from oil spill cleanup activities

Oil spill cleanup activities could increase disturbance effects on either whales or seals, causing temporary disruption and possible displacement (MMS 1996). The Northstar Oil Discharge Prevention and Contingency Plan (BPXA 1998a, b) includes a scenario of a production well blowout to the open water in August. In this scenario, approximately 177,900 barrels of North Slope crude oil will reach the open water. It is estimated that response activities will require 186 staff (93 per shift) using 33 vessels (BPXA 1998b) for about 15 days, to recover oil in open water. Shoreline cleanup will occur for about 45 days employing low pressure, cold water deluge on the soiled shorelines. In a similar scenario during solid ice conditions, it is estimated that 97 pieces of equipment, along with 246 staff (123 per shift), will be required for response activities (BPXA 1998a).

In the event that a large spill contacts and extensively oils coastal habitats, the presence of response staff, equipment, and the many aircraft involved in the cleanup will (depending on the time of the spill and its cleanup), potentially displace seals and other marine mammals. Oil spill cleanup activity could exacerbate and increase disturbance effects on subsistence species, cause localized displacement of subsistence species, and alter or reduce access to those species by hunters. On the other hand, the displacement of marine mammals away from oil contaminated areas by cleanup activities would reduce the likelihood of direct contact with oil.

The potential effects on cetaceans are expected to be less than those on seals. Cetaceans tend to occur well offshore where cleanup activities (in the open-water season) are unlikely to be as concentrated. Also, cetaceans are transient and, during the majority of the year, they are absent from the area. However, if an oil spill does occur, it is likely that large numbers of personnel, vessels, and aircraft will be present and will conduct cleanup operations near Northstar. 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.

Conclusions regarding effects on cetaceans

The proposed activity will consist of oil production and associated gas injection, minor construction operations (i.e., island maintenance and repair), and possible drilling activity during two main periods: the ice-covered season and the open-water season. During the ice-covered season, cetaceans will not be in the Northstar areas. The planned activities will have no effect on bowhead whales migrating east through offshore waters of the Beaufort Sea during the spring.

In the open-water period, the principal activities will be related to oil production, and associated helicopter and vessel traffic. Underwater sounds from continuous production activities on the islands are not expected to be detectable more than about 2-4 km (1.2-2.5 mi) offshore of Northstar Island. Sounds of transient nature, such as vessel traffic, can be detectable to distances of about 30 km (18.6 mi) from the island. Disturbance to bowhead whales by on-island activities will be limited to substantially less than that distance.

Helicopter traffic will be limited to nearshore areas between the mainland and the islands, and is very unlikely to approach or disturb whales. Barge and vessel traffic will be located mainly inshore of the migrating whales, and will involve vessels moving slowly, in a straight line and at constant speed. Little disturbance or displacement of whales by vessel traffic is expected. Vessels operating for prolonged periods around Northstar may at times produce sufficient underwater sound to cause slight offshore deflection or other behavioral changes in a small minority of the bowhead whales passing Northstar at those times. No biologically significant consequences are expected either for individual bowhead whales or for the population.

Potential impacts on pinnipeds
NMFS listed the Beringia DPS of the bearded seal and the arctic subspecies of the ringed seal as threatened species. Both occur in the Northstar/Prudhoe Bay area and have the potential to be impacted by Northstar related activities. Possible impacts on pinnipeds from activities at and near Northstar involve both acoustic and non-acoustic effects.

Effects of sound on pinnipeds
To determine the effects of man-made sounds on marine mammal species it is important to understand the characteristics of the sound sources, sound propagation, and the ambient or natural sound levels. In addition it is relevant to understand the hearing abilities and sound production of the receiver, in this case pinnipeds.

Pinniped hearing abilities and sound production
Pinniped (and other animals) hearing abilities are functions of the following (Richardson et al. 1995b):

1. Absolute hearing threshold (i.e., the level of sound barely audible in the absence of ambient noise).
2. Critical ratio (i.e., the signal-to-noise ratio required to detect a tonal sound in the presence of background noise).
3. The ability to localize sound direction at the frequencies under consideration.
4. The ability to discriminate among sounds of different frequencies and intensities.

Underwater audiograms have been obtained using behavioral methods for four species of phocinid seals: ringed seal, harbor seal, harp seal (*Pagophilus groenlandicus*), and northern elephant seal (*Mirounga angustirostris*) (Richardson et al. 1995b; Kastak and Schusterman 1998). Below 30-50 kHz, the hearing threshold of phocinids is essentially flat down to at least 1 kHz, and ranges between 60-85 dB re 1 μPa. There are few published data on in-water hearing sensitivity of phocid seals below 1 kHz. However, measurements for one harbor seal indicated that, below 1 kHz, its thresholds deteriorated gradually to 96 dB re 1 μPa at 100 Hz (Kastak and Schusterman 1998). More recent data suggest that harbor seal hearing at low frequencies may be more sensitive than that, and that earlier data were confounded by excessive background noise (Kastelein et al. 2009a, 2009b). If so, harbor seals have considerably better underwater hearing sensitivity at low frequencies than do small odontocetes. In air, the upper frequency limit of phocid seals is lower (about 20 kHz).

The acoustic discrimination and localization abilities of pinnipeds appear to be less sensitive than those of odontocetes. Critical ratios tend to increase with increasing frequency, and are probably similar to those of other mammals. The bearded and ringed seals that occur in the Northstar area are all members of the same functional hearing group, pinnipeds in water as recognized by Miller et al. (2005) and Southall et al. (2007).

Pinniped call characteristics are relevant when assessing potential masking effects of manmade sounds. In addition, for those species whose hearing has not been tested, call characteristics are useful in assessing the frequency range within which hearing is likely to be most sensitive. Ringed and bearded seals are most vocal during the spring mating season and much less vocal during late summer. In each species, the calls are at frequencies from several hundred to several thousand hertz, above the frequency range of the dominant noise components from most of the proposed oil production and operational activities.

Possible effects on hearing sensitivity

Temporary or permanent hearing impairment is possible (although rarely demonstrated) when marine mammals are exposed to very strong sounds. This impairment is known as a Temporary Threshold Shift (TTS) when the condition is short-term and Permanent Threshold Shift (PTS) when the condition is chronic. There is no direct evidence that free-ranging marine mammals suffer TTS or PTS. However, it is now possible to predict, to a first approximation, situations where TTS would and would not occur in free-ranging pinnipeds based on systematic TTS studies on captive pinnipeds (Bowles et al. 1999; Kastak et al. 1999, 2005, 2007; Finneran et al. 2003; Southall et al. 2007). Kastak et al. (1999) reported TTS of approximately 4-5 dB in three species of pinnipeds (Californian sea lion (*Zalophus californianus)*, harbor seal, and northern elephant seal) after underwater exposure for about 20 minutes, to noise with frequencies ranging from 100-2,000 Hz at received levels 60-75 dB above hearing threshold. This approach allowed similar effective exposure conditions to each of the subjects, but resulted in variable absolute exposure values depending on subject and test frequency. Recovery to near baseline levels was reported within 24 hours of noise exposure (Kastak et al. 1999). Kastak et al. (2005) followed up on their previous work using higher sensitive levels and longer exposure times (up to 50-minutes) and corroborated their previous findings. The sound exposures necessary to cause slight threshold shifts were also determined for two California sea lions and a juvenile elephant seal exposed to underwater sound for similar duration. 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). For pinnipeds exposed to in-air sounds, auditory fatigue has been measured in response to single pulses and to nonpulse noise (Southall et al. 2007), although high exposure levels were required to induce TTS onset (SEL: 129 dB re: [20 μPa]2-s; Bowles et al. unpublished data). 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 (i.e., captivity) are the likely to cause differences in study results.

For pulsed underwater sounds, NMFS has taken the position that Level A harassment for pinnipeds occurs when received levels exceed 190 dB re 1 μPa (NMFS 1995). That criterion, on a root mean square (rms) over duration of pulse basis, was established before there were any data on sound levels that do and do not elicit TTS in pinnipeds. It also did not consider the effects of sound duration on TTS and PTS thresholds.

In any case, underwater sound levels from production and drilling activities that occur continuously over extended periods are not very high (Blackwell and Greene 2006). For example, received levels of prolonged drilling sounds are expected to diminish below 140 dB re 1 μPa at a distance of about 40 m (131 ft.) from the center of activity. Sound levels during other production activities aside from drilling usually would diminish below 140 dB re 1 μPa at a closer distance. The 140 dB re 1 μPa radius for drilling noise is within the island and drilling sounds are attenuated to levels below 140 dB re 1 μPa in the water near Northstar. However, when vessels were present at Northstar Island, received levels within at least 20-30 km (12.4-18.6 mi) of the island were above background levels (Blackwell and Greene 2006). Neither TTS nor permanent hearing damage is expected from the operations at Northstar.

Masking
Masking of calls or other natural sounds would not extend beyond the maximum distance where the operational sounds are detectable, and at that distance only the weakest sounds would be masked. The maximum distances for masking will vary greatly depending on ambient noise and sound propagation conditions, but will typically be about 2-5 km (1.2-3.1 mi) in air and 3-10 km (1.9-6.2 mi) underwater. Also, some types of Northstar sounds (especially the stronger ones) vary over time, and at quieter times masking would be absent or limited to closer distances.

Behavioral reactions to noise and disturbance
Disturbance is the main concern in this project. When the received noise level exceeds some behavioral reaction threshold, some pinnipeds will exhibit disturbance reactions. The levels, frequencies, and types of noise that elicit a response vary among and within species, individuals, locations, and seasons. Behavioral changes may be an upright posture for hauled out seals, movement away from the sound source, or complete avoidance of the area. The reaction threshold and degree of response are related to the activity of the animal at the time of the disturbance.

Behavioral reactions do not occur throughout the zone ensonified by industrial activity. In most cases that have been studied, including recent work on ringed seals, the actual radius of effect is considerably smaller than the radius of detectability (Richardson et al. 1995b; Moulton et al. 2003a, 2005; Blackwell et al. 2004a).

Effects from drilling and production activity
Utilizing radio telemetry to examine the short-term behavioral responses of ringed seals to human activities, Kelly et al. (1988) found that some ringed seals temporarily departed from lairs when various sources of noise were within 97-3,000 m (0.06-1.9 mi) of an occupied structure. Radio-tagged ringed seals did return to re-occupy those lairs. The durations of haul-out bouts during periods with and without disturbance were not significantly different. Also, the time ringed seals spent in the water after disturbance did not differ significantly from that during periods of no disturbance (Kelly et al. 1988).

Moulton et al. (2003a, 2005) conducted intensive and replicated aerial surveys during the springs of 1997-99 (“pre-Northstar”) and 2000-02 (with Northstar activities) to study the distribution and abundance of ringed seals within an area about 4,140 km^2 (1,598 mi^2) around the Northstar development. The main objective was to determine whether, and to what extent, oil development affected the local distribution and abundance of ringed seals. The 1997-1999 surveys were conducted coincident with aerial surveys over a larger area of the central Beaufort Sea (Frost et al. 2004). Moulton et al. (2003a, 2005) determined that the raw density of ringed seals over their study area ranged from 0.39-0.83 seals/ km^2 (0.4 mi^2) while Frost et al. (2004) obtained raw densities of 0.64-0.87 seals/ km^2 (0.4 mi^2) in similar area at about the same times. There was no evidence that drilling and production activities at Northstar in 2000-2002 significantly affected local ringed seal distribution and abundance relative to the baseline years (1997-99). Additionally, after natural variables that affect haul-out behavior were considered (Moulton et al. 2003a, 2005), there was no significant evidence of reduced seal densities close to Northstar as compared with farther away during the springs of 2000, 2001, and 2002. The survey methods and associated analyses were shown to have high statistical power to detect such changes if they occurred. Environmental factors such as date, water depth, degree of ice deformation, presence of melt water, and percent cloud cover had more conspicuous and statistically significant effects on seal sighting rates than did any human related factors (Moulton et al. 2003a, 2005).

To complement the aerial survey program on a finer scale, specially-trained dogs were used to find seal structures and to monitor the fate of structures in relation to distance from industrial activities (Williams et al. 2006c). In late 2000, surveys began before construction of ice roads but concurrent with drilling and other island activities.

In the winter of 2000-2001, a total of 181 seal structures were located, of which 118 (65 percent) were actively used by late May 2001. However, there was no relationship between structure survival or the proportion of structures abandoned, and distance to Northstar-related activities. The most important factors predicting structure survival were time of year when found and ice deformation. The covariate distance to the ice road improved the fit of the model, but the relationship indicated that structure survival was lower farther away from the ice road, contrary to expectation. However, new structures found after the ice-road was constructed were, on average, farther from the ice-road than were structures found before construction (though this was marginally statistically significant). This may have been related to the active flooding of the ice road, which effectively removed some of the ice as potential ringed seal habitat.

Effects from aircraft activity

Helicopters are the only aircraft associated with Northstar oil production activities. Helicopter traffic occurs primarily during late spring and autumn when travel by ice road, hovercraft, or vessel is not possible.

Blackwell et al. (2004a) observed 12 ringed seals during low-altitude over flights of a Bell 212 helicopter at Northstar in June and July 2000. One seal showed no reaction to the aircraft while the remaining 11 seals (92 percent) reacted, either by looking at the helicopter or by departing from their basking site. 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. There have been few systematic studies of pinniped reactions to aircraft over flights, and most available data concern pinnipeds hauled out on land or ice, rather than pinnipeds in the water (Richardson et al. 1995b; Born et al. 1999). Any reactions to helicopter over flights can be prevented by maintaining a minimum altitude of 305 m (1,000 ft.) when weather allows.

Effects from vessel activity

Few authors have specifically described the responses of pinnipeds to boats, and most of the available information on reactions to boats concerns pinnipeds hauled out on land or ice. Ringed seals hauled out on ice pans often showed short-term escape reactions when a ship came within 0.25-0.5 km (0.15-0.3 mi) (Brueggeman et al. 1992). Jansen et al. (2006) reported that harbor seals approached by vessels to 100 m (328 ft.) were 25 times more likely to enter the water than were seals approached at 500 m (1,640 ft.). In places where boat traffic is heavy, there have been cases where seals have habituated to vessel disturbance. In England, harbor and gray (*Halichoerus grypus*) seals at specific haul-outs appear to have habituated to close approaches by tour boats (Bonner 1982). Jansen et al.
(2006) found that harbor seals in Disenchantment Bay, Alaska increased in abundance during the summer as ship traffic also increased. Southall et al. (2007) report that seals exposed to about 110-120 dB re 1 μPa in air, tended to respond by leaving their haulouts and seeking refuge in the water; while animals exposed to in-air sounds of about 60-70 dB re 20 μPa often did not respond at all.

It is difficult or impossible to discern how boats affect pinnipeds while in water. The mere presence and movements of ships in the vicinity of seals can cause disturbance to 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). However, seals appear quite tolerant of vessels that do not alter course and would operate at relatively slow speeds, similar to the boats used at Northstar. During the open water season in the Beaufort Sea, bearded and ringed seals are commonly observed close to vessels (e.g., Harris et al. 2001; Moulton and Lawson 2002). The limited data, plus seal responses to other noisy human activities, suggest that seals often show considerable tolerance of vessels.

Effects from oil

Bearded and ringed seals are present in open water areas during summer and early autumn, and ringed seals remain in the area through the ice-covered season. During the spring periods in 1997-2002, the observed densities for ringed seals on the fast-ice in areas more than 3 m (9.8 ft.) deep ranged from 0.35-0.72 seals/ km^2 ($0.4\ mi^2$). After allowance for seals not seen by aerial surveyors, actual densities may have been about 2.84 times higher (Moulton et al. 2003a). Although bearded seals avoid the landfast ice that is found around Northstar during the late winter/spring, small numbers of bearded seals have been reported in the project area. Therefore, an oil spill from the Northstar development or its pipeline could affect seals. Any oil spilled under the ice also has the potential to directly contact seals.

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 oil characteristics. 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 are likely to 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. Bearded and ringed seals may ingest oil-contaminated foods, but there is little evidence that oiled seals will ingest enough oil to cause lethal internal effects. Newborn seal pups, if contacted by oil, will likely die from oiling through loss of insulation and resulting hypothermia.

Reports on 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 there is a lack of baseline data and/or the brevity of the post-spill surveys. The largest documented impact from 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 EVOS in Alaska. There may have been a long-term decline of 36 percent 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) than a result of EVOS. The results from Hoover-Miller et al. (2001) strongly indicate that the effects from 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 percent less 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 23-26 percent, which may have been higher than natural mortality, although no baseline data for pup mortality existed prior to EVOS (Frost et al. 1994a).

Oiling of external surfaces

Adult seals rely on a blubber layer for insulation and oiling 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 cause increased stress and can irritate the ringed seal’s eyes (Geraci and Smith 1976; St. Aubin 1990). These effects seemed to be temporary and reversible, but continued oil exposure to eyes could cause permanent damage (St. Aubin 1990).

Newborn seal pups rely on their fur for insulation. In spring of each year, newborn bearded seal pups are born on drifting ice floes in shallow waters, not near Northstar; however, newborn ringed seal pups can be found near Northstar in lairs on the ice. These lairs could be contaminated through contact with oiled mothers. Newborn ringed seal pups that were contaminated with oil would probably die from hypothermia.

Ingestion
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 ingested oil is voided in vomit or feces, but some oil is absorbed and can 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).

Avoidance and behavioral effects
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 an oil spill area because of human disturbance associated with cleanup efforts, but they most likely will remain in the oil spill area. 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).

Factors affecting the severity of effects
Seals that are under natural stress, such as lack of food or a heavy infestation by parasites, could die with the additional stress from 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 from 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.

Seals exposed to heavy doses of oil for prolonged periods could die. This type of 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 in winter when seals have limited mobility. Seals residing in these habitats may not be able to avoid prolonged contamination and some would die.

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 likely to have only minor impacts on seals.

Effects from oil spill cleanup activities
Oil spill cleanup activities could increase disturbance effects on either whales or seals, causing temporary disruption and possible displacement (MMS 1996). The Northstar Oil Discharge Prevention and Contingency Plan (BPXA 1998a, b) includes a scenario of a production well blowout to the open water in August. In this scenario, approximately 177,900 barrels of North Slope crude oil will reach the open water. It is estimated that response activities will require 186 staff (93 per shift) using 33 vessels (BPXA 1998b) for about 15 days to recover oil in open water. Shoreline cleanup will occur for about 45 days employing low pressure, cold water deluge on the soiled shorelines. In a similar scenario during solid ice conditions, it is estimated that 97 pieces of equipment along with 246 staff (123 per shift) will be required for response activities (BPXA 1998a).

In the event of a large spill contacting and extensively oiling coastal habitats, the presence of response staff, equipment, and the many aircraft involved in the cleanup will, depending on the time of the spill and the cleanup, potentially displace seals and other marine mammals. If extensive cleanup operations occur in the spring, they could cause increased stress and reduced pup survival for ringed seals. Oil spill cleanup activity could exacerbate and increase disturbance effects on subsistence species, cause localized displacement of subsistence species, and alter or reduce access to those species by hunters. On the other hand, the displacement of marine mammals away from oil contaminated areas by cleanup activities would reduce the likelihood of direct contact with oil.

Conclusions regarding effects on pinnipeds

Disturbance ("potential take by harassment") is the main concern during Northstar's continued production and maintenance. Seal responses to acoustic disturbance vary highly, with the most conspicuous changes in behavior occurring when seals are hauled out on ice or land when exposed to human activities. Seals in open water do not appear to react as strongly.

The number of seals potentially affected most likely will include those seals excluded from physically disturbed areas. Those areas include the artificial island and ice road, plus a 100 m (0.06 mi) zone around these areas. Updated totals for the numbers of seals expected within the potential impact zone from 1997-2002 range from 3-8 seals. Seal monitoring in an area extending out to about 950 m (3,116 ft.) around Northstar, as conducted from the process module during the break-up period (May 15-July 15), showed high variation in the ringed seal numbers observed, with a total of 229 seals in 2005, 59 seals in 2006, 3 seals in 2007, and 415 seals in 2008 (Aerts 2009). These totals of near-daily counts are believed to include, for most years, a large number of resightings of the same individual seals. The overall results suggest that any effects from Northstar production activities on seals will continue to be minor and localized, with no consequences for the seal populations. There is a small possibility of injury or mortality to a very small number of ringed seal pups during on-ice construction and transportation activities, although no injuries or mortalities were detected during monitoring from 1999-2008.

In the unlikely event of a large oil spill, there is the possibility that seals could be oiled. While the most likely consequence of oil exposure would be non-lethal impacts to individual bearded and ringed seals, some seals contacting oil, particularly fresh-spilled oil, could be seriously injured or killed by oiling.

Anticipated impact on habitat

<u>Seal and whale prey</u>

The ringed seal, the most common seal near Northstar, feeds on fish and a variety of benthic species, including crabs and shrimp. Bearded seals feed mainly on benthic organisms, primarily crabs, shrimp, and clams.

Bowhead whales feed in the eastern Beaufort Sea during summer and early autumn, but continue feeding to varying degrees while on their migration through the central and western Beaufort Sea in the late summer and fall (Richardson and Thomson 2002). When feeding in relatively shallow areas such as those where oil development may occur, bowhead whales feed throughout the water column. However, feeding is concentrated at depths where zooplankton is concentrated (Würsig et al. 1984, 1989; Richardson 1987; Griffiths et al. 2002). Lowry and Sheffield (2002) found that copepods and euphausiids were the most common prey found in stomach samples from bowhead whales harvested in the Kaktovik area from 1979-2000. Areas to the east of Barter Island appear to be used regularly for feeding, as bowhead whales migrate slowly westward across the Beaufort Sea (Thomson and Richardson 1987; Richardson and Thomson 2002). However, in some years, sizable bowhead whale groups have been seen feeding as far west as the waters just east of Point Barrow, near the Plover Islands (Braham et al. 1984; Ljungblad et al. 1985; Landino et al. 1994). The situation in September-October 1997 was unusual in that bowhead whales fed widely across the Alaskan Beaufort Sea, including higher numbers in the area east of Barrow, than reported in any previous year.[7]

Routine production operation effects

Noise effects on seal and whale Food

Construction activities produced both pulsed sounds (e.g., pile driving) and longer-duration sounds. Short, sharp sounds can cause overt or subtle changes in fish behavior. Chapman and Hawkins (1969) tested the reactions of whiting (hake) in the field to an air gun. When the air gun was fired, the fish dove from 25-55 m (80-180 ft.) depth and formed a compact layer. The whiting dove when received sound levels were higher than 178 dB re 1 μPa (Pearson et al. 1992).

Pearson et al. (1992) conducted a controlled experiment to determine effects from strong noise pulses on several rockfish species off the California coast. They used an air gun with a source level of 223 dB re 1 μPa. They noted:

- startle responses at received levels of 200-205 dB re 1 μPa and above for two sensitive species, but not for two other species exposed to levels up to 207 dB
- alarm responses at 177-180 dB for the two sensitive species, and at 186-199 dB for other species
- an overall threshold for the above behavioral response at about 180 dB
- an extrapolated threshold at about 161 dB for subtle changes in rockfish behavior
- a return to pre-exposure behaviors within the 20-60 minute exposure period

In summary, fish often react to sounds, especially strong and/or intermittent sounds, at low frequency. Sound pulses at received levels of 160 dB re 1 μPa may cause subtle changes in behavior. Pulses at levels of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992). It also appears that fish often habituate to repeated strong sounds rather rapidly, on time scales of minutes to an hour. However, the habituation does not endure, and resumption of the strong sound source may again elicit disturbance responses from the same fish. Underwater sound levels from Northstar Island, even during construction, were lower than the response threshold reported by Pearson et al. (1992), and are not likely to result in significant effects to fish near Northstar.

[7] S. Treacy and D. Hansen, Minerals Management Service, personal communication.

Fish reactions to research vessel sounds have been measured in the field with forward-looking echosounders. Sound produced by a ship varies with aspect, and is lowest directly ahead of the ship and highest within butterfly-shaped lobes to the ship's side (Misund et al. 1996). With this directivity, fish that react to ship sounds by swimming in the same direction as the ship may be guided ahead of it (Misund 1997). Fish in front of a ship that show avoidance reactions may do so at ranges of 50-350 m (164-1148 ft.) (Misund 1997), though reactions probably will depend on the fish species. In some instances, fish will avoid the ship by swimming away from its path and will become relatively concentrated to the ship's side (Misund 1997). Most schools of fish will show avoidance if they are not in the vessel's path. When the vessel passes over fish, some species, in some cases, show sudden escape responses that include lateral avoidance and/or downward compression of the school (Misund 1997). Some fish show no reaction. Avoidance reactions are quite variable and depend on species, life history stage, behavior, time of day, whether the fish have fed, and sound propagation characteristics of the water (Misund 1997).

Behavior of zooplankters is not expected to be affected by drilling and production operations at Northstar. These animals have exoskeletons and no air bladders. Many crustaceans can make sounds and some crustacea and other invertebrates have some type of sound receptor. However, the reactions of zooplankters and benthic animals to sound are, for the most part, not known. Their abilities to move significant distances are limited or nonexistent, depending on the type of animal. Impacts on zooplankton behavior are predicted to be negligible, and this would translate into negligible impacts on feeding bowhead whales.

Habitat disruption

The main impact issues associated with drilling and production activity will be temporarily elevated noise levels, as other emissions are strictly controlled, and bottom disturbance is a natural phenomenon in this region. Sea floor surface disruption associated with island construction and pipeline trenching likely resulted in disturbance to benthic communities within the island and pipeline footprint. These communities have a naturally patchy distribution. In nearshore areas, such as the Northstar development and along the pipeline route, these communities are subject to natural seasonal disruption by ice scour and ice gouging of the sea floor; and transport of significant amounts of suspended sediments due to river outflow and coastal erosion (MBC 2003). This suggests that recovery of disturbed areas will occur in a manner similar to that occurring after natural disturbance, except for those areas buried by island construction. Effects of pipeline trenching on total suspended sediments in the water column were localized within about 500 m (1,640 ft.); and effects are likely indistinguishable from naturally occurring disturbances to the benthos by sea ice, river outflow, and coastal erosion (MBC 2003). In addition, the island slope protection system introduced hard bottom structures for possible colonization by arctic kelp species, some invertebrates and fish.

Oil spills

Oil spill probabilities for the Northstar project have been calculated based on historic oil spill data. Probabilities vary depending on assumptions and method of calculation. Very large spills (more than 150,000 barrels [bbl.]) happen very infrequently, and there are limited data to use in statistical analysis and predictive efforts. Five of the six well control incident events (with more than 1,000 bbl.) in the OCS database occurred during 1964-1970. The sixth OCS well control incident that resulted in a large spill was the Deepwater Horizon (DWH) event (April 20, 2010).

Although no official volume has been determined by Bureau or Ocean Energy Management, it is clear from the spill volume estimates that the DWH exceeds the threshold of a very large oil spill. A comparison to the DWH incident to Northstar indicates the following risk reductions:

	DWH, Gulf of Mexico	Northstar
Water depth	More than 5,000 ft. (1.5 km) deep	Gravel island
Geological formation pressures	Unknown	Established and well known
Distance from shore	50 mi (80.5 km) offshore	Less than 10 mi (16 km) offshore
Rig type	Floating drill rig	Stationary

S.L. Ross Environmental Research, Ltd, (1998) analyzed the worldwide oil spill data indicates the probability of a large or very large oil spill (more than 1,000 barrels or 150,000 barrels, respectfully) during the lifetime of Northstar is low). That report uses standardized units such as well-years and pipeline mile-years to develop oil spill probabilities for the Northstar project. Well-years represent the summed number of years that the various wells will be producing, and mile-years represent the pipeline length times the amount of time the pipeline is in service. The calculated probability for a large oil spill allows for the state-of-the-art engineering and procedures used at Northstar. That probability is far lower than previously estimated probabilities (23-26 percent) that was based on MMS studies of offshore oil field experience in the Gulf of Mexico and California (USACE 1998a).

Oil effects on foods of seals and whales

Arctic cod and other fish are a principal food item for ice seals in the Beaufort Sea. Anadromous fish are more sensitive to oil when in the marine environment than when in the fresh water environment (Moles et al. 1979). Generally, arctic fish are more sensitive to oil than are temperate fish (Rice et al. 1983). However, fish in the open sea are unlikely to be affected by an oil spill. Fish in shallow nearshore waters could sustain heavy mortality if an oil slick were to remain in the area for several days or longer. Fish concentrations in shallow nearshore areas that are used as feeding habitat for seals could be unavailable as prey. Because the animals are mobile, effects would be minor during the ice-free period.

Effects of oil on zooplankton as food for bowhead whales were discussed by Richardson (1987). Zooplankton populations in the open sea are unlikely to be depleted by the effects from an oil spill. Oil concentrations in water under a slick are low and unlikely to have anything but very minor effects on zooplankton. Zooplankton populations in near surface waters could be depleted; however, zooplankton concentrations in near-surface waters generally are low compared to those in deeper water (Bradstreet et al. 1987; Griffiths et al. 2002).

Some bowhead whales feed in shallow nearshore waters (Bradstreet et al. 1987; Richardson and Thomson 2002). Wave action in nearshore waters could cause high oil concentrations to be found throughout the water column. Oil slicks in nearshore feeding areas could contaminate food and render the site unusable as a feeding area. However, bowhead feeding is uncommon along the coast near the Northstar Development area, and contamination of certain areas would have only a minor impact on bowhead feeding.

Effects from oil spills on zooplankton as food for seals would be similar to those described above for bowhead whales. Effects would be restricted to nearshore waters. During the ice-free period when animals are mobile, effects on seal feeding would be minor.

Bearded seals consume benthic animals. Wave action in nearshore waters could cause oil to reach the bottom through adherence to suspended sediments (Sanders et al. 1980). There could be mortality of benthic animals and elimination of some benthic feeding habitat. However, during the ice-free period when seals are mobile and can find alternate feeding habitats, effects on seal feeding would be minor.

Effects on availability of feeding habitat would be restricted to shallow nearshore waters. During the ice-free period, seals and whales could find alternate feeding habitats. The ringed seal is the only marine mammal present near Northstar in significant numbers during the winter. An oil spill in shallow waters could affect habitat availability for ringed seals during winter. The oil could kill ringed seal food and/or drive away mobile species such as the arctic cod.

Because ringed seals are found year round in the U.S. Beaufort Sea and more specifically in the project area, an oil spill at any time of year could potentially affect ringed seals. Although a major oil spill is unlikely, effects from an oil spill on food supply and habitat would be locally significant for ringed seals in shallow nearshore waters in the immediate vicinity of the spill and oil slick in winter. However, ringed seals are more widely dispersed during the open water season, and, as a population, effects from an oil spill on marine mammal foods and habitat under other circumstances would be negligible.

Oil effects on habitat availability

The subtidal marine plants and animals associated with the Boulder Patch community of Stefansson Sound are not likely to be affected directly by an oil spill from Northstar Island, seaward of the barrier islands and farther west. The only type of oil that can reach the subtidal organisms (located in 5-10 m [16-33 ft.] of water) will be highly dispersed oil created by heavy wave action and vertical mixing. Such oil has no measurable toxicity (MMS 1996). The amount and toxicity of oil reaching the subtidal marine community is expected to be so low as to have no measurable effect. However, oil spilled under the ice during winter, if it reached the relevant habitat, could act to reduce the amount of light available to the kelp species and other organisms directly beneath the spill. This could be an indirect effect of a spill. Due to the highly variable winter lighting conditions, any reduction in light penetration resulting from an oil spill would not be expected to have a significant impact on the kelp communities' growth.

Depending on the timing of a spill, planktonic larval forms of organisms in arctic kelp communities such as annelids, mollusks, and crustaceans may be affected by floating oil. The contact may occur anywhere near the surface of the water column (MMS 1996). Due to their wide distribution, large numbers, and rapid rate of regeneration, the recovery of marine invertebrate populations is expected to occur soon after the surface oil passes. Spill response activities are not likely to disturb the prey items of whales or seals sufficiently to cause more than negligible effects.

Summary

Northstar has operated since October 31, 2001 and continuing the Northstar activities is not expected to cause significant impacts on habitats used by marine mammals or on the food sources they use. No observations of impacted habitat or food were made during the construction phase, and none are anticipated during continued operations. A major oil spill is unlikely, but if it occurred it could have local and short-to-medium term effects on habitat availability, especially for seals occupying nearshore waters near the development site where the spill occurred. A localized oil spill would have a negligible effect to the abundance Arctic ringed seal population because it is widely distributed outside the locally affected area.

Anticipated impact of habitat loss or modification

The footprint for Northstar Island covers about 25 acres of benthic habitat; and about 21 acres of seabed were excavated for the two pipelines. Much of the island footprint was in place prior to the beginning of Northstar construction in 2000, because Seal Island was constructed at the same site in 1982. The small additional area covered and excavated was not known to influence marine mammal use.

Ice habitat for ringed seal breathing holes and lairs (especially for mothers and pups) is normally associated with pressure ridges or cracks (Smith and Stirling 1975). The amount of habitat altered by Northstar ice-road construction is minimal compared to the overall habitat available in the region. Ringed seal densities on the ice near Northstar during late spring are similar to elsewhere in the region (Miller et al. 1998; Link et al. 1999; Moulton et al. 2002, 2005). Ringed seals use multiple breathing holes (Smith and Stirling 1975; Kelly and Quakenbush 1990), and are not expected to be adversely affected by the loss of 1-2 breathing holes within the thickened ice road. Ringed seals near Northstar appear to have the ability to open new holes and create new structures throughout the winter, and ringed seal use of landfast ice near Northstar did not appear to be much different than that of ice 2-3.5 km (1.2-2.2 mi) away (Williams et al. 2002). Active seal structures were found within 10s of meters of thickened ice (Williams et al. 2006b, c). A few ringed seals occur within areas of artificially thickened ice if cracks that can be exploited by seals form in that thickened ice.

Bowhead whales are not present near Northstar during the winter and are not normally found in the development area during July through mid-August. Starting in late August through late October, bowhead whales may travel close enough to Northstar to hear sounds from Northstar Island or to encounter vessel traffic to and from the island. Some migrating bowhead whales might be displaced seaward by these activities. To the extent that bowhead whales are displaced offshore as a result of Northstar, it is a subtle and inconsistent effect that involves no more than a small proportion of the passing bowhead whales (Richardson et al. 2008b). Feeding does not appear to be an important activity for bowhead whales that migrate through the central part of the Alaskan Beaufort Sea in most years. In the absence of important feeding areas, the potential diversion of a small number of bowhead whales from parts of the Northstar development area is not expected to have any significant or long-term consequences for individual bowhead whales or their population. Bowhead whales are not predicted to be excluded from any habitat.

Mitigation measures

To minimize the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, all activities associated with the Northstar will be conducted in accordance with all Federal, state, and local regulations. BPXA will coordinate important activities with the relevant Federal and state agencies and will also coordinate important activities with local authorities (North Slope Borough), community representatives (Barrow, Nuiqsut, and Kaktovik), and whaling captain representatives (Alaska Eskimo Whaling Association (AEWC), and Barrow (BWCA), Nuiqsut (NWCA), and Kaktovik (KWCA) Whaling Captains Associations). A plan of cooperation was developed between BPXA and the subsistence users in the region during the previous five-year regulations. We anticipate annual renewal/renegotiation of these documents during the subsequent period. This will ensure efforts have been made by BPXA to minimize the possibility that operational, maintenance, and training activities interfere with the fall hunt for bowhead whales, and that all activities are conducted safely.

BP has participated in all peer-review workshops convened by NMFS in Seattle and Anchorage since 1998 to discuss ringed seal and bowhead whale mitigation, monitoring methods, and study results. BPXA plans to participate in future peer-review workshops sponsored by NMFS.

Mitigation during production, facilities repair, and maintenance

<u>Ice-covered season</u>

During winter and spring activities on the sea ice, the ringed seal is the only marine mammal species under NMFS jurisdiction that is likely to be encountered near Northstar. Winter activities are planned to commence on the sea ice as early as practical before female ringed seals have established their birth lairs and before pups are born. The most likely effects from these early winter activities will be temporary and localized disturbance to a small number of adult and subadult ringed seals. This disturbance will result from ice road construction, traffic on the ice, spill response training, emergency evacuation training, and exposure to noise and vibration from island activities. Seals may be displaced for a few hours from the immediate area because of some activities (Kelly et al. 1986). However, if displacement occurs, it is limited to a distance of, at most, 100 m (320 ft.) from activities such as those proposed for Northstar (Williams et al. 2006b, c).

Female ringed seals establish their birth lairs before pupping in late March-April. It was thought that female seals would avoid establishing birth lairs in close proximity to on-going activities associated with Northstar. However, the closest suspected birth lairs were found about 1,600 m (1 mi) from the island and 54 m (177 ft.) from the ice road in 2001 (Williams et al. 2006b, c). All study results of structure location and seal distribution indicate that minimal displacement of ringed seals occurred.

In the event that construction activities are required after March 1 in a previously undisturbed area of floating landfast ice (i.e., in waters deeper than 3 m (9.8 ft.)), a survey with dogs will be completed to delineate an area where activities may proceed without disturbing seal structures or, alternatively, another suitable approach will be taken in consultation with NMFS. With the dog surveys, trained dogs will search all floating sea ice for any ringed seal structures. The dog surveys will be done prior to the new proposed activity on the floating sea ice, which will provide information needed to prevent injury or mortality to young seals. Seal structures will be avoided by 150 m (429 ft.) during subsequent BPXA activities, when practicable. Since 2001, no BPXA's activities took place after March 1 in previously undisturbed areas during late winter, and as such no on-ice searches were conducted.

A report will be prepared describing the area searched, activities that occurred, and methods of any surveys with dogs that BPXA conducts to locate ringed seal lairs; which are to be avoided by on-ice activities initiated after mid-March. A report will be submitted to NMFS in preliminary form 90 days after the proposed activity is complete, and in its entirety (methods, results, and discussion) as described for the annual reporting requirements.

Broken ice and open water season

All non-essential boat, hovercraft, barge, and air traffic will be scheduled to avoid periods when whales are migrating through the area. Helicopter operations have the potential to disturb marine mammals. Helicopter flights will be primarily during ice breakup or freeze-up. Unless limited by weather conditions, a minimum flight altitude of 305 m (1,000 ft.) above sea level (ASL) will be maintained, except during takeoff and landing. No flights over whales or subsistence hunters are anticipated. Helicopter flights to Northstar will occur in a corridor from the mainland. Essential traffic has been and will continue to be closely coordinated with the NSB and AEWC to avoid disrupting subsistence activities.

The number of marine mammals that are likely to be exposed to activities related to Northstar operations and maintenance is small, relative to their regional populations. Past monitoring has indicated that effects from Northstar activities (with mitigation measures in place) have been limited, when they occur, to short-term behavioral changes by a small number of individual ringed seals and bowhead whales. (Similar short-term behavioral effects might possibly occur in very small numbers of bearded seals, though there is no indication of effects on those species as a result of Northstar activities to date.) These behavioral changes have resulted in insignificant impacts on individuals or on the species or stocks. Effects from future (2014-2019) Northstar activities are expected to be no greater than those during initial and continued production in 2002-2009, and less than during the construction period in 2000-2001. No specific rookeries, areas of concentrated feeding or mating, or other areas of special significance for marine mammals occur in or near the planned operational area, although some ringed seal breeding occurs in the general area during the ice covered season.

Impact hammering activities may occur at any time of year to repair sheet pile or dock damage due to ice impingement. Impact hammering is most likely to occur during the ice-covered season or break-up period and would not be scheduled during the fall bowhead migration. Based on studies by Blackwell et al. (2004a), it is predicted that only impact driving of sheet piles or pipes that are in the water (i.e., those on the dock) could produce received levels of 190 dB re 1 μPa (rms), and then only in immediate proximity to the pile. The impact pipe driving in June and July 2000 did not produce received levels as high as 180 dB re 1 μPa (rms) at any location in the water. This was attributable to attenuation by the gravel and sheet pile walls (Blackwell et al. 2004a). It is anticipated that received levels for any future pile driving that might occur within the sheet pile walls of the island would also be less than 180 dB_{rms} at all locations in the water around the island. If impact pile driving were planned in areas outside the sheet pile walls, it is possible that received levels underwater might exceed the 180 dB re 1 μPa (rms) level. Under Northstar's present operations and requested authorization to take individuals of three cetacean and three pinniped species by Level B harassment, whales are not to be exposed to levels above 180 dB re 1 μPa_{rms} and pinnipeds are not to be exposed to pulses with received levels above 190 dB, (NMFS 2000). Mild and infrequent TTS does not have long-term negative effects on hearing. However, to prevent or at least minimize exposure to sound levels that might elicit TTS, a safety zone will be established and monitored for the presence of seals and whales. Establishment of the safety zone for any source predicted to result in received levels underwater above 180 dB_{rms} will be analyzed using existing data collected in the waters of the Northstar facility.

A marine mammal observer stationed at an appropriate viewing location on the island will conduct watches commencing 30 minutes prior to the onset of impact hammering or other identified activity. If pinnipeds are seen within the 190 dB re 1 μPa contour ("safety zone"), then operations will be shut down immediately until the mammals move beyond and outside the "safety zone". Whales are very unlikely to be present; however, if they are observed within the 180 dB re 1 μPa (rms) zone, operations will shut down. If no mammal is seen within the "safety zone" for 20 minutes, it will be assumed to have moved beyond the "safety zone", and the activity can resume.

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." Reasonably 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 Beaufort Sea require Federal authorizations from one or more agencies, such as the Army Corps of Engineers and NMFS PR1. Such agencies must consult under the ESA on the effects of such activities on the bowhead whale and the threatened bearded and ringed seals.

The State of Alaska is currently leasing State-owned portions of the Beaufort Sea for oil and gas exploration and production. Activities on tracts leased by the State 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 (less than 3 m (10 ft.)) constructed in early winter and abandoned by the following spring melt. Additional exploration and development of State lands within this region appears likely.

Because offshore oil and gas activities in State waters are generally well shoreward of the bowhead whales' main migration route, and some of the activities occur inside the barrier islands, the overall effects on bowhead whales 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 of 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. Many of these State tracts would occur near the area of shore-fast ice that is important to ringed seals for winter habitat and pupping.

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 bowhead whales 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 whales and seals would be as have been 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. During 1976-1992, 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 bowhead whales 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.

An increase in vessel traffic and, perhaps, aircraft activity is expected to occur in the future in the Beaufort Sea. 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 whale

The continued operation of Northstar oil and gas facilities is largely confined to areas from Northstar southward, where bowhead whales are rare. As evident from monitoring studies conducted in 2001-2004, any effects from Northstar sound on whales traveling near the southern (proximal) edge of the bowhead whale migration corridor are subtle. Possible deflections during this migration are not likely to be injurious to individual animals or their population. While many feeding areas are dynamic and may change location from year to year, Native hunters have reported the Kaktovik area as a traditional feeding area for bowhead whales. Monitoring the bowhead whale migration, as they pass the Northstar oil production facility in the Beaufort Sea, has not found evidence of any such shifts to the migration corridor, although localized displacement has been observed. Even were they to occur, it is unlikely these impacts would prevent the survival and recovery of this species, as Northstar operations would not be expected to affect more than a very small portion of the migration corridor through the Alaskan Beaufort Sea. The primary feeding habitat is considered to be in the Canadian Beaufort and Bering Sea. The Alaskan Beaufort Sea certainly provides feeding habitat for bowhead whales, however the importance of this habitat is not fully studied at this time.

Consideration of the potential impacts from oil spills to bowhead whales must assess: 1) the probabilities for a spill to occur and to make contact with the whales and/or their habitat; 2) the effects of oil spills and spill responses on these whales; and 3) industry's ability to prevent, control, and recover spilled oil. Should a spill occur, its effects to these whales would depend on factors such as: size of the spill, time and location of the spill, nature of the product spilled, its persistence and toxicity, and effectiveness of any response measures. The estimated physical and behavioral effects of an oil spill on bowhead whales have been described. While it is clear additional research is needed to assess these effects and that no consensus has been reached regarding the degree to which oiling might impact the whales, whales 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 in an amount that would have to affect the whales, spilled oil would have to coincide with the whales' seasonal occurrence in these waters, the spilled oil would have to be transported to the area the whales occupy (e.g. migration corridor), and clean-up or response efforts would have to have been at least partially unsuccessful. The impact from such an event could be significant, yet the statistical probability for the coincident occurrence of these events would be low.

The impacts of the oil and gas industry on individual survival and reproduction likely have been minor in the past, as evidenced by the Western Arctic bowhead whale population approaching its pre-exploitation population size and increasing at a roughly constant rate for more than 20 years (Angliss and Outlaw 2008). The IHA authorization for BPXA to operate their Northstar oil and gas facility is unlikely to have any effect on the other four stocks of bowhead whales. No lethal takes are anticipated because of these activities, nor are population-level consequence to the stocks expected. Most impact would be due to harassment of whales by noise, which may lead to behavioral reactions from which recovery is fairly rapid.

Bearded seal and ringed seal

The proposed drilling will occur in an area that supports low numbers of bearded seals and moderate numbers of ringed seals. The most common behavior of these seals within the action area would be foraging. We expect seals to show little significant reaction to the Northstar 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 bearded or ringed 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 spilled oil 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 could be significant, yet the statistical probability for the coincident occurrence of these events would be low.

Exposure analysis

Bowhead whales are not resident in the region of activity. During the open-water season, relatively few westward migrating bowhead whales occur within 10 km (6 mi) of Northstar during most years. However, in some years (especially years with relatively low ice cover) a larger-percentage of the bowhead whale population migrates within 10-15 km (6-9 mi) of Northstar (Treacy 1998; Blackwell et al. 2008, 2009). It is doubtful that the apparent Northstar effects found in the Northstar studies would have had biologically significant consequences for any individual bowhead whales or for the population. However, for the purpose of the current application, covering production years 2014-2019, BPXA requested a “Level B Harassment” authorization for an annual maximum of 15 bowhead whales (about 0.1 percent of the estimated 2011 population size) to cover for any unexpected circumstances that might lead to a “take”.

The few bearded seals that remain in the area during winter and spring are generally found north of Northstar in association with the pack ice or the edge of the landfast ice. Based on available data, and the ecology of bearded seals, it is unlikely that more than a few bearded seals (and most likely none) will be present in close proximity (less than 100 m (328 ft.)) to the ice road and Northstar itself during the ice-covered season. During open-water seasons, bearded seals are widely and sparsely distributed in areas of pack ice and open water, including some individuals in relatively shallow water as far south as Northstar. The most probable number of bearded seals predicted to be potentially impacted by Northstar activities during the ice-covered and break-up season in any one year is zero. However, to allow for unexpected circumstances that might lead to “take” of bearded seals when they are present, BPXA requested a “Level B Harassment” authorization for a maximum of five bearded seals per year during the ice-covered and break-up period.

Individual ringed seals in the Northstar area during the ice-covered and break-up seasons may be displaced a short distance away from the ice road corridors connecting the production islands to the mainland. The presence of numerous seals near the Northstar facilities during late spring of 2000, 2001 and 2002 indicates that any displacement effect was localized and, if it occurred at all, involved only a small fraction of the seals that would otherwise have been present. However, for the purpose of the current application, covering production years 2014-2019, BPXA requested a “Level B Harassment” authorization for a maximum of 31 ringed seals for the ice-covered period of each year to cover for any unexpected circumstances that might lead to harassment “take”.

Because ringed seals are resident in the Beaufort Sea, they are the most abundant and most frequently encountered seal species in the Northstar area. There is no specific evidence that any of the seals occurring near Northstar during the 1997-2009 open-water seasons were disturbed appreciably or otherwise affected by BPXA’s activities (Williams et al. 2006a; Moulton et al. 2003a, 2005; Rodrigues et al. 2006; Rodrigues and Richardson 2007; Aerts and Rodrigues 2008; Aerts 2009). However, for the purpose of the current application, covering production years 2014-2019, BPXA requested a “Level B Harassment” authorization for a maximum of 31 ringed seals per year to allow for any unexpected circumstances during the open-water season that might lead to harassment “take”.

BPXA requested that the LOA authorize a small number (five) of incidental, non-intentional, injurious or lethal takes for ringed seals in the unlikely event that they might occur (should a ringed seal lair be crushed or flooded), but no lethal or injurious takes are anticipated for bearded seals. No population-level consequence is expected for bearded and ringed seals. Most impact would be due to harassment by noise, which may lead to behavioral reactions from which recovery is rapid. Both bearded and ringed seals currently exist at what are believed to be high levels of abundance; population-level concerns for these seals’ are based on expected habitat conditions projected over the next century.

Response analysis

A review of the reactions of bowhead whales, bearded seals, and ringed seals exposed to continuous, broadband low frequency industrial noise in the Alaskan Arctic suggests that these animals will elicit short-term behavioral responses to the proposed 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 marine mammals exposed, although individual animals 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, bearded seals, or ringed 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 between 120-180 dB re 1µPa, the information available would not lead us to expect bowhead whales, bearded seals or ringed seals to respond in ways that would reduce their numbers, reproduction, 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 receive levels equal to or greater than 180 dB.

Risk analysis
Numerous studies on 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 Northstar operation activities are likely to elicit short-term responses in bowhead whales, bearded seals, and ringed seals that are not known to have any long-term, adverse consequences for the biology or ecology of the individuals exposed. This expected temporary displacement from the immediate area around Northstar is not likely to be life threatening and/or effect the recovery of these three species.

We do not expect this exposure to translate into chronic or cumulative reductions in the current or expected future reproductive success of the Western Arctic population of bowhead whales, the Beringia DPS of bearded seals, or the Arctic sub-species of ringed seals. Therefore, the Northstar operation is not likely to affect performance of these demographic divisions or the species they represent. By extension, we would not expect the LOA for BPXA's Northstar oil and gas operations to appreciably reduce their likelihood of surviving and recovering in the wild.

VII. 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 issuance of five-year incidental take regulations and subsequent Letters of Authorization for the continued operation of the Northstar oil and gas facilities in the U.S. Beaufort Sea is not likely to jeopardize the continued existence of the endangered bowhead whale, the Beringia DPS of bearded seal, or the Arctic sub-species of ringed 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) In the event that ice roads or construction activities are required after March 1 in a previously undisturbed area of floating landfast ice (i.e., in waters deeper than 3 m [9.8 ft.]), a survey will be completed to delineate an area where activities may proceed without disturbing seal structures:
    a. Using trained dogs is the preferred method, but if they are not available or practicable, the use of a comparable method is appropriate to search all floating sea ice for any ringed seal structures.
    b. Those surveys will be done prior to the new proposed activity on the floating sea ice, to provide information needed to prevent injury or mortality of young seals.
    c. Seal structures will be avoided by 150 m (429 ft.) during subsequent BPXA activities, when practicable.
2) All non-essential boat, hovercraft, barge, and air traffic will be scheduled to avoid periods when whales are migrating through the area.
3) Helicopter flights will be primarily during ice breakup or freeze-up. Unless limited by weather conditions, a minimum flight altitude of 305 m (1,000 ft.) ASL will be maintained, except during takeoff and landing.
    a. Helicopter flights to Northstar will occur in a corridor from the mainland;
    b. Essential traffic has been and will continue to be closely coordinated with the NSB and AEWC to avoid disrupting subsistence activities.
4) For impact hammering activity, a marine mammal observer stationed at an appropriate viewing location on the island will conduct watches commencing 30 minutes prior to the onset of impact hammering.
    a. If pinnipeds are seen within the 190 dB re 1 μPa contour ("safety zone"), then operations will be shut down immediately until the mammals move beyond outside the "safety zone".
    b. Whales are very unlikely to be present; however, if they are observed within the 180 dB re 1 μPa (rms) zone, operations will shut down immediately.
    c. If no mammal is seen within the “safety zone” for 20 minutes, it will be assumed to have moved beyond the "safety zone", and the activity can resume.

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 taking specified in the incidental take statement 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 prohibits the take of endangered species 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 an incidental take statement.

Section 7(b)(4)(C) of the ESA provides that the operator needs to obtain authorization under section 101(a)(5) of the MMPA before this incidental take statement can become effective. Accordingly, the terms of this statement and the exemption from section 9 of the ESA that the statement affords are conditional upon the issuance of MMPA authorization to take the marine mammals identified here. This biological opinion and letter of authorization cover the entire scope of the proposed activities, (i.e., five years [2014-2019] of activity at Northstar operations in the Beaufort Sea, Alaska). The LOA will allow the operator MMPA authorization for five years (2014-2019), which allows this incidental take statement to become effective immediately. Absent such authorization, this statement is inoperative.

NMFS PR1, as the lead federal action agency for purposes of this incidental take statement, is responsible for the terms and conditions described herein. These requirements would normally be met through BPXA, as the operator of the Northstar Island facility.

Amount or Extent of the Take
Available information indicates that incidental acoustic harassment of small numbers of the endangered bowhead whales, threatened Beringia DPS bearded seals, and threatened Arctic ringed seals may occur during BPXA's continued oil and gas operations associated with the Northstar facility. NMFS does not expect bowhead whales or bearded seals to be injured or killed by the Northstar operations; however, BPXA requested authorization for five incidental, non-intentional, injurious or lethal takes of ringed seals in the unlikely event that they occur. Ringed seals very close to Northstar operations (i.e., production operations, ice road

construction, pipeline installation, island maintenance, boat traffic, air traffic, and drilling activities) could be at risk of temporary threshold shift due to noise. However, planned monitoring and mitigation measures are designed to avoid exposing listed species to sound pulses that may cause hearing impairment.

NMFS anticipates the annual non-lethal non-injurious incidental take of no more than 15 bowhead whales, five bearded seals, and 31 ringed seals, as well as no more than five injurious or lethal takes of ringed seals as a result of exposure to continuous sounds at received levels at or exceeding 120 dB re:1 μPa_{rms} and impulsive sounds with received levels at or exceeding 160 dB re:1 μPa_{rms}. The amount of take included in this incidental take statement will be exceeded if the number of bowhead whales or bearded and ringed seals taken exceeds this level in any operational year.

Reasonable and Prudent Measures:

NMFS believes the following reasonable and prudent measures, along with their implementing terms and conditions are designed to minimize the impact of incidental take that might result from the proposed action. NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize or to monitor the incidental take of the endangered bowhead whale and the threatened bearded and ringed seals, resulting from the proposed action:

1. This incidental take statement is valid only for activities associated with Northstar operations as described in the accompanying Northstar biological opinion, and which has been authorized under section 101(a)(5) or the MMPA. The terms of this incidental take statement and the exemption from section 9 of the ESA becomes effective immediately with the issuance of an MMPA authorization for the taking of bowhead whales, bearded seal, and ringed seals (79 FR 3347, January 21, 2014).

2. All activity at Northstar Island listed in the current LOA issued, under MMPA section 101(a)(5) and 50 CFR 217.148, to the operator for this project must comply with all Terms and Conditions to this incidental take statement.

3. The taking of bowhead whales and bearded seals shall be by incidental harassment only. Ringed seals may be taken by harassment and no more than five ringed seals may be taken by incidental, non-intentional, injurious or lethal means annually. The taking by serious injury or death of bowhead whales and bearded seals, or the taking by harassment of greater numbers of animals than authorized in this incidental take statement, is prohibited and may result in the modification, suspension, or revocation of the incidental take statement.

4. A comprehensive monitoring and reporting program shall be implemented to ensure that bowhead whales, bearded seals, and ringed seals are not taken in numbers or in a manner not anticipated by the biological opinion.

5. BPXA shall report to NMFS on its mitigation measures and the results of its monitoring program.

Terms and Conditions:
For any incidental takes that result from the actions of NMFS PR1, or their applicant BPXA and its contractors, to be exempt from the prohibitions of section 9 of the ESA[8], the action which causes the take must comply with the following terms and conditions. These terms and conditions implement the reasonable and prudent measures described above and are non-discretionary.

To carry out reasonable and prudent measures #1 and #2, BPXA must undertake the following:

1. At all times, the operator must possess at the Northstar facility a current and valid letter of authorization issued by NMFS PR1 to BPXA under section 101(a)(5) of the MMPA. Any take must be authorized by the letter of authorization issued by NMFS PR1 to BPXA under section 101(a)(5) of the MMPA, and such take must occur in compliance with all terms, conditions, and requirements included in this authorization.

To carry out reasonable and prudent measures #3, BPXA must undertake the following:

2. The taking of any marine mammal in a manner other than that described in this incidental take statement must be reported immediately to NMFS, Protected Resources Division at 907-271-5006.

To carry out reasonable and prudent measures #4, BPXA must undertake the following:

3. All mitigation measures as outlined in section IV. Effects of the Action, in the biological opinion must be implemented. BPXA is required to submit annual reports from these mitigation measures to NMFS by June 1 of each year.

To carry out reasonable and prudent measures #5, BPXA must undertake the following:

4. Submit copies of all reports (annual and comprehensive) required by all MMPA authorizations and within the same timeframes to:
   NMFS AKR
   ATTN Barbara Mahoney
   222 W. 7th Ave, Box 43
   Anchorage, AK 99513
   barbara.mahoney@noaa.gov

Effective Date:
This ITS will be in effect immediately upon signature and remain in effect for five years, provided the operator possesses a current and valid MMPA letter of authorization at all times throughout each operational year. Should the operator fail to possess such an authorization, this incidental take statement shall become ineffective immediately and shall remain ineffective until such time as the operator again possesses a current and valid MMPA authorization.

[8] The prohibitions contained in section 9(a) of the ESA do not apply to threatened ringed and bearded seals.

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