LGL Alaska Research Associates, Inc.
1101 E. 76th Avenue, Suite B
Anchorage, Alaska 99518 USA
Tel: (907) 562-3339 Fax: (907) 562-7223
e-mail: alaska@lgl.com web: www.lgl.com

30 August 2004

Mr. Ken Hollingshead
National Marine Fisheries Service
Office of Protected Resources
1315 East West Highway
Silver Springs, MD 20910-3226

Application for issuance of a Letter of Authorization for Taking of Marine Mammals Incidental to Operation of the Northstar Facility in the U.S. Beaufort Sea, Alaska

Dear Mr. Hollingshead:

LGL Alaska Research Associates, Inc. is submitting on behalf of BP Exploration (Alaska) Inc., pursuant to Section 101 (a) 5 of the Marine Mammal Protection Act ("MMPA"), 16 U.S.C. § 1371.101 (a) (5); 50 C.F.R § 216, Subpart R, a request that the National Marine Fisheries Service ("NMFS") issue a letter of authorization (LoA) for small takes of marine mammals incidental to oil and gas production activities at the Northstar Development for the period 26 May 2005 to 25 May 2006.

The enclosed application addresses each of the fourteen specific items required for the issuance of a LoA as described in 50 CFR 216.207 and 50 CFR 216.104. The planned operation activities described in the application will have no greater than a negligible impact on individual marine mammals or their populations found in the Beaufort Sea and no unmitigable adverse impact on the availability of marine mammals for subsistence purposes. Operational measures that will mitigate impacts to marine mammals and subsistence activities, as well as a description of the proposed monitoring for 2005-2006, are also discussed.

If you have any questions about the enclosed application, please contact Bill Streever at (907) 564-4383.

Sincerely,

Michael T. Williams
Wildlife Biologist
LGL Alaska Research Associates, Inc.

Enclosure

cc: Bill Streever, BP Exploration (Alaska) Inc.
Wilson Cullor, BP Exploration (Alaska) Inc.
W. John Richardson, LGL Limited, environmental research associates
Robert Suydam, North Slope Borough
Maggie Ahmaogak, Alaska Eskimo Whaling Commission

UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

REQUEST FOR A LETTER OF AUTHORIZATION PURSUANT TO SECTION 101 (a) (5) OF THE MARINE MAMMAL PROTECTION ACT COVERING

Taking of Marine Mammals Incidental to Operation of the Northstar Facility in the U.S. Beaufort Sea (50 C.F.R. Part 216, Subpart R)

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submitted by

BP Exploration (Alaska) Inc.
Department of Health, Safety, and Environment
900 East Benson Blvd., P.O. Box 196612
Anchorage, AK 99519-6612

Biological Consultant:
LGL Alaska Research Associates, Inc.
4175 Tudor Centre Drive, Suite 202
Anchorage, Alaska 99508

and
LGL Limited, environmental research associates
22 Fisher Street, P.O. Box 280
King City, Ontario L7B 1A6

Submitted 30 August 2004

Table of Contents

I. NATURE OF THE REQUEST

In 1999, BP Exploration (Alaska) Inc. ("BP") petitioned the National Marine Fisheries Service ("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. That Petition was submitted pursuant to Section 101 (a) 5 of the Marine Mammal Protection Act ("MMPA" or the "Act"), 16 U.S.C. § 1371.101 (a) (5), and 50 C.F.R § 216, Subpart I. The regulations were promulgated by NMFS on 25 May 2000 at 50 C.F.R. § 216, subpart R. Those regulations allowed NMFS to issue Letters of Authorization (LoA) for the incidental, but not intentional, "taking" of small numbers of marine mammals of six species in the event that such "taking" occurred during construction and operation of oil and gas facilities in the Beaufort Sea offshore from Alaska.[1] The six species were the ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), spotted seal (*Phoca largha*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), and beluga whale (*Delphinapterus leucas*). To date, four LoAs have been issued under those regulations; the fourth LoA expires on 3 December 2004. A fifth LoA will be requested by BP later in 2004 to cover the period from then through 25 May 2005, when the regulations expire.

The purpose of this request by BP is for NMFS to issue a letter of authorization, effective 26 May 2005, 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 the period 26 May 2005 through 25 May 2010.

Aside from the aforementioned six species for which "take" authorization is again sought, other species that have occurred in small numbers in the Alaskan Beaufort Sea include the harbor porpoise, killer whale, narwhal, and hooded seal. Because of the relative numerical insignificance of those species in the Beaufort Sea, they are not expected to be exposed to or affected by any activities associated with the planned Northstar activities and, therefore, are not discussed further. Two other species of marine mammals—Pacific walrus and polar bear—are under the jurisdiction of the U.S. Fish and Wildlife Service and are thus subject to a separate application to that Agency.

BP does not anticipate that the operation of 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 not likely to be lethal, and any impact on the species would be no more than negligible. 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 for individuals or their populations. Furthermore, there would be no unmitigable adverse impact on the availability of seals or whales for subsistence uses. This request has been filed for the purpose of ensuring that there is no question 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.

[1] 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).

II. INFORMATION SUBMITTED IN RESPONSE TO THE REQUIREMENTS OF 50 C.F.R. § 216.104 and 216.207

The NMFS' regulations governing the issuance of letters of authorization permitting incidental takes under certain circumstances are codified at 50 C.F.R. Part 216, Subpart I (216.101 – 216.106). Section 216.104 sets out fourteen specific items that must be addressed in requests for rulemaking and renewal of regulations pursuant to Section 101(a) (5) of the MMPA. Section 216 Subpart R (216.200 – 216.210) describes the specific regulations for operation of oil and gas facilities in the U.S. Beaufort Sea. Section 216.207 references the fourteen requirements in section 216.104 in order to apply for a new Letter of Authorization. Each of these items is addressed in detail below.

1. OPERATIONS TO BE CONDUCTED

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals

Overview of the Activity

BP Exploration (Alaska) Inc. (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 makes use of 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 approximately 6 miles (9.6 km) north of Point Storkersen and slightly less than 3 n.mi. from the closest barrier island, on the remnants of Seal Island.

The construction and operation of the Northstar development in the Beaufort Sea was approved via other permitting processes. This request for a Letter of Authorization concerning potential takes of small numbers of whales and seals is associated with plans for continued drilling and oil production activities at Northstar. Upon expiry of the LoA now being sought, additional requests for LoAs will be submitted for future operations of Northstar, in anticipation that regulations regarding incidental take of marine mammals in association with Northstar will be renewed.

Much of what has already occurred during Northstar construction, drilling, and production provides a basis for what we anticipate will happen during the next five years of activity at Northstar. The following section describes activities during the construction period and the periods of initial drilling and production. That description is followed by information about the activities expected to occur during the next five year period. A detailed description of these activities can be found in Williams and Rodrigues (2004), submitted to NMFS on 9 July 2004. Construction was completed in 2001, and activity that intense is not expected or planned for any date within the 5-year period from 2005 to 2010. Information about the levels of activity in prior years is helpful in characterizing the upper limit that could occur in future. The following section summarizes past activities at Northstar.

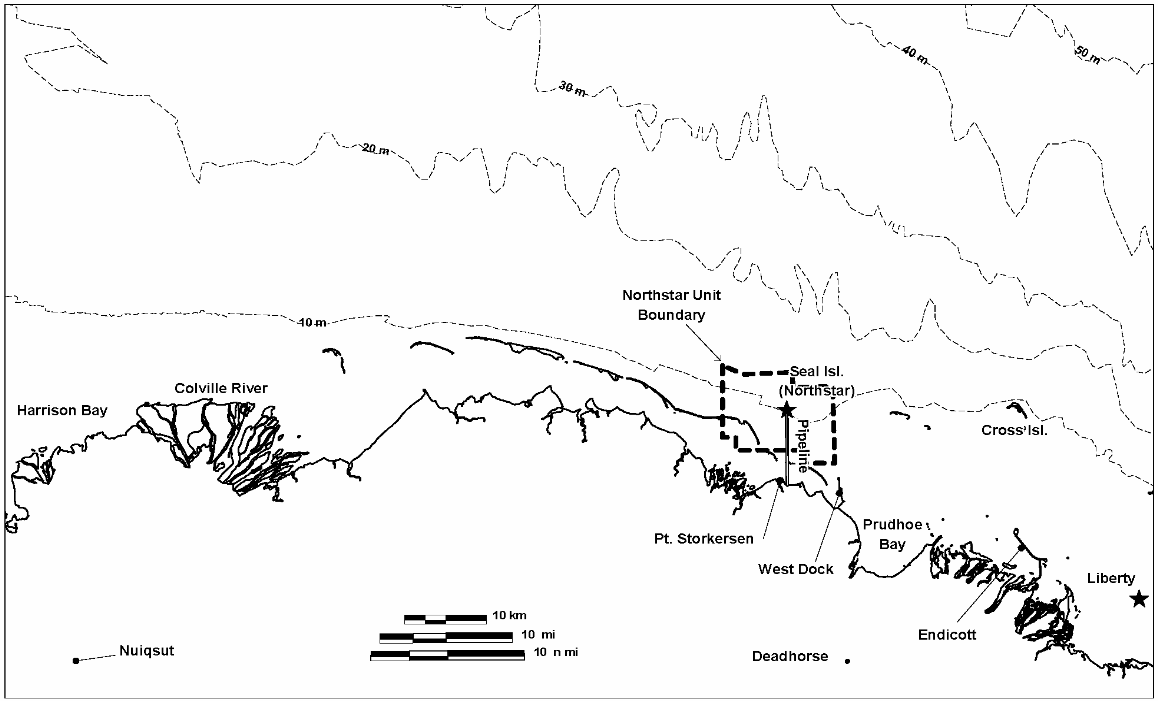

FIGURE 1. Location of the Northstar Unit and Northstar Development at Seal Island in the central Alaskan Beaufort Sea.

Northstar

Previous Activities—Construction, Drilling and Initial Production

The Northstar Unit is located between 2 and 8 miles (3.2 and 12.9 km) offshore from Point Storkersen in the Beaufort Sea. The unit is adjacent to Prudhoe Bay, and is approximately 54 miles (87 km) 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 connecting the island to the existing infrastructure at Prudhoe Bay. One pipeline transports crude oil to shore, and the second imports gas from Prudhoe Bay for gas injection at Northstar. Permanent living quarters and supporting oil production facilities are also located on the island.

BP's original plans called for construction of Northstar to begin during early 1999 on the remnants of Seal Island, an old exploratory site. Ice roads to Seal Island were constructed in 1999 but island construction was cancelled that winter due to delays in the EIS process. Ice roads were again constructed during the ice-covered period 1999-2000 to allow reconstruction of Seal Island and installation of pipelines between the Northstar development and the shore. Trucks completed ~18,300 round trips to haul a total of ~548,000 cubic yards of gravel along the ice roads from the Kuparuk delta for the reconstruction of Seal Island. During this period a sheetpile wall was built around the entire working surface on the island to provide protection of island facilities in case of extreme ice ride-up during the winter. Two 10-inch pipelines were buried below the seafloor between the island and the mainland during the ice-covered period 1999-2000.

During the open-water period in 2000, construction of basic facilities on Northstar Island continued. Impact hammers were used to drive the well conductor pipes into the island, and permanent living quarters, a utility module, and pipe racks were delivered to the island by sealift barge. The living quarters and utility module were functional before the end of 2000. Helicopters, crew boats, and barges were used for transportation of personnel and equipment to and from the island. Alaska Clean Seas (ACS) conducted spill drills to train Northstar personnel in spill response techniques.

An ice road was constructed during the ice-covered period in late 2000 and early 2001 for transport of personnel, equipment, and construction material between Prudhoe Bay (West Dock) and Northstar Island. A path was cleared along the pipeline alignment to allow emplacement, at certain locations, of additional gravel fill over the sub-sea pipeline that had been installed during the previous winter. A total of 9 locations along the pipeline route required addition gravel backfill, necessitating 130 truckloads to haul ~3,640 cubic yards of stockpiled gravel. A third ice road was built along the coast from West Dock to the pipeline landfall; this provided access to the valve pad at the pipeline landfall and to the backfill sites south of Stump Island. Helicopters were used to transport personnel during periods when ice thickness was not sufficient to support vehicles or when ice roads were otherwise not suitable for vehicle use. Construction activities that occurred on Northstar Island during the ice-covered period of 2000-2001 included the following: completing assembly of the drilling rig, pipe rack, permanent living quarters, and grind and inject module; dock improvements; installation of the mini-injection effluent skid and the foundation blocks for modules housing the processing plant, compressor, and garage. Well drilling began during this period. Five wells were drilled from 14 December 2000 to 13 June 2001 when drilling was suspended until late 2001 to satisfy regulatory requirements. In December 2000 two ARKTOS emergency escape vehicles were driven to Northstar Island and subsequently tested on the sea ice.

The major activity that occurred at Northstar during the open-water period of 2001 was the arrival of the main production facilities via sealift during August, subsequent offloading, installation, and initial testing. As in 2000, helicopters and crew vessels were used for transportation of personnel to and from Northstar during the break up and broken-ice periods of 2001. Tugs and barges periodically traveled to and from Northstar delivering equipment and fuel. On 24 October 2001, the primary power supply for the island changed from the diesel generators used until then to gas-turbine-powered generators. Drilling operations resumed on 17 November 2001 (after being suspended since 13 June), and oil production commenced on 31 October 2001.

Oil production and associated gas injection occurred throughout the ice-covered season of 2001-2002. Also, a total of 7 wells were drilled between 17 November 2001 and 7 June 2002. Power was produced from gas-turbine generators, and additional gas turbine engines were operating to compress and inject gas. One ice road was constructed during the period and transportation to and from the island was by helicopter at the start and end of the ice-covered period, and by ice road during the remainder of the period. Three oil spill exercises were conducted during the period, 2 for containment of oil in water, and 1 for detection of oil under ice. No major construction or maintenance activities occurred during the ice-covered period in 2001-2002, although various test, training, and inspection activities occurred in the area on an intermittent basis through the winter and spring.

Oil production and gas injection continued during the open-water period 2002 and the gas-turbine generators continued to be used as a source of power for the island. No major sea lift occurred but the usual helicopter and vessel traffic took place for routine island support activities. Drilling occurred for 130 days between 16 June and 28 October 2002 although all drilling during this period was above reservoir depths. During July through October 2002, ACS conducted 11 spill drill exercises.

During the 2002-2003 ice-covered period an ice-road was constructed to transport personnel, equipment, materials, and supplies between the Prudhoe Bay facilities at West Dock and Northstar Island. As usual, helicopters were used for transportation during freeze-up in 2002 and during break-up in 2003. A hovercraft was tested along the ice road during the end of the period to determine its potential as an alternate means of transportation. No major construction or maintenance activities occurred on the island during the period, but equipment testing and exercises for spill detection and safety on the sea ice occurred periodically throughout the season. Oil production and gas injection continued throughout the period, and well drilling occurred from 1 November 2002 through 9 June 2003.

During the 2003 open-water period, in addition to continued oil production and gas injection, a number of construction and maintenance activities also occurred. During construction of Northstar Island a gravel berm was installed around the perimeter of the island to protect the island from wave and ice action. The presence of exceptionally thick ice rubble during construction, and substantial ice movement at the time of break-up, caused the volume of the as-built berm to be less than the original design configuration. During 10 through 25 August 2003, 2 barges made a total of 52 round-trips to haul 30,000 cubic yards of gravel from West Dock to complete berm construction. Other on-island maintenance activities included the following: a well cellar retrofit project to repair breaches in the seal between the concrete floors and corrugated metal pipe walls of the well cellars; heat pipe and thermister installation to prevent thawing and uneven settlement of gravel supporting various on-island structures; repair of the island slope protection and ramp; modification to the hovercraft landing area; and miscellaneous gravel placement inside the island sheetpile wall. Most of this activity occurred during August and September 2003. During the 2003 open-water period, helicopters and vessels were used for most of the transportation requirements, but the hovercraft was tested and used at various times for transportation of personnel and equipment.

Equipment Used during Construction and Initial Drilling and Production Operations

Vehicles and Heavy Equipment

The following list summarizes the vehicles and machinery used during BP's construction activities and pipeline installation for the Northstar Development. Not all of these activities are planned to take place during the operational phase of Northstar. However, some of the activities may be required to repair or replace existing structures or infrastructure on Northstar in the future, and therefore are retained to cover any major repairs should they become necessary. Specific vehicles and heavy equipment are mentioned where possible, but it may be necessary to substitute similar vehicles or heavy equipment in some cases.

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 during ice-road construction.
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, as are 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.
Backhoe	*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 Construction and 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, trench spoils handling, truck loading, trench spoils placement, snow removal (with snow blower attachment), ice road maintenance, and various other island construction- and 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* were used to haul gravel on the floating landfast ice.
Crane	A Manitowoc 888 crane is used to lift and place sheetpiles for island reinforcement and pilings for the dock face.
Vibratory Hammer	*APE 200A* vibratory hammers are used to drive the sheetpiles, dock piles, and well casings.
Impact Hammer	A *DELMAG D62-22 Diesel Impact Hammer* is used to install sheetpiles and well casings through frozen surfaces that can not be penetrated by the vibratory hammer.

Drilling Operations

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.

Other Equipment

In addition to the equipment mentioned above, the following equipment has been used at certain times for various activities related to construction or maintenance operations:

M777 truck crane

82-ton link belt truck crane

Polaris 6-wheeler

Mechanic box truck

Compactors

Mobile aerial lifting platform

Scheuerle trailer model MPEK 5200

Expected Activities--Continuation of Drilling, Production, Emergency Training Operations.

<u>Transportation of Personnel, Equipment, and Supplies</u>

Transportation needs for the Northstar project 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. During construction, large quantities of pipe, gravel, and heavy modules were transported to the site. Much of the equipment that was used to transport these materials is noted above in the section describing heavy equipment during the construction period. Drilling operations require movement of pipe materials, chemicals, and other supplies to the island. During ongoing field operations, equipment and supplies will need to be transported to the site. All phases of construction, drilling, and operation required movement of personnel to and from the Northstar area.

During 2002-2004, fewer ice roads were required compared to the construction phase. The future scope of ice-road construction activities during the latter stages of drilling and during ongoing production is expected to be similar to that described for 2002 through 2004. The locations, dimensions, and construction techniques of these ice roads are described in the multi-year comprehensive report submitted on 9 July 2004 (Richardson and Williams [eds.] 2004). The presence of ice roads allows the use of standard vehicles such as pick-up, SUVs, buses and trucks for transport of personnel and equipment to and from Northstar during the ice-covered period. Ice roads are planned to be constructed and used as a means of winter transportation for the duration of Northstar operations. The orientation of future ice roads is undetermined, but will not exceed the number of ice roads created in during the winter of 2000/2001.

Barges and crew vessels are used to transport personnel and equipment from the Prudhoe Bay area to Northstar during the open-water season, which extends from approximately mid- to late-July through early- to mid-October. Seagoing barges were used to transport large modules and other supplies and equipment during the construction period. To minimize the potential for conflicts with subsistence users, marine vessels transiting between Prudhoe Bay or West Dock and Northstar Island travel shoreward of the barrier islands as much as possible, and avoid the Cross Island area during the bowhead hunting season in autumn.

Helicopter access to Northstar Island continues to be the main transportation option during break-up and freeze-up of the sea ice. In general, helicopters will be used for movement of personnel and supplies in the fall after freeze-up begins and vessel traffic is not possible, but before ice roads have been 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 are also available for use at other times of year in emergency situations. Helicopters fly at an altitude of at least 1,000 feet (305 m), except for take-off, landing, and as dictated for safe aircraft operations as governed by the Federal Aviation Administration (FAA). Designated flight paths are assigned to minimize potential disturbance to wildlife and subsistence users.

A small hovercraft was first tested in June 2003 for use as an alternate means of transportation of personnel to and from Northstar. It was used sporadically during the 2003 open-water season. Its specifications and sounds are described in Richardson and Williams (eds., 2004), and a manuscript regarding the acoustic characteristics of the hovercraft is being submitted to the Journal of the Acoustical Society of America. It has also been used intermittently during the 2003-2004 ice-covered period, and is being evaluated as a potential means to transport personnel and supplies during the break-up and freeze-up periods to reduce helicopter use.

<u>On-Island Operations</u>

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 will be operating at any one time), two high pressure turbine compressors, one low pressure flare, and one high pressure flare. Both flares are located on the 215 foot (66 m) 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, wastewater treatment plant), warehouse/shop module, communications module, diesel and potable water storage, and chemical storage. The operational phase of Northstar began with initial drilling in late 2000. Oil production began on 31 October 2001. Operations were continuing at the time this request for an LoA was prepared (August 2004), and are expected to continue well beyond 2010.

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. The first well drilled was the Underground Injection Control well, which was commissioned for disposal of permitted muds and cuttings on 26 January 2001. Thereafter, drilling above reservoir depth was permitted year-around, and drilling below that depth, while drilling below that depth is allowed only during the ice covered period.

Twenty-three wells have been planned for Northstar, including 15 oil producing wells, 6 gas injection wells, and 2 waste injection wells. The planned well-drilling program was completed in May 2004 and the drill rig is expected to be demobilized by barge during the 2004 or 2005 open-water period. Although future drilling is not specifically planned, additional wells or well workover may be required at some time in the future.

Pipeline Design, Inspection, and Maintenance

The 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 BP will conduct long-term monitoring of the pipeline system to assure design integrity and to detect any potential problems through the life of the 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 to 2.4 m (6-8 ft) below the original seabed (this is 2 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 over 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 LEOS leak detection system, 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, BP conducts aerial (helicopter) surveillance of the offshore and on-shore pipeline corridors at least once per week. A helicopter landing site was constructed on the tie-in pad on Northstar island, and another at the landfall pad, to allow routine access without damage to the surrounding tundra. The goal of these surveys is to visually detect a pipeline leak, either by evidence of a sheen on the water surface or by staining of the tundra or snow. Pipeline isolation valves are inspected on a regular basis. In addition to visual observations/inspections, BP conducts a regular oil pipeline pig inspection program to assess continuing pipeline integrity. The LEOS Leak Detection System is used 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, a multi-beam sonar, a single-beam sonar, and a 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.

During the ice covered period, the pipeline route is inspected for traces of oil under the sea ice every 30 days. Hand-held electric powered augers powered by a portable generator are used to bore holes through the ice along the entire length of the subsea pipeline route. Crews access the drill sites using Hägglunds tracked vehicles. A pair of 5-7 cm (2-3 in) holes is drilled at 61 m (200ft) intervals on each side of the pipeline, requiring ~300 holes per inspection. Water coming up through the holes when the auger is pulled out is inspected visually for oil.

Routine Repair and Maintenance

Various routine repair and maintenance activities have occurred since the end of the construction period. Examples of some of these activities include completion and repair of the island slope protection berm, well cellar retrofit repairs, heat pipe and thermister installation, ARKTOS ramp repair, and modifications for a hovercraft landing area. Activities associated with these repairs or modifications are reported in Richardson and Williams (eds., 2004). Some of these activities, such as repair of the island slope protection berm, were major repairs that involved the use of barges and heavy equipment, while others were smaller-scale repairs involving 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 of these forces. The berm will require regular surveying and maintenance in future. Maintenance will require the use of barges and gravel-moving equipment similar to that used during 2003 (see Williams and Rodrigues 2004, p. 2-32). Potential repair and maintenance activities that may be expected to occur at Northstar in future include activities similar to those that have occurred in the past, principally from 2002 to 2004.

Emergency and Oil Spill Response Training

Emergency and oil spill response training activities are conducted at various times throughout the year at Northstar. Oil spill drill exercises are conducted by Alaska Clean Seas (ACS) during both the ice-covered and open-water periods. During the ice-covered periods, exercises are conducted for containment of oil in water and for detection of oil under ice. These spill drills have been conducted on mostly bottom-fast ice in an area 61 m x 61 m (200 ft x 200 ft) located just west of the island. The locations of future spill drills or exercises will vary depending on the condition of the sea ice and training needs. Snow machines and all-terrain vehicles are used. The spill drill includes the use of 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 to allow access to the ice. Two portable generators are used to power light plants at the drill site.

ACS conducts spill response training activities during the open-water season during late July through early October. Vessels used as part of the training typically include Zodiacs, Kiwi Noreens, and Bay-class boats that range in length from 3.7 to 13.7 m (12 to 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 for the decommissioning of Northstar will be prepared near the end of field life, which will be long after the expiry of the 2nd five year period addressed in this request. (The production lifetime of the Northstar field is expected to be approximately 15 years.) Decommissioning will be conducted in accordance with the provisions of 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 for consideration of the environmental effects of decommissioning 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 in place to maintain low sediment release into the surrounding marine environment. The actual method of 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.

2. DATES, DURATION AND REGION OF ACTIVITY

The date(s) and duration of such activity and the specific geographical region where it will occur.

BP seeks authorization to continue operate the Northstar development during the 25 May 2005 through 24 May 2010 period as it was operated during the second half of the previous 5-year period. The geographic region encompasses the area described in the regulations at 50 CFR 216, subpart R.

3. SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

The species and numbers of marine mammals likely to be found within the activity area.

The area where the Northstar production facilities are located is within or near the southern edge of the migration path, or within the range, of several species of marine mammals. These include six species under the jurisdiction of the National Marine Fisheries Service: ringed, bearded and spotted seals, and bowhead, gray and beluga whales. Other extralimital species that occasionally occur in very small numbers in the Alaskan Beaufort Sea include the harbor porpoise, killer whale, narwhal, and hooded seal. Because of the rarity of the latter species in the Beaufort Sea, they are not expected to be exposed to or affected by any activities associated with the Northstar development and, therefore, are not discussed further. Some of these species are important subsistence resources used by the North Slope communities of Barrow, Nuiqsut and Kaktovik. To reduce redundancy, we have included the required information about species and numbers of marine mammals within the project area in Section 4.

4. STATUS, DISTRIBUTION AND SEASONAL DISTRIBUTION OF AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

The following six species of seals and cetaceans can be expected to occur in the region of proposed activity: ringed, spotted and bearded seals, and bowhead, gray and beluga whales. These six species are discussed in this section and are the species for which general regulations governing potential incidental takes of small numbers of marine mammals are sought. The descriptions provided in the original petition (BPXA 1999) are updated here to provide more recent information. Furthermore, NMFS annually publishes stock assessment reports for all marine mammals in Alaskan waters and those are referenced in the sections on individual species, below.

Two other marine mammal species found in this area, the Pacific walrus and polar bear, are managed by the U.S. Fish and Wildlife Service (USFWS). Potential incidental takes of those two species will be dealt with under a separate application for a Letter of Authorization from the USFWS.

Ringed Seal (*Phoca hispida*)

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. No estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Lodge 2002). Past ringed seal population estimates in the Bering-Chukchi-Beaufort area 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. The Alaska stock of ringed seals is not classified as a strategic stock by the NMFS.

During winter, ringed seals occupy landfast ice and offshore pack ice of the Bering, Chukchi and Beaufort seas. In winter and spring, the highest densities of ringed seals are found on stable shorefast ice. However, in some areas where there is limited fast 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 shorefast ice (Burns 1970; Stirling et al. 1982; Finley et al. 1983). Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They 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).

Based on studies of ringed seals in Alaska and the Canadian High Arctic, ringed seals start to 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. 2001, 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 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. (2001) reported substantially higher abandonment rate of structures from December 1999 through May 2001 than had been previously reported by other investigators (Frost and Burns 1989; Kelly et al. 1986). Williams et al. (2002) reported similar densities of structures (both abandoned and active) out to 3.5 km from Northstar island and the ice road, and that new structures were likely 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 for male and 0.6 km for female ringed seals (maximum distance between 2 lairs was 3.4 km). 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).

Frost et al. (2004) recently reported ringed seal densities during spring surveys ranging from 0.81 to 1.17 seals/km^2 on the ice between Oliktok Point and Barter Island. Spring density estimates in the same area from 1985-1987 ranged from 1.01 to 2.94 seals/km^2 (Frost and Lowry 1988). It is not known whether the more recent lower densities correspond to an actual reduction in the population or are related to earlier survey dates in 1990s. At earlier dates, a higher proportion of the seals are still using their lairs and are unavailable to be counted by aerial surveyors (Kelly et al. 2004). Frost et al. (2002) reanalyzed the earlier estimates for 1985-87 and reported ringed seal densities in their "survey sector B-3" (Oliktok Point to Flaxman Island) ranged from 0.56 to 1.16 seals/km^2 (about half the density originally reported) during the spring seasons of 1985 to 1987. Based on more recent surveys from 1996 through 1999, ringed seal density in fast ice areas in sector B-3 ranged from 0.48 to 0.77 seals/km^2 (Frost et al. 2002).

Coincident with the survey program of the Alaskan Beaufort Sea by Frost et al. (2002, 2004), BP 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 for comparison with the baseline data. Ringed seal densities reported by Moulton et al. (2002) ranged from 0.39 to 0.63 seals/km^2 prior to construction in the Northstar development area. Ringed seal densities close to Northstar in 2000, 2001, and 2002 were not reduced relative to those farther away or to those during the 1997 to 1999 pre-development period (Moulton et al. 2003a,b).

Although aerial surveys during spring are the standard method for documenting densities and distribution of ringed seals, 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 of survey conditions, miss some seals that are on the ice. Thus, the average density figures quoted above are minimum estimates.

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. 2004a). However, many groups consisting of >5 ringed seals were seen in September 1997 offshore from the Northstar area (Harris et al. 1998). These groups were in water 50-2000 m deep, well offshore from the planned development area. Large concentrations of ringed seals are not expected to be encountered near Northstar Island. A summary of earlier data on summer sightings of ringed seals in the region can be found in BPXA (1999).

Spotted Seal (*Phoca largha*)

An early estimate of the size of the world population of spotted seals was 370,000-420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000-250,000 animals (Bigg 1981). The total number of spotted seals in Alaskan waters is not known (Angliss and Lodge 2002) but the estimate is most likely between several thousand and several tens of thousands (Rugh et al. 1997). The Alaska stock of spotted seals is not classified as a strategic stock by NMFS (Hill and DeMaster 1998).

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering seas (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to two hundred animals. During the summer, spotted seals are found primarily in the Bering and Chukchi seas, but some range into the Beaufort Sea (Rugh et al. 1997; Lowry et al. 1998). At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. The seals are commonly seen in bays, lagoons and estuaries, but also range far offshore. In summer, they are rarely seen on the pack ice, except when the ice is very near to shore. As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

A small number of spotted seal haul-outs are (or were) located in the central Beaufort Sea in the deltas of the Colville River and, previously, the Sagavanirktok River. Historically, these sites supported as many as 400-600 spotted seals, but in recent times <20 seals have been seen at any one site (Johnson et al. 1999). In total, there are probably no more than a few tens of spotted seals along the coast of the central Alaska Beaufort Sea during summer and early fall. No spotted seals were positively identified during BP's Northstar marine mammal monitoring activities, although a few spotted seals might have been present. A total of 12 spotted seals were positively identified near the source vessel during open-water seismic programs in the central Alaskan Beaufort Sea generally near Northstar during the six years from 1996 to 2001 (Moulton and Lawson 2002, p. 3-17). Numbers seen per year ranged from zero (in 1998 and 2000) to four (in 1999)

Given their seasonal distribution and low numbers in the nearshore waters of the central Alaskan Beaufort Sea, no spotted seals are expected in the project area during the late winter and spring construction period, and few to none are expected near Northstar during the summer or autumn.

Bearded Seal (*Erignathus barbatus*)

The Alaska stock of bearded seals, which occupy the Bering, Chukchi, and Beaufort seas off Alaska, may consist of about 300,000-450,000 individuals (MMS 1996). No reliable estimate of bearded seal abundance is available for the Beaufort Sea (Angliss and Lodge 2002). The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

The bearded seal is the largest of the northern phocids. It is primarily a bottom feeder. It prefers areas of water no deeper than 200 m (660 feet). 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 <200 m. 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 more than 200 m deep.

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 there 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 the summer they are found near the widely fragmented margin of multi-year ice covering 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 haulouts.

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. 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 Development area is covered by landfast ice which bearded seals tend to avoid, preferring areas of moving ice and open water in depths of less than 200 m (Mansfield 1967; Burns and Harbo 1972). However, bearded seals have been observed to maintain 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 aerial surveys from 1997 to 2002 ranged from zero to 15 (Moulton et al. 2000, 2001, 2002, 2003c).

Bowhead Whale (*Balaena mysticetus*)

The pre-exploitation population of bowhead whales in the Bering, Chukchi, and Beaufort seas is estimated to be 10,400-23,000 whales, and was reduced by commercial whaling to perhaps 3000 (Woodby and Botkin 1993). Up to the early 1990s, the population size was believed to be increasing at a rate of about 3.2% per year (Zeh et al. 1996; Angliss and Lodge 2002) despite annual subsistence harvests of 14-74 bowheads from 1973 to 1997 (Suydam et al. 1995; Section 8). This is consistent with an annual population growth rate of 3.4% (95% CL 1.7-5%) from 1978 to 2001 reported by George et al. (2004) who estimated the population in 2001 at approximately 10,470 animals. Based on a continuing annual population growth of 3.4%, the 2004 bowhead population may number around 11,575 animals. The large increases in population estimates that occurred from the late 1970s to the early 1990s were partly a result of actual population growth, but were also partly attributable to improved census techniques (Zeh et al. 1993). This bowhead population is currently listed as Endangered under the Endangered Species Act and is classified as a strategic stock by the NMFS (Angliss and Lodge 2002).

Bowheads winter in the central and western Bering Sea and summer in the Canadian Beaufort Sea (Moore and Reeves 1993). Spring migration through the Western Beaufort Sea occurs through offshore ice leads, generally from mid-April through mid-June (Braham et al. 1984; Moore and Reeves 1993). East of Point Barrow, the lead systems divide into numerous branches that vary in location and extent yearly, but are located well offshore of the Alaskan coast. 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 of Northstar during the spring migration period.

Bowheads arrive in coastal areas of the Canadian Beaufort Sea and Amundsen Gulf in late May and June. After feeding in the Canadian Beaufort Sea, bowheads migrate westward from late August through mid- or late October. Fall migration into Alaskan waters is primarily during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; LGL and Greeneridge 1996a:30; Greene 1997a, p. 3-55; Greene et al. 1999; Blackwell et al. 2004b). Consistent with this, Nuiqsut whalers have stated that the earliest arriving bowheads have apparently reached the Cross Island area earlier in recent years than formerly (T. Napageak, pers. comm.).

The Minerals Management Service (MMS) has conducted or funded late-summer/autumn aerial surveys for bowhead whales in the Alaskan Beaufort Sea since 1979 (e.g., Ljungblad et al. 1986, 1987; Moore et al. 1989; Treacy 1988-1998, 2000, 2002a, b).

Bowheads tend to migrate in deeper water offshore during years with higher than average ice coverage than in years with lower than average ice cover (Moore 2000). In addition, the sighting rate tends to be lower in heavy ice years (Treacy 1997:67). During fall migration, most bowheads migrate west in water ranging from 15 to 50 meters (49 to 164 feet) deep. Some individuals enter shallower water, particularly in light ice years, but very few whales are ever seen shoreward of the barrier islands. Survey coverage far offshore in deep water is usually limited, and offshore movements may have been underestimated.

During construction and initial operations of BP's Northstar facilities in 2000–2003, an intensive program of acoustic monitoring has been used to characterize the late summer/early autumn migration of bowheads past Northstar. The methods and results are described in the comprehensive monitoring report submitted in July 2004 (Richardson and Williams [eds.] 2004), and in previous annual reports included as Appendices to the comprehensive report. An array of bottom-mounted acoustic recorders with direction-finding capability has been deployed 6-22 km (4-14 mi) seaward of Northstar (Greene et al. 2004). These recorders have determined the locations of large numbers of calling whales during the late summer/early autumn seasons in 2000-2003. The offshore distribution of calling bowheads has been analyzed in relation to the variable level of underwater sound emanating from Northstar itself and (especially) its supporting vessels (Richardson et al. 2004; McDonald and Richardson 2004). To the extent that there is offshore displacement of bowheads as a result of Northstar, it is a subtle and inconsistent effect involving no more than a small proportion of the passing bowheads.

Gray Whale (*Eschrichtius robustus*)

Gray whales originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s. A relic population survives in the Western Pacific. The eastern Pacific or California gray whale population has recovered significantly from commercial whaling, and now numbers about 26,600 (Rugh et al. 1999; Angliss and Lodge 2002). The eastern Pacific stock was removed from the Endangered Species List in 1994 and is not considered by NMFS to be a strategic stock.

The eastern Pacific gray whales breed and calve in the protected waters along the west coast of Baja California and the east coast of the Gulf of California from January to April (Swartz and Jones 1981; Jones and Swartz 1984). At the end of the breeding and calving season, most of these gray whales migrate about 8,000 km (5,000 mi.), generally along the west coast, to the main summer feeding grounds in the northern Bering and Chukchi seas (Tomilin 1957; Rice and Wolman 1971; Braham 1984; Nerini 1984).

Most summering gray whales congregate in the northern Bering Sea, particularly off St. Lawrence Island and in the Chirikov Basin (Moore et al. 2000), and in the southern Chukchi Sea. More recently, Moore et al. (2003) suggested that gray whale use of Chirikov Basin was reduced, likely as a result of the combined effects of changing currents resulting in altered secondary productivity dominated by lower quality food. The northeastern-most of the recurring feeding areas is in the northeastern Chukchi Sea southwest of Barrow (Clarke et al. 1989). Only a small number of gray whales enter the Beaufort Sea east of Point Barrow. Hunters at Cross Island in

1933 took a single gray whale (Maher 1960). Only one gray whale was sighted in the central Alaskan Beaufort Sea during the extensive aerial survey program funded by MMS from 1979 to 1997. None were seen during the LGL/BP surveys in that area during 1996 or 1997 (Miller et al. 1997, 1998b). However, during September 1998, small numbers of gray whales were sighted by LGL and MMS personnel on several occasions in the central Alaskan Beaufort—mainly in the Harrison Bay area west of Northstar, but occasionally in waters closer to Northstar (Miller et al. 1999; Treacy 2000). More recently a single sighting of a gray whale was made on 1 August 2001 near the Northstar production island (Williams and Coltrane 2002). Several single gray whales have been seen farther east in the Beaufort Sea (Rugh and Fraker 1981; LGL Ltd., unpubl. data), indicating that small numbers must travel through the waters offshore from the Prudhoe Bay region during some summers.

No gray whales will occur in the Northstar area during the late winter/spring period. In addition, given their rare occurrence in the central Beaufort Sea in summer, no more than a few are expected during the summer and early fall.

Beluga Whale (*Delphinapterus leucas*)

The beluga whale is an arctic and subarctic species that has several populations that occur in Alaska. The Beaufort population was estimated to contain 39,258 individuals as of 1992 (Angliss and Lodge 2002). This estimate is based on the application of a sightability correction factor of 2x to the 1992 uncorrected census of 19,629 individuals. This population is not considered by the NMFS to be a strategic stock.

Beluga whales of the Beaufort stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate around western and northern Alaska (Angliss and Lodge 2002). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July. The spring migration occurs through ice leads far offshore, including some of the same leads used by bowhead whales, plus additional cracks and leads farther offshore (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995a).

A portion of the Beaufort Sea seasonal population concentrates in the Mackenzie River estuary during July and August, but many of the belugas remain in offshore waters of the eastern Beaufort Sea and Amundsen Gulf (Davis and Evans 1982; Richard et al. 2001). Belugas are rarely seen in the central Alaskan Beaufort Sea during the summer.

During late summer and autumn surveys most belugas migrate far offshore near the pack ice front (Frost et al. 1988; Hazard 1988; Clarke et al. 1993; Miller et al. 1998b). Moore (2000) and Moore et al. (2000) suggest beluga whales select deeper slope water independent of ice cover. During the westward migration in late summer and autumn; however, small numbers of belugas are sometimes seen near the north coast of Alaska (e.g., Johnson 1979). The main fall migration corridor of beluga whales is ~100 km (62 mi.) north of the Northstar development. Satellite-linked telemetry data show that some belugas migrate west considerably farther off-shore, as far north as 76ºN to 78ºN latitude (Richard et al. 1997, 2001). The proportion of the belugas that migrate west within 15 km (9 mi.) of shore is not precisely known but is very small (Miller et al. 1997, 1998b, 1999). No beluga whales were detected near Northstar during 2000-2003.

Some belugas of the eastern Chukchi Sea stock move into the Beaufort Sea during late summer (Suydam et al. 2001). They also appear to occur predominantly in deep, offshore waters, and are unlikely to approach Northstar.

During the seismic monitoring programs in the central Alaskan Beaufort Sea during 1996 through 2001, aerial and vessel-based surveyors have observed only a few beluga whales migrating along or near the coast (LGL and Greeneridge 1996a; Miller et al. 1997, 1998b, 1999). The vast majority of belugas seen during those projects were far offshore. No belugas are expected in or near the Northstar Project area during late winter/spring, and few belugas are expected in nearshore waters during the summer/fall activities.

5. TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

BP requests a Letter of Authorization to authorize potential non-lethal incidental takes by harassment during its planned Northstar production, maintenance and training operations in the Beaufort Sea of Alaska. Although injury or mortality is unlikely during routine production activities, BP requests that the LoA authorize a small number of incidental, non-intentional, injurious or lethal takes of ringed seals in the unlikely event that they might occur.

The production and maintenance activities outlined in Sections 1 and 2 for the Northstar project have the potential to disturb or displace small numbers of marine mammals. These effects will not exceed what is defined in the 1994 amendments to the MMPA as "Level B" harassment (behavioral disturbance). No take by serious injury or death is likely, given the planned monitoring and mitigation measures (Sections 11 and 13). No injurious or lethal takes have been documented during the intensive monitoring efforts that have occurred during the periods of Northstar construction and initial operations from 2000 to mid-2004 (Richardson and Williams [eds.] 2004). The planned mitigation measures are designed to minimize the possibility of injury, e.g., to seal pups in birth lairs (see Section 11). BP's planned mitigation measures are also designed to cause the least practicable disturbance to marine mammals that might occur very close to the ice roads, the pipeline corridor, and the Northstar Island area.

During continuing production activities at Northstar, sounds and non-acoustic stimuli will be generated by vehicle traffic, vessel operations, helicopter operations, drilling, and general operations of oil and gas facilities (e.g., generator sounds and gas flaring). The sounds generated from transportation activities will be detectable underwater and/or in air some distance away from the area of activity. The distance will depend on the nature of the sound source, ambient noise conditions, and the sensitivity of the receptor. At times, some of these sounds may be strong enough to cause localized avoidance or other disturbance reactions by small numbers of marine mammals. The type and significance of behavioral reaction is likely to depend on the activity of the animal at the time of reception of the stimulus, as well as the distance from the sound source and the level of the sound relative to ambient conditions. However, monitoring studies done at Northstar since 2000 have shown that any disturbance and displacement effects on seals and whales that do occur are subtle and quite localized (Richardson and Williams [eds.] 2004). These very limited effects would not have biologically significant consequences for many (if any) individual seals and whales, and would have no population consequences.

In winter and spring, flooding on the sea ice may displace some ringed seals along the ice road corridor. No other species of marine mammal under the jurisdiction of the NMFS is expected to be present near the planned activities during winter or spring, although it is remotely possible that a very small number of bearded seals might be present. With the monitoring and mitigation measures that are planned (see Sections 11 and 13), and the ice conditions that prevail between Northstar and the shore, it is unlikely that any seals will be injured or killed during winter or spring. However, there is the possibility of injury or death of a seal pup in a lair, and it is requested that this possibility be covered by the regulations and associated LoA.

During the open water season, all six species of seals and whales discussed in Section 4 could theoretically be exposed to vessel or island noise, as well as other stimuli associated with the planned operations. Vessel traffic is known to cause avoidance reactions by whales at certain times (Richardson et al. 1995b). Helicopter operations, and perhaps some other summer activities may also lead to disturbance of small numbers of seals or whales (although helicopter traffic associated with Northstar is largely confined to areas from Northstar southward, where bowheads and belugas are rare). In addition to disturbance, some limited masking of whale calls or other low-frequency sounds potentially relevant to bowhead whales could occur. However, as evident from monitoring studies in 2001–2003, any effects of sounds from Northstar on whales traveling near the southern (proximal) edge of the bowhead migration corridor are, at most, subtle (Richardson et al. 2004).

If an oil spill occurs, marine mammals may be unintentionally disturbed as a result of spill response measures. However, it is anticipated the spill response command would have separate authorization for such harassment. Response measures for the ice-covered and open-water season may be markedly different, resulting in varying risk of Level A taking (i.e., injury or death) depending on the season.

Potential takes of marine mammals by incidental ("Level B") harassment could occur for the duration of the requested Letter of Authorization, and for the duration of regulations, upon renewal. Ringed seals will be in the area throughout this period. Small numbers of bearded and spotted seals may be present during the open water seasons, and a very small number of bearded seals might also be present during winter in some years. Few whales are likely to be in the area before late August, and whales will be absent after freeze-up, which typically occurs by late October.

6. NUMBERS OF MARINE MAMMALS THAT MAY POTENTIALLY BE TAKEN

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [section 5], and the number of times such takings by each type of taking are likely to occur.

General Considerations

BP seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the proposed region of activity. Species for which authorization is sought are ringed, spotted, and bearded seals, and bowhead, gray, and beluga whales. Potential takes are most likely to result from operational noise and vehicle, vessel, or aircraft activity. This section summarizes the numbers of marine mammals that might potentially be "taken" during operation of Northstar.

The Northstar facility is located north of the barrier islands. Northstar is not expected to "take" more than small numbers of marine mammals, nor to have more than a negligible effect on their populations. In addition, Northstar is not expected to adversely impact subsistence hunting of marine mammal species that are important to the Alaskan Native communities of the Beaufort Sea.

In the unlikely event of an oil spill, there is the possibility of serious injury or mortality to some unpredictable number of marine mammals; even then, population effects are expected to be negligible.

NMFS has previously stated (in NMFS 1997) the following policy:

> "…NMFS finds that a negligible impact determination may be appropriate if the probability of occurrence is low, but the potential effects may be significant. In this case, the probability of occurrence of impacts must be balanced with the potential severity of harm to the species or stock when determining negligible impact. In applying this balancing test, NMFS evaluates the risks involved and the potential impacts on marine mammal populations and habitat."

This policy was clarified in NMFS (2000) where taking by an oil spill was not authorized.

Ringed Seal (*Phoca hispida*)

Ringed seals are the most abundant and most frequently encountered marine mammals in the proposed region of activity. They are resident in the area, and therefore some of the same individuals could be exposed to Northstar activities on more than one occasion. Individual ringed seals are more likely to be exposed on a repeated or extended basis during the ice-covered season than during the open-water season. Ringed seals may be displaced a short distance away from the ice road corridors connecting the production islands to the mainland. However, traffic along the ice roads was at a maximum during the initial construction period in 2000, and there was no more than very localized displacement (Williams et al. 2001, MS; Moulton et al. 2003a,b). The potential for marine mammal takes to occur during the drilling and production periods is expected to be reduced compared to the construction period. During most of the year, all age and sex classes, except for newborn pups, could occur in the proposed activity area. In late March and April, ringed seals give birth; therefore, at that time of year young pups may also be encountered. Mitigation measures (see Section 11) will be used to minimize the possibility that any seal pups in lairs will be injured or killed.

Spotted Seal (*Phoca largha*)

In the region of activity, spotted seals are most often found in the waters adjacent to river deltas during the open-water season. Therefore, it is unlikely that spotted seals will be "taken" during normal operations of Northstar. Pupping and mating occur in the spring when spotted seals are not in the Beaufort Sea. Hence, young pups will not be encountered. All other sex and age classes may be encountered in small numbers during late summer/autumn. The noise from vessel or aircraft activity may be audible to spotted seals in the nearshore waters, and spotted seals at coastal haul-out sites are sensitive to aircraft overflights (see Section 7). However, in the absence of major haul-out concentrations within the project area, potential takes by disturbance will have a negligible impact on the species or any subsistence activities directed toward them.

Bearded Seal (*Erignathus barbatus*)

The few bearded seals that remain in the area during winter and spring are generally found north of the proposed region of activity in association with the pack ice or the edge of the landfast ice. Based on all available data, we estimate that no more than 1 bearded seal (and most likely none) was present within the 0.64 km zone around the ice roads before ice-road construction began in January 1999. Bearded seals are rarely found in land-fast ice (Burns 1981). Bearded seals were not noted on the fast ice during the 1997 or 1998 BP/LGL surveys (G. Miller, LGL Ltd., pers. comm.), but small numbers were seen there in 1999, 2000, 2001 and 2002 (Moulton et al. 2000, 2001, 2002, 2003c). No bearded seals were seen during ADF&G's surveys of Sector B3 (Frost et al. 1997, 1998). The large size of this phocid makes it conspicuous to observers, reducing the likelihood of missing animals on the ice and hence underestimating abundance. At most, we predict that five bearded seals might be present within 2-4 km of the Northstar facilities during winter/spring of any one year. The most probable number present there in winter/spring is zero.

During the open-water season, 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. A few bearded seals may be exposed to noise and other stimuli from production activities on and around the island, and it is possible that some individuals may show localized avoidance. A few bearded seals may also be disturbed briefly by vessel or aircraft traffic, but this disturbance will not have any prolonged or biologically significant effects. There will be negligible impact on the species or any subsistence activities directed towards them.

Studies also indicate that pups and other young bearded seals up to 3 years of age comprise 40-45% of the population (Nelson et al., n.d.), and that younger animals tend to occur closer to shore. Therefore, although all age and sex classes could be encountered, many of those that are encountered in the Northstar project area in the open-water period are likely to be young, non-reproductive animals.

Bowhead Whale (*Balaena mysticetus*)

Bowhead whales are not resident in the region of activity. They migrate through the general region during the spring and fall. However, during spring, no bowheads are expected to occur within 75 km of Northstar, and no takes are expected. During the westward autumn migration, few bowheads occur within 10 km of Northstar during most years (<2% of the population in 1979-95). However, in some years (e.g., especially 1997, 2001, and 2003, see Treacy 1998; Blackwell et al. 2004b) a larger percentage of the bowhead population migrates within 10-15 km of Northstar. The 2001 bowhead whale population occupying the Bering-Chukchi-Beaufort area has been estimated at approximately 10,470 animals (George et al. 2004). To estimate the 2004 population size for purposes of calculating potential "takes", the annual rate of increase was assumed to be 3.4% (George et al. 2004). Based on these figures, the 2004 population size could be approximately 11,575 bowhead whales.

There are few data on the age and sex composition of bowhead whales that have been sighted near the proposed survey area. The few data from the area and more extensive data from more easterly parts of the Alaskan Beaufort Sea in late summer/autumn (Koski and Johnson

1987; Koski and Miller 2002) suggest that almost all age and sex categories of bowheads could be encountered. However, newly born calves (<1 month old) are not likely to be encountered during the fall (Nerini et al. 1984; Koski et al. 1993). Males, non-pregnant females, pregnant females, and calves (mostly 3-6 months old) are likely to occur in the area.

About 43.7% of the bowheads in this stock are sexually mature (Koski et al. 2004), and about 25% of the mature females are pregnant during autumn migration (Zeh et al. 1993). About 50.5% of the whales in this stock are juveniles (excluding calves), and 5.8% are calves (Koski et al. 2004). The sex ratio is close to 1:1, about half of each category would be males and half females. The potential take would be limited to "Level B Harassment" (including avoidance reactions and other behavioral changes). Most bowheads that could be encountered would be migrating, so it is unlikely that an individual bowhead would be potentially "taken by harassment" more than once.

Gray Whale (*Eschrichtius robustus*)

Gray whales are not resident and rarely migrate through the proposed region of activity. They are typically found southwest of Point Barrow. Only one gray whale was observed in the central Alaskan Beaufort Sea during the extensive aerial surveys conducted by or for MMS during the period 1979 – 1997. However, there were several sightings in that area during the autumn of 1998 and during vessel based operations in 2001 (see section 4). Gray whales do not occur in the region during the ice-covered season, and few are expected during the open-water season. No specific data on age or sex composition are available for the few gray whales that move east into the Beaufort Sea. All sex and age classes (including pregnant females) could be found, with the exception of calves less than six months of age.

Beluga Whale (*Delphinapterus leucas*)

The Beaufort Sea beluga population was estimated at 39,258 individuals in 1992, with a maximum annual rate of increase of 4.0% (Hill and DeMaster 1998; Angliss and Lodge 2002). Assuming a continued 4% annual growth rate, the population size could be approximately 62,850 beluga whales in 2004. However, the 4.0% estimate is a maximum value and does not include loss of animals due to subsistence harvest. Thus, the population size in 2004 may be less than the estimated value. Additionally, the southern edge of the main fall migration corridor is approximately 100 km (62 mi.) north of the Northstar region (Section 4). During seismic monitoring programs in the central Alaskan Beaufort Sea during 1996 through 2001, aerial and vessel-based surveyors observed only a few beluga whales migrating along or near the coast (LGL and Greeneridge 1996a; Miller et al. 1997, 1998b, 1999).

Any potential take of beluga whales is expected to involve a very small percentage of the population, and would be limited to "Level B harassment". Belugas from the Chukchi stock occur in the Alaskan Beaufort Sea in summer, but are even less likely than the Beaufort stock to be encountered in the nearshore areas where sounds from Northstar will be audible. The few animals involved could include all age and sex classes. Calving probably occurs in June to August in the Beaufort Sea region and calves 1-4 months of age could be encountered. Most of the few belugas that could be encountered would be engaged in migration, so it is unlikely that a given beluga would be repeatedly "taken by harassment".

Potential Numbers of "Takes"

Presented below are the estimated annual numbers of potential "takes" for each seal and whale species during the ice-covered and open water seasons for the Northstar oil production period.

Ice-Covered Season

During the ice-covered season, the only species of seal or whale that occurs regularly in the area of landfast ice surrounding Northstar is the ringed seal. An occasional bearded seal can occur in the landfast ice in some years. Bowhead and beluga whales are absent from the Beaufort Sea in winter, and in spring their eastward migrations are through offshore areas north of the landfast ice, which excludes whales from areas close to Northstar. Therefore, only potential "takes" for ringed seals are discussed here. For the ice-covered season, areas used in calculations of potential "takes" were limited to floating fast-ice, i.e. outside the 5-foot isobath. After six consecutive seasons (1997-2002) of ringed seal studies and monitoring, no statistically significant displacement or exclusion of ringed seals from areas beyond 500 m (0.31 mi) from the island, ice roads, or physically-disturbed ice was detected. The only evidence of displacement was that new subnivean structures created after December were located, on average, ~500 m farther away from the recently flooded ice road than those created before December (Williams et al. 2004b, MS). The potential for pseudoreplication (Underwood 1994) is recognized for this single line of evidence, but provides a conservative estimate of the potential effects for Northstar activities in the following assessment.

In order to evaluate how seals may have been displaced by industrial activities during the ice-covered season, the number of seals that might have occurred within 100 m of on-ice activity or the island itself (i.e., the potential impact zone) if the Northstar Development had not been constructed was estimated (Williams et al. 2004c). Those estimates are based on aerial survey data collected in 1997-2002 (Miller et al. 1998a; Link et al. 1999; Moulton and Elliott 1999; Moulton et al. 2000, 2001, 2002, 2003c) in otherwise-similar non-industrial areas, or surveys of the Northstar area in non-industrial years. Estimates of the seals expected in the absence of industrial activities are compared to observed densities of ringed seals in the same area. The difference is an estimate of the number of ringed seals that may have been displaced by industrial activities at Northstar.

When calculating the number of ringed seals expected within the potential impact zone in the absence of industrial activity, we considered the area at a distance of 4-10 km from the Northstar Development zone as a "reference" area. The reference area was limited to those near-by locations in case there were undocumented characteristics (independent of industry) of the Northstar area that made it either more or less "favorable" to ringed seals. We also controlled for water depth, because ringed seal density in the overall study area was highest in water 5-20 m deep.

To calculate the number of ringed seals expected to occur within the potential impact zone in the absence of avoidance, we applied densities determined for four water depth categories (0–3 m, 3–5 m, 5–10 m, 10–15 m) within the "reference" zone 4–10 km from Northstar. These four densities (in seals/km^2) were multiplied by the corresponding four stratum areas within the potential impact zone (totaling 3.91 km^2) to give the expected numbers of ringed seals within that zone. This was the expected number of ringed seals within 100 m of the ice road to the island and/or within 100 m of the artificial island. This was done separately based on 1997, 1998, 1999, 2000, 2001, 2002, and average 1997–1999 (pre-Northstar) and 2000-2002 (Northstar) data from the BP/LGL surveys. Based on the 2000–2002 surveys of the 4–10 km "reference" zone, the expected "uncorrected" numbers of seals in the potential impact zone in the absence of any avoidance averaged ~2. The estimate based on 2002 survey data was 2 seals (Table 1).

The estimates quoted above are the estimates prior to correction for the proportions of the seals that would be missed by aerial surveyors because of "detection bias" or "availability bias". ("Detection bias" refers to the fact that aerial surveyors do not see every seal that is on the ice and potentially sightable. "Availability bias" refers to the fact that seals are not always hauled out above the ice and snow, and thus "available' to be seen by aerial surveyors.) Instead, the estimates quoted above represent the average numbers of seals that one would expect to see during a single aerial survey of the entire potential impact zone, i.e., assuming 100% on-transect coverage.

We adjusted the above estimates to allow for seals hauled out but not sighted by observers (detection bias; ×1.22) and for the proportion of ringed seals not hauled out during the survey coverage (availability bias; ×2.33). Those two correction factors are based, respectively, on Frost et al. (1988) and Kelly and Quakenbush (1990). These adjustments increased the estimated numbers of seals present within the potential impact zone by a combined factor of ×2.84, within the limits of rounding error (Table 1). For example, based on the 2002 survey data, the number of seals expected within the potential impact zone in the absence of any avoidance effect increased from the uncorrected estimate of 2 seals to a corrected estimate of 7 seals.

We calculated that 6 ringed seals would have been expected in the "potential impact zone", on average, in the absence of Northstar industrial activity. This estimate is based on observed ringed seal densities in 2000-2002 in a reference area 4–10 km from the 2003 Northstar development zone, corrected for observer and availability bias. This number corresponds to a raw survey density of 0.57 seals/km^2. In fact, the observed raw density in the potential impact zone was 0.59 seals/km^2 over those years, slightly higher than the expected density (Table 1), corresponding to a corrected estimate of ~7 ringed seals within the potential impact zone. The small difference between these two figures (~1 seal), and the direction of the change is consistent with other evidence that displacement of seals was minimal from 2000-2002, if it occurred at all.

As noted earlier, we predict that no more than five bearded seals could be present in winter/spring within 2-4 km of the Northstar facilities during any one year, and fewer would be present in the "potential impact zone". The most probable number in any one year is zero.

Spotted seals, bowhead whales, gray whales, and beluga whales are expected to be absent during the ice-covered period. There is no potential for "taking" of those species during the ice-covered period.

TABLE 1. Numbers of ringed seals expected to occur in spring 1997–2002 within the "Potential Impact Zone" (as defined for 2003) in the absence of any Northstar impact, based on observed seal densities in a reference area 4–10 km away from Northstar. The potential impact zone included areas within 100 m of the ice road and Northstar/Seal Island. All values differ from those previously reported for 1997–2002 (Moulton et al. 2003d) because the "Potential Impact Zone" as now recognized is limited to smaller distances from Northstar facilities.

BP/LGL Survey	Expected Density[a] (seals/km^2)	Expected Number of Seals Within Potential Impact Zone		Observed Density Within the 2003 Potential Impact Zone (seals/km^2)
		Uncorrected	Corrected Total[b]	
1997	0.48	2	5	0.33
1998	0.33	1	4	0.00
1999	0.27	1	3	0.00
2000	0.54	2	6	0.19
2001	0.54	2	6	1.04
2002	0.62	2	7	0.55
Average 1997-1999	0.36	1	4	0.11
Average 2000-2002	0.57	2	6	0.59

[a] These average uncorrected densities are based on data from the zone 4-10 km away from the 2003 development zone, controlling for water depth by weighting density based on the proportions of the potential impact zone within the various depth strata.

[b] "Uncorrected" multiplied by the 1.22 correction factor for seals hauled out but not seen by observers (Frost et al. 1988), and by the 2.33 correction factor for seals not hauled out (Kelly and Quakenbush 1990).

Break-Up Season

For the break-up period, our estimates are based on the following assumptions: (1) Seals within a 1 km distance (3.11 km^2) of Northstar Island might be potentially "taken". (2) The density of seals within that area is equal to the corrected density around Northstar from 30 May – 7 June 2002. (3) The seals within the affected area are replaced once for each of six 7-day intervals during the break-up period. Based on these assumptions, an estimated 30 seals (1.56 seals/km^2 x 3.11 km^2 x 6 weeks) might be present and potentially affected. Most of the seals present during the break-up period are likely to be ringed seals, although bearded seals could also be present in some years.

As noted earlier, we predict that few bearded seals could be present within 2-4 km of the Northstar facilities during any one year, and fewer would be present in the "potential impact zone". The most probable number in any one year is zero.

Spotted seals, bowhead whales, gray whales, and beluga whales are expected to be absent during the break-up period. There is no potential for "taking" of those species during the break-up period.

Open-Water Season

Seals

For the open-water period, our estimates are based on the following three assumptions: (1) Seals within a 1 km distance (3.11 km^2 area) of Northstar Island might be potentially "taken". (2) The density of seals within that area would be no more than 2x the density observed during boat-based surveys for seals within the general Prudhoe Bay area in 1996-2000 (0.19 seals/km^2 x 2 = 0.38 seals/km^2). (3) The seals within the affected area are replaced once for each of fifteen 7-day intervals during the open-water period. The first of these points assumes that seals in open water are not significantly affected by passing vessels (or helicopters) that they could occasionally encounter in areas >1 km from Northstar. Passing boats and helicopters might cause startle reactions and other short-term effects. However, NMFS has indicated that short-term behavioral effects having no negative consequences for biologically important activities are not relevant in estimating the number of ringed seals potentially affected (NMFS 2000).

Based on the above assumptions, an estimated 18 seals might be present and potentially affected, i.e., 3.11 $km^2 \times 0.38$ seals/$km^2 \times 15$ weeks. Ringed seals constituted 94% of the seals identified in the area during the open-water seasons of 1996–2000, with 4.3% being bearded seals and 1.5% spotted seals. Thus, of the estimated 18 seals, about 17 would be ringed seals, one might be a bearded seal, and probably none would be spotted seals. These estimates are subject to wide uncertainty (in either direction) given the uncertainties in each of the three assumptions listed above.

There is no specific evidence that any of the seals occurring near Northstar during the 1997-2003 open-water seasons were disturbed appreciably or otherwise affected by BP's activities (Williams et al. 2004a). Following NMFS (2000b, 2001), we assume that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a biologically significant manner (e.g., looking at a passing vessel or helicopter), do not constitute harassment or "taking".

Bowhead Whales

The acoustic monitoring of the bowhead whale migration was designed to determine (with the limitations discussed in Chapters 8 and 9 of Richardson and Williams [eds., 2004]) whether bowhead whales were displaced offshore by Northstar construction and operational activities and, if so, to what geographical extent. If the southernmost calling bowheads detected by the acoustic monitoring system tended to be farther offshore when Northstar operations were noisy than when they were quieter, this was to be taken as evidence of an effect. The geographic scale of any documented effect, as a function of Northstar sound level, would provide a basis for estimating the number of whales affected. In fact, the monitoring results provided subtle evidence of a small displacement effect in the southern part of the migration corridor during a minority of the 2001 migration season when the industrial noise level in the water near Northstar was highest. The evidence for a corresponding displacement effect in 2002 was equivocal, and there was no convincing evidence of a displacement effect at high-noise times in 2003 (Richardson et al. 2004; see also Fig. 7.18B vs. A *in* Blackwell et al. 2004b). The lack of a clear displacement effect in 2003 occurred despite the fact that the 2003 results provided the "best" dataset with which to assess displacement, if it occurred: a much larger sample size than in 2001 or 2002, industrial sounds that were more variable than in 2002, and a migration corridor that was closer to shore than in 2001 or 2002 (Richardson et al. 2004).

The numbers of bowhead whales passing Northstar that were displaced offshore by ≥ 2, 3 and 5 km (≥ 1.2, 1.9 and 3.1 mi) have been estimated for each of 2001, 2002, and 2003 based on the acoustic localizations of calling whales. The procedure considered the calls localized within an analysis area extending to 26.6 km (16.5 mi) seaward of Northstar, and for 20 km (12.4 mi) in the alongshore direction. The procedure is explained in detail in McDonald and Richardson (2004). In summary, quantile regression was used to determine the dependence of the offshore distances (within the analysis area) on the variable level of underwater sound. Regression relationships were determined for various quantiles (2.5^{th} to 30^{th}) of offshore distance vs. a measure of the underwater sound level ~450 m (¼ mi) from Northstar. From these results, the percentages of the migrating whales apparently deflected by ≥ 2, 3 and 5 km were estimated for various levels of underwater sound associated with Northstar. The overall number of whales deflected was estimated by multiplying these percentages by three factors: (a) The proportions of whales estimated to migrate past with each sound level, based on the proportion of whale calls (or alternatively time) with various sound levels. (b) The proportion of the bowhead population estimated to pass through the analysis area (vs. farther offshore), taken to be 50% in 2001 and 2002, and 75% in 2003. (c) The size of this bowhead population, estimated as 10,470 (George et al. 2004).

In 2001, analysis of the localization data indicated that a small number of bowhead whales in the southern part of the migration corridor (closest to Northstar) were deflected by vessel or island operations at the times with highest sound levels. In 2001, estimates of the number of bowheads apparently deflected offshore by ≥ 2, 3 and 5 km were 19, 12 and 4, respectively, with approximate 90% upper confidence bounds of 69, 38 and 18. In 2002, the corresponding estimates were 49, 19 and 0, respectively, with the approximate upper bounds on the 90% confidence region being 149, 119 and 27. In 2003, the estimated number of whales displaced by ≥2 km (or any larger distance) was 0. The 90% upper bounds on the numbers displaced by ≥2, 3 and 5 km in 2003 were 169, 84 and 0.

The above figures assume that the number of whales passing with each sound level was directly related to the number of whale calls detected in the analysis area. Alternatively, we could assume that the number of whales passing with each sound level was proportional to the fraction of the time with that sound level. Under that assumption, the ≥2 km point estimates for 2001, 2002 and 2003 are, respectively, 2.4× higher, 1.8× higher, and the same as those quoted above. The alternative estimates of numbers displaced by ≥2 km were 47, 89 and 0 in 2001, 2002 and 2003, vs. primary estimates of 19, 49 and 0. Corresponding 90% upper confidence bounds (approximate) were 157, 484 and 117 via the alternative method, vs. 69, 149 and 169 via the primary method (see Table 9.2 vs. 9.1 *in* McDonald and Richardson 2004).

The estimated numbers of whales involved in the "apparent displacement effect", and even the upper bounds on those estimates, are only small proportions of the bowhead population, which is estimated as ~10,470 whales in 2001 (George et al. 2004). The best estimates of numbers displaced by ≥2 km, ranging from 0 to 89 depending on year and analysis method, are all very small percentages of the population size (0–0.9% of 10,470). There is a low probability that the number displaced by ≥2 km was as high as the estimated 90% upper bounds, which ranged from 69 to 484 depending on year and analysis procedure. Even if the number "displaced" was that high in one or more years, these 90% upper bounds represent only 0.7–4.6 % of the population. These 90% upper bounds are well below the number (765) of bowheads that NMFS authorized BP to "take by harassment" on an annual basis from 2000 to 2004. (Previous LoAs also set limits of a maximum of 1533 bowhead "takes" in 2 out of 5 seasons or 3585 in 5 years.)

BP's Northstar activities during the late summer and autumn periods of 2005–2009 are expected to be no more disturbing to bowhead whales than those in 2000–2003. Thus, there is no reason to expect stronger or more frequent disturbance in future than in the recent past. Given the 2001–2003 monitoring results, the number displaced by ≥2 km will probably be <100 per year, is unlikely to exceed 500 in any given year, and is highly unlikely to exceed the previously authorized 765 per year.

There is no established criterion for determining how large the displacement would need to be before a bowhead whale should be considered "taken by harassment". However, it seems improbable that the apparent displacements evident in the southern part of the migration corridor at high-noise times during 2001 and possibly 2002 would have negative consequences for the individual whales involved let alone their population. There is considerable natural variation in the distances of bowheads from shore both within and between years (Treacy 2002a,b). Thus, the displacement would need to be by many kilometers before the whales could be said to be following a migration route outside the normal range of routes. Offshore displacement of the migration route of a given whale by 2 or 3 km, or even 5 km, is well within the natural range of variability, and is unlikely to have negative consequences for the individual whale. An exception could occur if the whales were displaced from a localized area of particular significance to bowheads. However, bowheads did not show any special tendency to congregate or feed near Northstar prior to the construction of Northstar Island in 2000 (e.g., Miller et al. 1996; Treacy 2002b).

The 2001–2003 monitoring data were deemed not suitable for estimating the number of whales displaced by <2 km (1.2 mi). The number of whales displaced by distances <2 km, e.g., by 1 km, can be assumed to be greater than the numbers reported for 2 km. The expected and observed tendency for the number displaced by $\geq x$ km increases as x decreases. Displacement at the scale likely to occur as the result of Northstar activities is unlikely to be biologically significant.

The "Northstar effect" on the distribution of whale calls (to the extent that it occurred) has often been treated as indicative of deflection offshore, but it might represent a change in the calling behavior of the whales close to shore rather than an offshore deflection. These possibilities cannot be distinguished with confidence. In either case, i.e., deflection or altered calling behavior, there was apparently a change in the behavior of some whales as a result of exposure to Northstar activities, and our estimates provide guidance regarding the number of whales involved.

Overall, it seems very unlikely that any biologically significant effects on individuals or their population have occurred as a result of the limited "apparent displacement effect" evident to date. Given the apparent rarity of displacements by ≥2 km, there is no evidence that impacts from Northstar are changing the migration corridor in a significant manner in the area offshore of Northstar. In addition, the continued increase in the overall Bering/Chukchi/Beaufort Stock of bowhead whales suggests that levels of disturbance, combined with continued harvests by North Slope Borough residents, are not having discernible population-level effects.

For the small number of whales in the southern part of the migration corridor that exhibit "apparent offshore displacement", it is not known how long the effect (whether actual offshore displacement or altered calling behavior) persisted. Even if this effect were prolonged, it is unlikely that a slight offshore displacement or a change in calling behavior among whales traveling through largely open water would result in long-term negative effects on biologically important activities of those individuals, or significant effects on their overall population.

Gray Whales

Gray whales are uncommon in the Prudhoe Bay area, with no more than a few sightings in any one year, and usually no sightings (Miller et al. 1999; Treacy 2000, 2002a,b). There were no sightings of gray whales during the MMS aerial surveys of the Beaufort Sea in 2002 (S. Treacy, MMS, pers. comm.). MMS data for 2003 are not yet available. Gray whales do not call very often when on their summer feeding grounds, and the infrequent calls are not very strong (M. Dahlheim and S. Moore, NMFS, pers. comm.). No gray whale calls were recognized in the data from the acoustic monitoring system near Northstar in 2000–03. It is most likely that no gray whales were affected by activities at Northstar during either 2003 or previous years.

Beluga Whales

There are no specific data on the numbers of beluga whales (if any) disturbed or otherwise affected by Northstar production activities in 2003 or earlier years. During aerial surveys of the central Alaskan Beaufort Sea, the great majority of beluga sightings have been far offshore, near or beyond the shelf-break (Miller et al. 1996, 1999; Moore et al. 2000; S. Treacy, MMS, pers. comm.). Satellite-linked telemetry also shows that most belugas follow offshore migration routes across the Alaskan Beaufort Sea during late summer and autumn (Richard et al. 2001). Specific monitoring of the beluga migration was not identified as a requirement during the 2000–2004 period, given the predominantly offshore nature of the beluga migration. The DASARs were not designed to monitor the beluga migration; the DASARs did not record sounds with frequencies above ~500 Hz, and beluga calls are at frequencies higher than that.

Moulton et al. (2003d), following procedures similar to those of Miller et al. (1999), used historical aerial survey data to estimate the number of belugas that might approach the Northstar site in the absence of any disturbance:

- Aerial survey data from 1979 to 2000, including both MMS and LGL surveys, were used to estimate the proportion of belugas migrating through waters ≤4 km seaward of Northstar. Of the belugas traveling through the surveyed waters (generally inshore of the 100-m contour), the overall percentage seen ≤4 km offshore of Northstar during 1979-2000 was 0.62% (8 of 1289 belugas). The maximum percentage for any one year was for 1996, when 6 of 153 (3.9%) were ≤4 km offshore of Northstar. These figures are based on beluga sightings within the area 147°00’ to 150°30’W.
- Most beluga whales migrate far offshore; the proportion migrating through the surveyed area is unknown but was assumed by Miller et al. (1999) to be ≤20%, which is probably an overestimate.
- The disturbance radius for belugas exposed to construction and operational activities in the Beaufort Sea, although not well defined, is apparently considerably less than that for bowheads (Richardson et al. 1995b). BPXA (1999) assumed that the potential radius of disturbance was ~1 km around the island. (There are no Northstar-specific data that could be used to obtain a better estimate than this ~1 km figure.) Based on the assumed 1 km radius, we would expect

that no more than 20% of the belugas migrating ≤4 km seaward of Northstar would approach within 1 km of the Northstar island in the absence of any industrial activity there.

- The most recent published estimate of the Beaufort Sea population of beluga whales is ~39,258 animals (Angliss and Lodge 2002).
- Satellite-tagging data show that some members of the Chukchi Sea stock of belugas could also occur in the Beaufort Sea generally near Northstar during late summer and autumn (Suydam et al. 2001, 2003). However, they (like the Beaufort belugas) tend to remain at or beyond the shelf break when in the Alaskan Beaufort Sea during that season. That, combined with the small size of the Chukchi stock, means that consideration of Chukchi belugas would not appreciably change the estimated numbers of belugas that might occur near Northstar.

From these values, the number of belugas that might approach within 1 km of Northstar (in the absence of industrial activities) during a given open water season is ~10 belugas based on the average distribution: $0.0062 \times 0.2 \times 0.2 \times 39{,}258$. If the disturbance effects extended to a radius of 2 km, then the estimated number of belugas potentially involved during a typical year would be ~20. The previous LoAs issued to BP authorize harassment of up to 91 belugas on an annual basis.

Summary for Years of Northstar Operations

Table 2 summarizes the results of the calculations described above for the proposed period of applicability of the requested LoA, and in anticipation of renewed regulations for 2005-2010. No allowance has been made for possible further increases in population sizes of belugas and bowheads.

TABLE 2. Estimated annual potential "takes" (displacement) for marine mammals during the ice-covered and open water seasons during the Northstar operation period. Probable number, with maximum number in parentheses (see text).

	Ringed Seal	Spotted Seal	Bearded Seal	Bowhead Whale	Gray Whale	Beluga Whale
Ice-covered	1 (5)	0	1 (5)	0	0	0
Break-Up	30	0	0	0	0	0
Open Water	17	0	1	<100 (765)	< 5	10 -20

No specific estimate of potential takes by oil spills has been made for reasons discussed in the preamble to the regulations at 50 CFR 216, subpart R. Even in the unlikely event of a major oil spill at Northstar or from the associated subsea pipeline, numbers of marine mammals injured or killed are expected to be small and effects on the populations negligible.

7. ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammal.

The likely or possible impacts of the planned offshore oil developments at Northstar on marine mammals involve both acoustic and non-acoustic effects. Petroleum development and associated activities in marine waters introduce sound into the environment. The acoustic sense of marine mammals probably constitutes their most important distance receptor system, and oil industry sounds could (at least in theory) have several types of effects on marine mammals. Acoustic effects relate to sound produced by island construction, impact hammering, and drilling (now completed, insofar as now foreseen) as well as vehicles operating on the ice, vessels, aircraft, generators, production machinery, gas flaring, and camp operations.

Potential non-acoustic effects could result from the physical presence of personnel, structures and equipment, vibratory hammering of sheet piles, and (rarely) the occurrence of oil spills. There is a small chance that a seal pup might be injured or killed by on-ice construction or transportation activities. A major oil spill is unlikely and, if it occurred, its effects are difficult to predict. A major oil spill might cause serious injury or mortality to small numbers of marine mammals.

Sound Characteristics and Effects

The effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson et al. 1995b):

(1) The noise may be too weak to be heard at the location of the animal, i.e. lower than the prevailing ambient noise level, the hearing threshold of the animal at relevant frequencies, or both.

(2) The noise may be audible but not strong enough to elicit any overt behavioral response. This has been demonstrated upon exposure of bowhead whales to low levels of seismic, drilling, dredge, or icebreaker sounds (Richardson et al. 1986, 1990, 1995a,b).

(3) The noise may elicit reactions of variable conspicuousness and variable relevance to the well-being of the animal. These can range from subtle effects on respiration or other behaviors (detectable only by statistical analysis) to active avoidance reactions.

(4) Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist or exhibit increasing responsiveness (sensitization). The latter are most likely with sounds that are highly variable in characteristics, unpredictable in occurrence, and associated with situations that the animal perceives as a threat.

(5) Any anthropogenic noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear natural sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes (used for navigation and other functions), and environmental sounds such as ice or surf noise. Intermittent sounds, such as those from impact hammers, will cause masking for only a fraction of the time when compared to continuous sounds.

(6) Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity. Effects of strong sounds of varying durations on hearing thresholds of

pinnipeds and odontocete cetaceans have received considerable study in recent years (e.g., Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002; Nachtigall et al. 2003). Received sound levels must far exceed the animal's hearing threshold for there to be any temporary threshold shift (TTS). The TTS threshold depends on duration of exposure; the sound level necessary to cause TTS is higher for short sound exposures than for long sound exposures. Received levels must be even higher to risk permanent hearing impairment, especially for non-impulse noise.

Construction Sounds

Sounds associated with construction of Seal Island in 1982 were studied and described by Greene (1983a) and summarized in the previous petition for regulations submitted by BP (BPXA 1999).

In Feb., March and May 2000 sounds associated with the final phases of construction of Northstar Island were recorded; results are summarized in Williams et al. (2004b, MS). They estimated the received levels at a standard distance of 100 m from the source based on the observed logarithmic relationship between received levels and distance from the sound source. They also summarized the distances at which background levels were reached, based on two methods:

- the distance at which the level in the strongest one-third octave band would equal the 50^{th} percentile level of background sound in that one-third octave band, assuming simple spherical spreading, and
- 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.

During construction of Northstar, the lowest received levels at 100 m were obtained during augering and pumping activities during ice road construction (Table 3). Large trucks hauling 30 cu. yd. of gravel on the ice roads to the island location also produced relatively low received levels at 100 m. The ditchwitch was recorded while cutting ice blocks and the backhoe was recorded while it was excavating the pipeline trench in the seafloor through a slot in the ice. Not surprisingly, they produced relatively higher ice vibration levels, compared to their own underwater and in-air values and to other activities. In March 2000, a trench was created across a barrier island to allow emplacement of pipelines connecting Northstar to the mainland. This was done by detonation, over a 3.6 s period, of a line of closely-spaced explosive charges. This yielded the highest received levels underwater and in the ice (Table 3), but such blasts occurred only twice in 2000, and are not expected to recur. Shephard et al. (2001) also recorded sound near Northstar during construction and reported that the noisiest conditions occurred during sheet pile installation with a vibrating hammer.

TABLE 3. Typical received broadband levels of underwater and airborne sound and of iceborne vibrations at a standard distance of 100 m from various Northstar-related sources, and typical distances at which those signals diminish to "background" levels (see text). Underwater (hydrophone) levels are in dB re 1 μPa (10–10,000 Hz), in-air (microphone) levels are in dB re 20 μPa (10–10,000 Hz), and in-ice (geophone) levels, from the vertical channel, are in dB re 1 pm/s (10–500 Hz). For impact pile-driving, the pulse sound pressure level was averaged over the pulse duration; the values reported are means of many pulses. Detonation values correspond to a single event (see text). N.A. = not available.

	Typical Received Level 100 m from Source			Typical Distance (km) to Background Level		
Source	Under-water	In Air	In Ice	Under-water	In Air	In Ice
Dozer	114	65	130	4.6	0.1	20
Augering on ice road	103	68	104	8.4	0.4	0.6
Pumping on ice road	108	73	114	9.5	0.2	1.8
Ditchwitch	122	90	128	11	1.6	14
Backhoe	124	130	165	9	>25	>25
Gravel Trucks	109	63	115	9.2	0.6	2.5
Vibratory Pile-driving	138	88	129	>25	0.9	15
Impact Pile-driving	131	N.A.	136	>25	N.A.	>25
Detonation	159	N.A.	183	Far	N.A.	Far
Drilling	118	87	127	5–10	5–10	2–10
Production	109	86	131	3–4	5–10	2–10
Background Levels	71-85	45-66	80-100			

Operational Sounds

Drilling operations were the first of the sound-producing activities associated with operational activities at Northstar; drilling began in December 2000 and continued until 2004. There are four principal operations that occur during drilling: drilling *per se*, tripping (extracting and lowering the drillstring), cleaning, and well-logging (lowering instruments on a cable down the hole). Continuous sounds from generators, process operations (e.g., flaring, seawater treatment, oil processing, gas injection), and island lighting all contribute to operational sounds from Northstar. Non-continuous sounds such as those from heavy equipment operation for snow removal, berm maintenance, and island surface maintenance contribute to the operational sound intermittently. Sounds from occasional movements of a "pig" through the pipeline may also propagate into the marine or nearshore environment. Drilling, gas-turbine-powered generators, and gas flaring are the largest contributors to the overall sound output during Northstar operations.

Ice-covered season

During the ice covered seasons from 1999 to 2002, drilling sounds were 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 from the drill rig, but had fallen to background values by 9.4 km. 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.

Underwater sound levels resulting from various equipment and activities on Northstar were quite variable. A single detonation event produced the highest received broadband level, followed by vibratory and impact pile driving (Table 3). However, those were construction sounds, not operational sounds. Received broadband levels were reduced for other types of equipment. The distance at which industrial sounds reached background levels varied over a wide range. For certain construction activities it exceeded 25 km, but was 2-10 km for production sounds (Table 3).

In air, drilling sounds were not distinguishable from overall island sounds based on spectral characteristics or on broadband levels (Blackwell et al. 2003). A similar result was found for recordings from geophones: broadband levels of iceborne vibrations with or without drilling were indistinguishable (Blackwell et al. 2003). 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 notably higher during drilling.

Richardson et al. (1995b) summarized then-available data by stating 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.

Both with and without drilling, underwater broadband levels recorded north of the island were similar with and without production (see Figs. 3.3.A and 3.3.B in Blackwell et al. 2003). 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 from the island, either with or without simultaneous drilling (Blackwell et al. 2003). Thus, oil production at Northstar 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). (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. 2003).

Open water season

Underwater and in-air sound levels were recorded during four open-water seasons (2000-2003) near Northstar Island. Data on sounds were obtained via

- boat-based recordings 0.3–37 km (0.2–23 mi) from the island,
- acoustic recording equipment deployed ~450 m (0.3 mi) north of Northstar over extended periods, and
- autonomous seafloor recorders deployed ~22 km (14 mi) away.

These data are reported in Blackwell and Greene (2004). Island activity during the recording period included construction of the island (2000, 2001), installation of facilities (2000, 2001), a large sealift that included several barges and associated Ocean Class, River Class, and Point Class tugs (2001), conversion of power generation from diesel-powered generators to Solar gas turbines (2001), drilling (2001, 2002, 2003), production (2002, 2003), and reconstruction of an underwater berm for protection against ice (2003).

Blackwell and Greene (2004) report that during the open water season, vessels were the main contributors to the underwater sound field at Northstar. The following paragraphs describe operational noise, without the presence of vessels, as reported in Blackwell and Greene (2004). Vessel noise is discussed in the next subsection.

During both the construction phase in 2000 and the drilling and production phase in 2002, island sounds underwater reached background values at distances of 2–4 km (1.2–2.5 mi). Broadband (10–10,000 Hz) levels reached a minimum at ~94 and 90 dB re 1 µPa in 2000 and 2002, respectively. The presence of a large sealift at Northstar during all of the boat-based recordings in 2001 precluded characterization of island sounds during that year.

Variability in sound levels was reduced as the island moved into the more routine production phases in 2002 and 2003. However, new tones appeared in 2002 that were presumably associated with the changeover in the island's power supply from diesel to gas-turbine power, and the onset of production and drilling. The diesel generators, which powered the island during construction, may have produced lower sound levels than the Solar gas-turbines in use during drilling and production. There were also differences in the tonal components of the island sounds during construction and production periods.

Airborne sounds were recorded concurrently with the boat-based recordings in 2000-2003 (Blackwell and Greene 2004). The strongest broadband airborne sounds were recorded ~300 m (~1000 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

Sounds related to winter construction activities of Seal Island in 1982 were reported by Greene (1983a) and information on this topic is included in the previous petition submitted by BP (BPXA 1999). During the construction and operation of Northstar Island from 2000 to 2002, sound from vehicles constructing and traveling along the ice road diminished to background levels at distances ranging from 4.6 to 9.5 km (Table 3 above).

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, although some vehicles were detectable to more than 2000 m. Ground vibrations (measured as velocity) were undetectable for most vehicles at a distance of 100 m, but were detectable to 200 m for a Hägglunds tracked vehicle (MacGillivray et al. 2003).

Helicopters were used for personnel and equipment transport to and from the production island during the unstable ice periods in spring and fall. Helicopters flying to and from Northstar generally maintain straight-line routes at altitudes of 1,000 ft ASL, thereby limiting the received levels at and below the surface.

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

Vessels, principally the crew boat and tugs, were the most important sound sources during all phases of the Northstar operation that were studied by Blackwell and Greene (2004). Both the crew boat and the tugs produced substantial broadband sound in the 50-2000 Hz range, which could at least 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 that corresponds to the 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. Propagation loss for the vessel sounds in the waters surrounding Northstar was about 15 dB / tenfold change in distance over distances from a few hundred meters to a few kilometers. However, on some occasions, vessels were detectable on recordings made at the farthest station at 29 km (18 mi). Background levels were not reached in any of the open-water recordings with boats present at Northstar.

Vessel sounds are a concern due to the potential disturbance to marine mammals (Richardson et al. 1995b). Therefore, during the summer of 2003 a small, diesel-powered hovercraft (Griffon 2000TD) was tested to transport crew and supplies between the mainland and Northstar Island (Blackwell 2004). It was anticipated that, along with other advantages, the hovercraft would produce less underwater sound than the crew boat. Recordings of underwater and airborne sounds from the hovercraft were obtained in August 2003 (Blackwell 2004).

Broadband (10–10,000 Hz) levels of underwater sound were generally highest when the hovercraft was at its closest point of approach (CPA, 6.5 m or 21 ft). Broadband levels were also higher at a shallow (1 m deep) hydrophone than for a deeper (7 m) hydrophone. Received levels at the CPA were 127.7–129.6 and 119.9–124.6 dB re 1 µPa for the shallow and deep hydrophones, respectively. There was an 8 dB difference in the two hydrophones' mean CPA values. For the deep hydrophone, received levels when the hovercraft was only 10–20 m away were barely 10 dB higher than background levels. The lowest broadband level from the shallow hydrophone was 108 dB re 1 µPa, obtained while the hovercraft was 1465 m (0.9 mi) away. Blackwell (2004) estimated that underwater sound levels diminished to background levels 0.5-1 km fore and aft of the Griffon 2000TD hovercraft cruising at full power.

The Griffon 2000TD hovercraft produced underwater sounds over a wide range of frequencies, including at least three peaks below 300 Hz that are probably related to the thrust propeller's blade rate and its harmonics. The lift fan was expected to contribute substantially to the underwater sound since the fan is directed downward, but the shaft rate of the lift fan was barely detectable underwater.

Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2004). Broadband source levels for most small ships (lengths about 55–85 m) are ~160–180 dB re 1 µPa. Vessels including crew boats, tugs, and self-propelled barges were the main contributors to the underwater sound field at Northstar during the construction and production periods (Blackwell and Greene 2004). The underwater sounds from the hovercraft were about 20 dB weaker than vessel sounds (Blackwell 2004).

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 2004). A simple sound propagation model (Eq. 1 in Blackwell and Greene 2004) was fitted to data recorded at various distances from Northstar on several dates in 2000 and 2002. With vessels, received levels continued to decrease until the farthest distance sampled (27 km, 17 mi), indicating that background levels were not reached. Spreading loss terms were 18.3 and 14.4 dB / tenfold change in distance on two dates. These recent spreading loss estimates are slightly lower (i.e., sounds are detectable farther away) than previous estimates from Greene (1998), which is to be expected in waters offshore of the lagoons where Greene (1998) made recordings.

Propagation of underwater sounds at Northstar during the ice-covered season was studied in 2000-2002. However, most analyses were on data from 2002, during production, rather than during construction activities (Blackwell et al. 2003). 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. At times with higher background noise (e.g., windy periods) Northstar sounds disappeared below ambient levels at closer distances, as expected. Spreading loss terms were about 22.0 dB / tenfold change in distance.

In winter, acoustic transmission loss near Liberty has been measured based on received levels of drilling sounds under the ice at different distances from Tern Island (Greene 1997b). At ranges between 0.2 and 2+ km and at frequencies below 150 Hz, transmission loss was rapid: about 35 dB / tenfold change in distance plus an addition linear absorption term of 2-9 dB per kilometer. This rapid attenuation is as expected for waters only 6 to 7 m deep (approx. half the depth at Northstar). Attenuation rates could not be measured at higher frequencies, but were also expected to be high (Greene 1997b).

In-Air Propagation

Airborne sounds from Northstar Island were recorded on several dates during the open-water seasons of 2001–2003. The strongest broadband airborne sounds were recorded ~300 m (~1000 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. A tone at 81 Hz that diminished with increasing distance from Northstar was detected on nearly every in-air recording, but its source is not known.

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 from the island, respectively. Airborne sounds diminished to background levels at 5 and 9.4 km without and with drilling, respectively. Spreading loss terms were 19.6 and 20.5 dB / tenfold change in distance without, and with drilling.

To our knowledge, no other studies of in-air sound propagation from industrial sources along the Alaskan Beaufort Sea coast have been conducted. However, some relevant, general principles are described in the original petition (BPXA 1999; see also section 4.6 *in* Richardson et al. 1995b).

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 of either natural or human origin. 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 restraints on an animal's ability to detect mammal calls, anthropogenic sounds, and other relevant sounds.

Underwater Ambient Noise

Primary sources of underwater ambient noise near the Northstar area are wind and waves, ice, and sounds of biological origin (e.g., ringed seals, bearded seals, bowhead whales, 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. Ambient noise levels were measured during the open-water season in the general Northstar region before Northstar construction began.

Open-Water Season

Ambient noise in waters near Prudhoe Bay during the open-water season has been measured systematically during several studies. For example, measurements with a bottom hydrophone 2.4 km from Seal Island spanned nine days (21–29 Sept 1984) when a drill rig on the island was not operating (Davis et al. 1985). Measurements with a hydrophone 0.46 km from Sandpiper Island spanned 14 days (28 Sept.–11 Oct 1985) while a rig on that island was inactive (Johnson et al. 1986). The results of analyses of these data in LGL and Greeneridge (1996a) are summarized in Table 4.

TABLE 4. Percentile broadband (20-1000 Hz) ambient noise levels in dB re 1 μPa in the Beaufort Sea of Alaska.

Percentiles	**Seal Isl. '84**	**Sandpiper Isl. '85**
5%	84	87
50%	94	94
95%	111	113

The median ambient noise levels measured at the two islands are the same. The median spectra for these measurements agree closely with the spectrum for Knudsen's Sea State One (Knudsen et al. 1948), which corresponds to wind speeds from 4–6 knots (Beaufort wind force 2). The environment during the measurement periods in 1984 and 1985 was reasonably quiet. However, the natural ambient noise level was quite variable as is illustrated by comparing the 5th and 95th percentile levels.

A large quantity of additional ambient noise data were collected in the Prudhoe Bay region during the open water seasons of 1995–98. 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). The median was similar to the 1984–85 median, but the 5th and 95th percentiles were lower in 1995. 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.

Levels of natural ambient noise during the open water seasons at Northstar are expected to be within the same general range of variability described above. Marine mammals inhabiting this region are likely accustomed to this range of natural sound levels. 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 mild weather conditions (Blackwell and Greene 2004). However, when vessels were present at Northstar Island, background levels were not reached in any of the open-water recordings (Blackwell and Greene 2004).

Ice-Covered Season

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).

In-Air Ambient Noise

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.

Pinnipeds

Pinniped Sound Production

Pinniped call characteristics are relevant when assessing potential masking effects of man-made 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. The three species of seals present in the study area, all of which are in the phocinid seal group, are all most vocal during the spring mating season and much less so 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. Information on the calls of ringed, spotted, and bearded seals can be found in BPXA (1999).

Pinniped Hearing Abilities

The hearing abilities of pinnipeds (and other animals) are functions of the following (Richardson et al. 1995b):

1. Absolute hearing threshold (the level of sound barely audible in the absence of ambient noise).
2. Critical ratio (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: the ringed, harbor (*Phoca vitulina*), harp (*Pagophilus groenlandicus*), and northern elephant (*Mirounga angustirostris*) seals (reviewed in Richardson et al. 1995b:211*ff*; 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 and 85 dB re 1 µPa. There are few published data on in-water hearing sensitivity of phocinid seals below 1 kHz. However, recent measurements for a harbor seal indicate that, below 1 kHz, its thresholds deteriorate gradually to 96 dB re 1 µPa at 100 Hz (Kastak and Schusterman 1998). If this result is representative for other phocinid seals, they have considerably better underwater hearing sensitivity at low frequencies than do small odontocetes like belugas (for which the threshold at 100 Hz is about 125 dB). In-air hearing of phocid seals is less sensitive than underwater hearing, and the upper frequency limit 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.

Noise Effects on Pinnipeds

The possible categories of noise effects on marine mammals in general were summarized earlier in this section. The categories relevant here are behavioral disturbance and associated habituation effects, masking, and possible effects on hearing sensitivity.

Behavioral Reactions to Noise and Disturbance

Disturbance is the main concern in this project. In the terminology of the 1994 amendments to the MMPA, oil field construction or operation noise could cause “Level B” harassment of certain marine mammals. Level B harassment is defined as "...disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."

When the received level of noise exceeds some behavioral reaction threshold, 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 (reviewed in Richardson et al. 1995b; Moulton et al. 2003a,b; Blackwell et al. 2004a).

Effects of Construction, Drilling and Production Activity

Systematic aerial surveys to assess ringed seal responses to the construction of Seal Island were done both for Shell Oil (Green and Johnson 1983) and for the Minerals Management Service (Frost and Burns 1989; Kelly et al. 1988). Green and Johnson (1983) found that some seals within several kilometers of Seal Island were apparently displaced by construction of the island during the winter of 1981–82. Similarly, Frost and Lowry (1988) found lower densities of seals within 3.7 km (2 n.mi.) of artificial islands than 3.7–7.4 km away when exploration activity was high. During years with construction or drilling activities, there was apparently a 38–40% reduction in seal densities near the islands (Frost and Lowry 1988). It is important to note that these early analyses did not account for non-industrial factors known to influence basking activity of seals (Moulton et al. 2002). Also, the numbers of sightings were small relative to the variation in the data.

Kelly et al. (1988) used trained dogs to study the use by seals of breathing holes and lairs in relation to exposure to industrial activities. They reported that the proportion of structures abandoned within 8 km (5 mi.) of Seal Island was similar to that within 150 m (164 yd) of on-ice seismic lines. However, there were no differences in abandonment rate within vs. beyond 150 m from Seal Island. Kelly et al. (1988) indicated that the data were not adequate to evaluate at what distances from the island abandonment of structures began to decrease. In a final analysis of those data, Frost and Burns (1989) reported that the proportion of abandoned structures was significantly higher within 2 km (1.2 mi) of Seal Island than 2–10 km away. Complicating the interpretation is that dog-based searches were conducted where structures were expected to be found, rather than over the entire study area, and multiple searches over a given area were not conducted. Hammill and Smith (1990) found that dogs missed as many as 73% of the structures during the first search of an area. Frost and Burns (1989) also noted that the analyses of disturbance and abandonment as a result of Seal Island construction were complicated by other noise sources active simultaneously. These included on-ice seismic exploration, excavation of structures by their investigations, and snow machine traffic. They suspected that, overall, there was no area-wide increase in abandonment of structures. Finally, it is unknown whether there are differences in detection rates by dogs for open vs. abandoned structures or for areas of different structure density. This detection bias potentially confounds interpretation of the data.

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 97–3000 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,b) 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 ~4140 km^2 area 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,b) determined that the raw density of ringed seals over their study area ranged from 0.39 to 0.83 seals/km^2, while Frost et al. (2004) obtained raw densities of 0.64 to 0.87 seals/km^2 in similar area at about the same times. There was no significant evidence that construction, drilling, and production activities at Northstar in 2000-2002 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,b), 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 meltwater, 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,b).

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 over the course of the winters of 1999-2000 and 2000-01, in relation to distance from industrial activities (Williams et al. 2001, 2002). In late 1999, surveys began before the construction of ice-roads, and before the onset of Northstar construction. In late 2000, surveys began before construction of ice roads but concurrent with drilling and other island activities.

In late 1999, a total of 26 seal structures were found, including 2 (7%) that had already been abandoned. In May 2000, 20 of 23 (87%) relocated structures had been abandoned, in some cases flooded over by ice-road construction, and 18 new structures were located. At least 19 active structures occurred within 1 km of locations where intensive construction activities had occurred during the previous months.

In the winter of 2000-2001, a total of 173 structures were located, 60 (35%) of which were abandoned by May 2001. Within 1 km of Northstar, 39% of structures (26 of 66) were abandoned. 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. New structures found after the ice-road was constructed were, on average, farther from the ice-road than were structures found before construction. 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.

Blackwell et al. (2004a) investigated the effects of noise from pipe-driving and other construction activities on Northstar to ringed seals in June and July 2000, during and just after break-up of the landfast ice. None of the ringed seals seen during monitoring showed any strong reactions to the pipe-driving or other construction activities on Northstar. Eleven of the seals (48%) appeared either indifferent or curious when exposed to construction or pipe-driving sounds. One seal approached within 3 m of the island's edge during pipe-driving and others swam in the 3-15 m moat around the island. Seals in the moat may have been exposed to sound levels up to 153-160 dB re 1 μPa (rms) when they dove close to the bottom.

Consistent with Blackwell et al. (2004a), seals are often very tolerant of exposure to other types of pulsed sounds. For example, seals tolerate high received levels of sounds from airgun arrays (Arnold 1996; Harris et al. 2001; Moulton and Lawson 2002). Monitoring work in the Alaskan Beaufort Sea during 1996-2001 provided considerable information regarding the behavior of seals exposed to seismic pulses (Harris et al. 2001, Moulton and Lawson 2002). These seismic projects usually involved arrays of 6 to 16 airguns with total volumes 560 to 1500 in^3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating than when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, on the order of 100 m (328 ft) to a few hundreds of meters, and many seals remained within 100-200 m (328-656 ft) of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year expect 1997. Similarly, seals are often very tolerant of pulsed sounds from seal-scaring devices (Mate and Harvey 1987; Jefferson and Curry 1994; Richardson et al. 1995b). Thus, it is not especially surprising that avoidance reactions to impulsive pile driving sounds did not extend very far from the pile driving operations on Northstar, if reactions occurred at all.

Effects of 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 or crew vessel is not possible.

Blackwell et al. (2004a) observed 12 ringed seals during low-altitude overflights of a Bell 212 helicopter at Northstar in June and July 2000 (9 observations took place concurrent with pipe-driving activities, see above). One seal showed no reaction to the aircraft while the remaining 11 (92%) 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 during the preceding winter and spring. There have been few systematic studies of pinniped reactions to aircraft overflights, and most of the available data concern pinnipeds hauled out on land or ice rather than pinnipeds in the water (Richardson et al. 1995b; Born et al. 1999). Any reactions to helicopter overflights can be prevented by maintaining a minimum altitude of 1,000 ft when weather allows.

Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They often rush into the water when an aircraft flies by at altitudes up to 300-750 m (1000-2500 feet). They occasionally react to aircraft flying as high as 1370 m and at lateral distances as far as 2 km or more (Frost and Lowry 1990; Frost et al. 1993a; Rugh et al. 1997). However, no spotted seal haul-outs are located near Northstar.

Effects of 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 to 0.5 km (0.15-0.3 miles) (Brueggeman et al. 1992). However, during the open water season in the Beaufort Sea, ringed and bearded seals are commonly observed close to vessels (e.g., Harris et al. 2001; Moulton and Lawson 2002). 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). In Maine, Lelli and Harris (2001) found that boat traffic was the best predictor of variability in harbor seal haulout behavior, followed by wave height and percent sunshine utilizing multiple regression. Lelli and Harris (2001) reported that increasing boat traffic reduced the number of seals counted on the haul-out.

<u>Masking</u>

Masking of calls or other natural sounds would not extend beyond the maximum distance where the construction or operational sounds are detectable, and at that distance only the weakest sounds would be masked. The maximum distances for slight masking will vary greatly depending on ambient noise and sound propagation conditions, but will typically be about 2-5 km in air and 3-10 km underwater. Strong masking would occur only at considerably closer distances where industrial sound levels are well above ambient levels. 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.

<u>Possible Effects on Hearing Sensitivity</u>

Temporary or permanent hearing impairment is a possibility (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; Schusterman et al. 2000; Finneran et al. 2003). Kastak et al. (1999) reported TTS in three species of pinnipeds after underwater exposure to moderate-level noise for ~20 minutes. A harbor seal exposed to white noise with frequencies ranging from 100 Hz to 2,000 Hz at received levels 60-75 dB above hearing threshold (i.e., about 135-150 dB) for 20–22 min. experienced a threshold shift of approximately 4.8 dB. Recovery to near baseline levels was reported within 24 hours of noise exposure (Kastak et al. 1999). The sound exposures necessary to cause slight threshold shifts were also determined for two California sea lions (*Zalophus californianus*) and a juvenile elephant seal (*Mirounga angustirostris*) 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). 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 pulsed underwater sounds, NMFS has taken the position that pinnipeds should not be exposed to received levels exceeding 190 dB re 1 μPa (NMFS 1995). That criterion was established before there were any data on levels of sounds that do and do not elicit TTS in pinnipeds. It also did not consider the effects of sound duration on TTS and PTS thresholds. There has not been any specific "do not exceed" criterion for pinnipeds exposed to prolonged or continuous sounds. However, it is accepted that any such criterion should be lower than that for pulsed sounds given the effects of exposure duration on the level at which TTS (and presumably PTS) becomes evident (Richardson et al. 1995b:368; Schusterman et al. 2000). A committee of specialists on noise vs. marine mammals is presently developing recommendations for new noise impact criteria applicable to pinnipeds in water and air.

In any case, levels of underwater sound from production and drilling activities that occur continuously over extended periods are not very high (Blackwell and Greene 2004). 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 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. Neither TTS nor permanent hearing damage are expected from the operations at Northstar.

Effects of Oil on Pinnipeds

Ringed, bearded and spotted 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 of ringed seals on the fast-ice in areas ≥3 m deep ranged from 0.35 to 0.72 seals/km^2. After allowance for seals not seen by aerial surveyors, actual densities may have been about 2.84 times higher (see Sections 4 and 6; also Moulton et al. 2003). 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 characteristics of the oil. Prolonged exposure could occur if fuel or crude oil was spilled in or reached nearshore waters, was spilled in a lead used by seals, or was spilled under the ice when seals have limited mobility (NMFS 2000). Adult seals 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. 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. These potential effects are addressed in more detail in subsequent paragraphs.

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

Intensive and long-term studies were conducted after the *Exxon Valdez* oil spill (EVOS) in Alaska. There may have been a long-term decline of 36% in numbers of molting harbor seals at oiled haul-out sites in Prince William Sound following EVOS (Frost et al. 1994a). However, in a reanalysis of those data and additional years of surveys, along with an examination of assumptions and biases associated with the original data, Hoover-Miller et al. (2001) concluded that the EVOS effect had been overestimated. The decline in attendance at some oiled sites was more likely a continuation of the general decline in harbor seal abundance in Prince William Sound documented since 1984 (Frost et al. 1999) than a result of EVOS. The results from Hoover-Miller et al. (2001) strongly indicate that the effects of EVOS were largely indistinguishable from natural decline by 1992. Harbor seal pup mortality at oiled beaches was 23 to 26%, which may have been higher than natural mortality, although no baseline data for pup mortality existed prior to EVOS (Frost et al. 1994a). There was no conclusive evidence of spill effects on Steller sea lions (Calkins et al. 1994). Oil did not persist on sea lions themselves (as it did on harbor seals), nor did it persist on sea lion haul-out sites and rookeries (Calkins et al. 1994). Sea lion rookeries and haul out sites, unlike those used by harbor seals, have steep sides and are subject to high wave energy (Calkins et al. 1994).

Oiling of External Surfaces

Adult seals rely on a layer of blubber for insulation and oiling of the external surface does not appear to have adverse thermoregulatory effects (Kooyman et al. 1976, 1977; St. Aubin 1990). Contact with oil on the external surfaces can cause increased stress and can irritate the eyes of ringed seals (Geraci and Smith 1976; St. Aubin 1990). These effects seemed to be temporary and reversible, but continued exposure of eyes to oil could cause permanent damage (St. Aubin 1990).

New-born seal pups rely on their fur for insulation. New-born ringed seal pups in lairs on the ice could be contaminated through contact with oiled mothers. New-born 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 of the ingested oil is voided in vomit or feces but some 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 the area of an oil spill because of human disturbance associated with cleanup efforts, but they are most likely to remain in the area of the spill. One notable behavioral reaction to oiling is that oiled seals are reluctant to enter the water, even when intense cleanup activities are conducted nearby (St. Aubin 1990; Frost et al. 1994b).

Factors Affecting the Severity of Effects

Seals that are under additional natural stress, such as lack of food or a heavy infestation by parasites, could die because of the additional stress of oiling (Geraci and Smith 1976; St. Aubin 1990; Spraker et al. 1994). Female seals that are nursing young would be under natural stress, as would molting seals. In both cases, the seals would have reduced food stores and may be less resistant to effects of oil than seals that are not under some type of natural stress. Seals that are not under natural stress (e.g., fasting, molting) would most likely survive oiling.

In general, seals do not exhibit large behavioral or physiological reactions to limited surface oiling or incidental exposure to contaminated food or vapors (St. Aubin 1990; Williams et al. 1994). Effects could be severe if seals surface in heavy oil slicks in leads, or if oil accumulates near haul-out sites (St. Aubin 1990). An oil spill in open water is likely to have only minor impacts on seals.

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. Impacts on regional populations of seals would be minor.

Effects of 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 (ODPCP) (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 (Table 1.6.1-3; BPXA 1998b). After 15 days, all of the oil in open water will be recovered. Shoreline cleanup will occur for approximately 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 of 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 re Effects on Pinnipeds

Disturbance ("potential take by harassment") was the main concern during the construction phase of this project, and one of the main concerns during the initial production phase. Responses of seals 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. In earlier monitoring reports, it was suggested that the number of seals potentially affected by Northstar activities on an annual basis during 1999-2002 was about 110 to 145 ringed seals plus 1 bearded seal (but no spotted seals). The numbers of ringed seals potentially affected during the ice-covered and break-up periods in November 2002 through October 2003 have been estimated based on a re-evaluation of the criteria used in previous years. This re-evaluation takes account of the results of aerial and on-ice studies indicating that the areas from which seals were displaced were quite small (Williams et al. 2002, 2004b,c, MS; Moulton et al. 2003a,b). The number of seals affected significantly probably includes only 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. Corrected totals for the numbers of seals expected within the potential impact zone from 1997 through 2002 range from 3 to 7 seals (Williams et al. 2004c). The overall results suggest that any effects of Northstar production activities on seals were minor, short-term, and localized, with no consequences for the seal populations.

Production activities planned for the ice-covered seasons are expected to cause no more than limited and localized short-term disturbance, and possibly displacement, of ringed seals. These effects fall within the MMPA definition of Level B harassment. In addition, 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 to 2002.

Operational activities during the open-water seasons are expected to cause no more than limited short-term and localized behavioral changes. These behavioral effects may include some that fall within the MMPA definition of Level B harassment.

In the unlikely event of a large oil spill, there is the possibility that a small number of pinnipeds could be oiled. Of these, most would not be seriously injured. However, there is the possibility that a small number of pinnipeds could be seriously injured or killed by oiling.

Cetaceans

Cetacean Sound Production

The characteristics of marine mammal calls are relevant in assessing the potential masking effects of man-made sounds. Also, when hearing abilities have not been measured directly (as for baleen whales), the frequencies of the calls are relevant in assessing the likely frequency range of best hearing.

Bowhead Whale

Most bowhead calls are tonal, frequency-modulated sounds at frequencies of 50 to 400 Hz. These calls overlap broadly in frequency with the underwater sounds emitted by many construction and operational activities (Richardson et al. 1995b). Several bowhead calls contain energy up to 1200 Hz (Clark and Johnson 1984; Würsig and Clark 1993), but most of the energy is below 500 Hz. Bowhead "songs" occur in spring but have not been reported in late summer or autumn. Functions of bowhead calls are not positively known, but are believed to include maintenance of contact among widely separated individuals, mother-calf interactions, and 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 calls are detectable more than 20 km (12.5 miles) away, but the ability to detect calls at long range diminishes with increasing background noise level (Greene et al. 2004).

Gray Whale

Gray whales make a wide variety of calls at frequencies from <100 to 2000 Hz; many calls are described as "knocks" and pulses (Dahlheim et al. 1984; Moore and Ljungblad 1984; Dahlheim 1987). Gray whales are less vocal in summer than during migration or (especially) when on their winter breeding/calving grounds (Dahlheim 1987). Gray whales feeding in groups may keep in acoustic contact when separated by distances >800 m (>2650 feet) (Bogoslovskaya 1986).

Beluga Whale

The beluga's extensive vocal repertoire includes trills, whistles, clicks, bangs, chirps and other sounds (Schevill and Lawrence 1949; Ouellet 1979; Sjare and Smith 1986a). Beluga whistles have dominant frequencies in the 2 to 6 kHz range (Sjare and Smith 1986a). This is above the frequency range of most of the sound energy produced by the planned Northstar production activities and associated vessels. Other beluga call types reported by Sjare and Smith (1986a,b) included sounds at mean frequencies ranging upward from 1.0 kHz.

The beluga also has a very well developed high frequency echolocation system, as reviewed by Au (1993). Echolocation signals have peak frequencies from 40 to 120 kHz and broadband source levels of up to 219 dB re 1 µPa-m (zero-peak). Echolocation calls are far above the frequency range of the sounds from the planned Northstar activities. Those industrial sounds are not expected to interfere with echolocation.

Cetacean Hearing Abilities

Cetacean hearing has been studied in relatively few species and individuals, but the beluga is one of the better-studied species. Belugas can hear sounds over a very wide range of frequencies, from 40 Hz to above 100 kHz (White et al. 1978; Awbrey et al. 1988; Johnson et al. 1989). However, belugas are most sensitive above 10 kHz. They have relatively poor sensitivity at the low frequencies (reviewed in Richardson et al. 1995b:208*ff*) that dominate the sound from industrial activities and associated vessels. Nonetheless, the noise from strong low frequency sources is strong enough to be detectable by belugas many kilometers away (Richardson and Würsig 1997). Also, beluga hearing at low frequencies in open water conditions is apparently somewhat better than in the captive situations where most hearing studies were done (Ridgway and Carder 1995; Au 1997). If so, low frequency sounds emanating from production activities may be detectable somewhat farther away than previously estimated.

The auditory sensitivity of bowheads, gray 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 (reviewed in Richardson et al. 1995b:236*ff*; Ketten 2000). Their frequency ranges of optimum hearing are believed to overlap broadly with the low frequency range where production activities and associated vessel traffic emit most of their energy. Bowheads and gray whales are not likely to hear sounds above 30 kHz.

Noise Effects on Cetaceans

The possible categories of noise effects on marine mammals in general were summarized earlier in this section. The categories relevant here are behavioral disturbance and associated habituation effects, masking, and possible effects on hearing sensitivity.

<u>Behavioral Reactions to Noise and Disturbance</u>

Disturbance is the main concern in this project. In the terminology of the 1994 amendments to the MMPA, construction noise could cause "Level B" harassment of certain marine mammals. Level B harassment is defined as "...disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."

When the received level of noise 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, more conspicuous responses such as 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 activity of the animal 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, gray and beluga whales, the actual radius of effect is considerably smaller than the radius of detectability (reviewed in Richardson and Malme 1993; Richardson et al. 1995b).

Effects of Construction, Drilling and Production

Spring migration of bowheads and belugas through the western and central Beaufort Sea occurs from April to June. Their spring migration corridors are far north of the barrier islands and of the Northstar project area. Whales, including bowhead, beluga, and gray 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 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 construction and operational activities at Northstar during the ice-covered season would have no effects on whales.

During the open-water season, "shadowing" by the island reduces the sound that propagates to offshore waters where whales are most likely to occur. In addition, 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 2004). However, when Northstar-related vessels were present, levels were higher and faint vessel sound was often still evident 20–30 km away.

Bowhead Whales

Information about the reactions of cetaceans to construction or heavy equipment activity on artificial (or natural) islands is limited (Richardson et al. 1995b).

During the construction of artificial islands and other oil-industry facilities in the Canadian Beaufort Sea during late summers of 1980-84, bowheads were at times observed as close as 800 m from the construction sites (Richardson et al. 1985, 1990). Richardson et al. (1990) showed that, at least in summer, bowheads 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.

Bowheads apparently reacted in only a limited and localized way (if at all) to construction of Seal Island, the precursor of Northstar (Hickie and Davis 1983).

There are no specific data on reactions of bowhead (or gray) whales to noise from drilling on an artificial island. However, playback studies have shown that both species begin to show overt behavioral responses to various low-frequency industrial sounds when received levels exceed 115-120 dB re 1 μPa (Malme et al. 1984; Richardson et al. 1990, 1995a,b). The overall received level of drilling sound from Northstar Island generally diminished to 115 dB within 1 km (Blackwell et al. 2003). Any reactions by bowhead (or gray) whales to drilling at Northstar would, therefore, be highly localized and would involve few whales.

Prior to construction of Northstar, it was expected (based on early data mentioned above) that some bowheads 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 bowheads would come close enough to shore receive sound levels that high from Northstar. Thus disturbance effects from continuous construction and operational noise were expected to be limited to the closest whales and the times with highest sound emissions.

In 2000-2003 bowhead whales were monitored acoustically to determine the number of whales that might have been exposed to Northstar related sounds. Data from 2001–2003 were useable for this purpose. The results showed that, during late summer and early autumn of 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. There was equivocal evidence of a Northstar effect on bowheads in 2002, and no such evidence in 2003 (Richardson et al. 2004). The best estimates of the numbers of bowheads that were apparently "deflected offshore" by ≥2 km (1.2 mi) were 19 bowheads in 2001, 49 in 2002, and 0 in 2003; these values are all ≤0.5 % of the population. The corresponding approximate upper 90% confidence bounds and percentage of the population for each of the three years were 69 (0.6%), 149 (1.3%) and 169

(1.5%) bowheads, respectively (McDonald and Richardson 2004). 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 a small number of whales. However, if the effect was partly attributable to a change in calling behavior, then the above estimates of the numbers of bowheads deflected offshore may be overestimates.

The occurrence of a small “Northstar effect” on a small number of bowheads was well within the provisions of the Northstar LoAs, which authorized “harassment” of up to 765 bowheads per year in 2000–2004. Furthermore, migrating bowheads whose paths are deflected offshore by a few kilometers probably would not, in most cases, incur biologically significant effects. Given that, no significant effects on their overall population would be expected.

Gray Whales

There are no data on the reactions of gray whales to production operations similar to those proposed here. Oil production platforms of a very different type have been in place off California for many years. Gray whales regularly migrate through that area (Brownell 1971), but no detailed data on distances of closest approach or possible noise disturbance have been published. Oil industry personnel have reported seeing whales near platforms, and that the animals approach more closely during low-noise periods (Gales 1982; McCarty 1982). Playbacks of recorded production platform noise indicate that gray whales react if received levels exceed ~123 dB re 1 μPa—similar to the levels of drilling noise that elicit avoidance (Malme et al. 1984).

A typical migrating gray whale tolerates steady, low-frequency industrial sounds at received levels up to about 120 dB re 1 μPa (Malme et al. 1984). Gray whales may tolerate higher-level sounds if the sound source is offset to the side of the migration path (Tyack and Clark 1998). Also, gray whales generally tolerate repeated low-frequency seismic pulses at received levels up to about 170 dB re 1 μPa measured on an (approximate) rms basis. Above those levels avoidance is common. Because the reaction thresholds to both steady and pulsed sounds are slightly higher than corresponding values for bowheads, reaction distances for gray whales would be slightly less than those for bowheads. In the unlikely event that gray whales occur near Northstar, disturbance effects would be highly localized and would have no biological consequences for individual whales or the population. Given the infrequent occurrence and low numbers of gray whales in the area, it is most likely that there would be no disturbance effects from sound sources on or associated with the island.

Beluga Whales

In the Canadian Beaufort Sea, beluga whales were seen within several feet of an artificial island. During the island’s construction, belugas were displaced from the immediate vicinity of the island, but not from the general area (Fraker 1977a). Belugas in the Mackenzie River estuary showed less response to a stationary dredge than to moving tug/barge traffic. They approached as close as 400 m from stationary dredges. Underwater sounds from Northstar Island are weaker than those from the dredge. In addition, belugas occur only infrequently in nearshore waters in the Prudhoe Bay region. They also have relatively poor hearing sensitivity at the low frequencies of most construction noises. Therefore, effects of construction and related sounds on belugas would be expected to be negligible.

Responses of beluga whales to drilling operations are described in Richardson et al. (1995a) and summarized here. In the Mackenzie Estuary during summer, belugas have been seen regularly within 100 to 150 m of artificial islands (Fraker 1977a,b; Fraker and Fraker 1979). However, in the Northstar area, belugas are present only during late summer and autumn, and almost all of them are migrating through offshore waters far seaward of Northstar. Only a very small proportion of the population enters nearshore waters. In spring, migrating belugas showed no overt reactions to recorded drilling noise (< 350 Hz) until within 200 to 400 meters of the source, even though the sounds were measurable up to 5 km away (Richardson et al. 1991). During another drilling noise playback study, overt reactions by belugas within 50 to 300 meters involved increased swimming speed (Stewart et al. 1983). The short reaction distances are probably partly a consequence of the poor hearing sensitivity of belugas at low frequencies (Richardson et al. 1995b). In general, very few belugas are expected to approach Northstar Island, and any such occurrences would be restricted to the late summer/autumn period. Even those few belugas would show no more than localized and brief avoidance reactions, limited to the area within several hundred meters of the island.

There are no specific data on the reactions of beluga whales to production operations similar to those at Northstar. Personnel from production platforms in Cook Inlet, Alaska, report that belugas are seen within 9 m of some rigs, and that steady noise is non-disturbing to belugas (Gales 1982; McCarty 1982). Beluga whales are regularly observed near the Port of Anchorage and the extensive dredging/maintenance activities that operate there regularly (NMFS 2003). Pilot whales, killer whales, and unidentified dolphins were also reported near Cook Inlet platforms. In that area, flare booms might attract belugas, possibly because the flares attract salmon in that area. Attraction of belugas to prey concentrations is not likely to occur at Northstar because belugas are predominantly migrating rather than feeding when in that area, and because only a very small proportion of the beluga population occurs in nearshore waters. Overall, effects of routine production activities on belugas are expected to be negligible.

Effects of Aircraft Activity

Helicopters are the only aircraft associated with Northstar drilling and oil production operations. Helicopter traffic occurs during late spring/summer and fall/early winter when travel by ice roads or crew vessels is not possible.

Low passes by aircraft over a cetacean, including a bowhead, gray or beluga whale, generally results in short-term responses, or no discernible reaction. Responses can include sudden dives, churning the water with the flippers and/or flukes, or rapidly swimming away from the aircraft track (reviewed in Richardson et al. 1995b; see also Patenaude et al. 2002). Belugas often roll and apparently look upward at the aircraft. The activity of the animal at the time of the overflight 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 of activities. Known or suspected reasons for this variation include aircraft altitude, engine setting changes, type of aircraft, weather conditions, and whale activity at the time. Whales appear less disturbed by quiet aircraft flying at slow speeds and reduced engine power. Single overflights 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., 250-500 feet or 75-150 m) and infrequent when higher (1,000-1,500 feet or 300-450 m), but there is much variability. Continued harassment 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 traffic over bowheads during the fall migration. Helicopter traffic is between the shore and Northstar Island. Almost all bowhead whales migrate west in waters farther north. Helicopters maintain an altitude of 1,000 feet 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 to circle or hover over the open water other than when landing or taking off. Gray whales are uncommon in the area and there is little likelihood that any will be overflown by a helicopter. The 1,000+ ft planned flight altitude will minimize any disturbance that might occur if a gray whale is encountered. Even if several bowheads or (less likely) gray whales did react to a single helicopter overflight, the reaction would be brief and of no long-term consequence to the whales.

Likewise, there is little likelihood of helicopter disturbance to belugas. Brief reactions by belugas are common when a helicopter is low (e.g., at 250 to 500 feet or 75 to 150 meters altitude) but uncommon when it is higher (1,000 to 1,500 feet or 300 to 450 meters). However, there is much variability (Richardson et al. 1995b; Patenaude et al. 2002). Because of the predominantly offshore migration route of belugas, very few (if any) will be overflown during helicopter flights over nearshore waters. Any overflights are most likely to be at an altitude of 1,000 ft or more. Therefore, few belugas will react to helicopters. Any such reactions will be brief and of no long-term significance to individuals or the population.

Effects of 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 of movement. 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 (reviewed in Richardson et al. 1995b). Past experiences of the animals with vessels are important in determining the degree and type of response 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 bowheads sometimes begin as subtle alterations in whale activity, speed and heading as far as 4 km (2.5 miles) from the vessel. Consequently, the closest point of approach is farther from the vessel than if the cetacean had not altered course. Bowheads sometimes begin to swim actively away from approaching vessels when they come within 2-4 km. 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 will involve slow-moving tugs and barges and crew 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 of these types are less dramatic than are their reactions to faster and/or erratic vessel movements. Bowhead, gray and beluga 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). Beluga whale reaction to vessel traffic is varied and may range from approach to avoidance. Cook Inlet belugas appear to be habituated to some vessel traffic. Blackwell and Greene (2002) observed belugas swimming in the Port of Anchorage within a few meters of the hull of a docked cargo-freight ship during a recording session. Lerczak et al. (2000) tagged belugas in the Susitna Delta during the summer of 1994-95 and observed that Cook Inlet belugas appeared to recover quickly from vessel disturbance. They report that even when being incidentally harassed and intentionally pursued by powerboats, the whales never left the immediate study area. If the pursuit vessel stopped, whales would approach to within 100 m after ~15 minutes, and if the engines were turned off, would approach closely or pass under the boat.

Most vessel traffic associated with Northstar will be inshore of the bowhead and beluga migration corridor, and/or prior to the migration season of bowhead and beluga whales. Underwater sounds from hovercraft are generally lower than for standard vessels since the sound is generated in air, rather than underwater. If vessels or hovercraft do approach whales, a small number of individuals 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 minority of the bowheads in the southern part of the migration corridor appear to be deflected slightly offshore (see above). To the extent that offshore deflection occurs as a result of Northstar, it is mainly attributable to Northstar-related vessel operations. As previously described, this deflection involves few whales and generally small deflections, and is unlikely to have important consequences for individual bowheads or their populations.

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.

Masking

No masking effects on cetaceans will occur during the ice-covered season because cetaceans will not occur near Northstar at those seasons. The sounds from oil production and any drilling activities are not expected to be detectable beyond several kilometers from the source (Greene 1983a; Blackwell et al. 2003; Blackwell and Greene 2004; Blackwell 2004).

Small numbers of bowheads, belugas and (rarely) gray whales could be present near Northstar during the open-water season, when underwater sounds from the island will sometimes be detectable 5-10 km away, and occasionally farther (Blackwell et al. 2003). 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 1000 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. 2003). These frequencies are mainly used by mysticetes like bowhead and gray whales, but not by odontocetes like the beluga.

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 its 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, as in the case of belugas, communication and echolocation 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. Because of the transient nature of moving boat noise, it will not cause significant masking effects. However, docking vessels or other vessels under power to maintain position can be a significant source of continuous noise (Blackwell et al. 2003), with potential to cause some degree of masking.

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; reviewed in Richardson et al. 1995b:233*ff,* 364*ff*). These adaptations, along with directional hearing, preadaptation to tolerate some masking by natural sounds, and the brief periods when most individual whales occur near Northstar, would all reduce the potential impacts of masking. Overall, masking effects from underwater sounds associated with project activities will have negligible effects on the abilities of cetaceans to hear other sounds.

<u>Possible Effects on Hearing Sensitivity</u>

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 TTS in baleen whales. For toothed whales, there are recent data concerning TTS thresholds for bottlenose dolphins and belugas exposed to a single short noise pulse (Schlundt et al. 2000; Finneran et al. 2002) as well as dolphins exposed to more prolonged sounds (Nachtigall et al. 2003). The lowest received level that elicited mild TTS was 192 dB re 1 μPa for a 1-s pulse, and about 175 dB for a prolonged (~55 min) exposure. Permanent hearing impairment would not be expected unless sound levels were substantially higher than those required to induce TTS. Such exposures will not occur near Northstar during the open-water season, 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, TTS and permanent hearing damage are not expected to occur in cetaceans during the drilling and production activities at Northstar.

Effects of Oil on Cetaceans

Bowhead and beluga whales migrate through the Alaskan Beaufort Sea, and a limited number of gray whales sometimes occur in the area during some years. Almost all of these whales are north of the barrier islands, and most of the belugas follow a far-offshore migration corridor.

The specific effects of an oil spill on bowhead, gray, or beluga 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 inhalation of hydrocarbon vapors, consumption of some contaminated prey items, and temporary displacement from contaminated feeding areas. Geraci and St. Aubin (1990) summarize effects of oil 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 size, timing, and duration of the spill. Whales may not avoid oil spills, and some have been observed feeding within oil slicks. These topics are discussed in more detail in subsequent paragraphs.

In the case of an oil spill occurring during migration periods, disturbance of 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 (Geraci 1990; Brownell 1971; 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, and has been nominated for listing on the Endangered Species List. No effects on humpback whales in Prince William Sound were evident after the *Exxon Valdez* spill (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, boat and aircraft disturbance, or displacement of food sources.

Migrating gray whales were apparently not greatly affected by the Santa Barbara spill. There appeared to be no relationship between the spill and mortality of marine mammals. The higher than usual counts of dead marine mammals recorded after the spill represented 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).

<u>Oiling of External Surfaces</u>

Whales rely on a layer of blubber for insulation, so oil would have little if any effect on thermoregulation by whales. Effects of oiling 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; continued exposure of the eyes to oil could cause permanent damage (St. Aubin 1990).

<u>Ingestion</u>

Whales could ingest oil if their food is contaminated, or oil could also be absorbed through the respiratory tract. Some of the 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).

<u>Fouling of Baleen</u>

Baleen itself is not damaged by exposure to oil and is resistant to effects of oil (St. Aubin et al. 1984). Crude oil could coat the baleen and reduce filtration efficiency; however, effects may be temporary (Braithwaite 1983; St. Aubin et al. 1984). Most of the oil that would coat the baleen is removed after 30 min and less than 5% would remain after 24 h (Bratton et al. 1993). Effects of oiling of the baleen on feeding efficiency appear to be minor (Geraci 1990).

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).

Factors Affecting the Severity of Effects

Effects of oil 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 migrating bowhead and beluga 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 migration route of bowheads can be close to shore (Blackwell et al. 2004b). 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 of the whales travel along routes well north of Northstar. Thus, only a small minority of the whales are likely to approach patches of spilled oil. Additionally, vessel activity associated with spill cleanup efforts may deflect the small number of whales traveling nearshore farther offshore, and thereby reduce the likelihood of contact with spilled oil. Also, during years when movements of oil and whales might be partially confined by ice, the bowhead migration corridor tends to be farther offshore (Treacy 1997; LGL and Greeneridge 1996a; Moore 2000).

Effects of Oil-Spill Cleanup Activities

General issues related to oil-spill cleanup activities are discussed under "Pinnipeds", above. 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, absent from the area. However, if intensive cleanup activities were necessary during the autumn whale hunt, this could affect subsistence hunting (see Section 8, below).

Conclusions re 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 or beluga whales migrating east through offshore waters of the Beaufort Sea during the spring. In the event of an oil spill during winter or spring, it is unlikely that much oil would be carried into the whale migration corridor.

In the open-water period, the principal activities will be related to oil production, and associated helicopter and vessel traffic. Underwater sounds from production activities on the islands are not expected to be detectable more than about 5-10 km offshore of Northstar Island. Disturbance to bowhead, gray and beluga 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 crew vessel traffic will be located mainly inshore of the 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 bowheads passing Northstar at those times. No biologically significant consequences are expected either for individual bowheads or for the population.

8. ANTICIPATED IMPACT ON SUBSISTENCE

The anticipated impact of the activity on the availability of the species or stocks of marine mammals for subsistence uses.

Inupiat hunters emphasize that all marine mammals are sensitive to noise, and take pains to make as little extraneous noise as possible when hunting. Seals are also said to be cautious of any unusual visual stimulus, especially if it is in motion. At the same time, seals are said to be curious and will sometimes investigate unusual objects, and can be attracted by imitating the normal, non-vocal sounds that seals make on the ice. In general, seals are sensitive to their surroundings, are especially responsive to sound, and may avoid unusual sounds.

Bowhead whales often show avoidance or other behavioral reactions to strong underwater noise from industrial activities, but often tolerate the weaker noise received when the same activities are occurring farther away. Various studies have provided information about these sound levels and distances (Richardson and Malme 1993; Richardson et al. 1995a,b; Miller et al. 1999). However, scientific studies done to date have limitations, as discussed in part by Moore and Clarke (1992) and in MMS (1997). Inupiat whalers believe that some migrating bowheads are diverted by noises at greater distances than have been demonstrated by scientific studies (e.g., Rexford 1996; MMS 1997). The whalers have also mentioned that bowheads sometimes seem more "skittish" and more difficult to approach when industrial activities are underway in the area. There is also concern about the persistence of any deflection of the bowhead migration corridor, and the possibility that sustained deflection might influence subsistence farther "downstream" during the fall migration.

Underwater sounds associated with drilling and production operations have lower source levels than do the seismic pulses and drillship sounds that have been the main concern of the Inupiat hunters. Sounds from vessels supporting activities at Northstar will attenuate below ambient noise levels at closer distances than do seismic or drillship sounds. Thus, reaction distances for whales approaching Northstar were expected to be considerably shorter than those for whales approaching seismic vessels or drillships (BPXA 1999).

Recently, there has been concern among Inupiat hunters that barges and other vessels operating within or near the bowhead migration corridor may deflect whales for an extended period (J.C. George, NSB-DWM, pers. comm.). It has been suggested that, if the headings of migrating bowheads are altered through avoidance of vessels, the whales may subsequently maintain the "affected" heading well past the direct zone of influence of the vessel. This might result in progressively increasing deflection as the whale progresses west. However, crew boats and barges supporting Northstar remain well inshore of the main migration corridor, so this type of effect is unlikely to occur in response to these types of Northstar-related vessel traffic.

Monitoring studies conducted under the provisions of incidental take authorizations can provide some of the data needed to resolve questions about the radius of influence of industrial activities on bowheads (e.g., Richardson [ed.] 1998, 1999, Richardson and Williams [eds.] 2004). Monitoring studies during the Northstar project were designed in consultation with representatives of the whalers to help ensure consensus on the methods and on the meaning of the results (Section 13). In addition, BP developed a plan of cooperation with the whalers in previous years (see Section 12) to reduce any potential interference with the hunt.

Potential effects on subsistence could result from direct actions of oil development upon the biological resources or from associated changes in human behavior. For example, the perception that marine mammals might be contaminated or "tainted" by an oil spill could affect subsistence patterns whether or not many mammals are actually contaminated. The following discussion addresses both aspects.

Marine Mammal Harvests in the Project Area

Residents of the village of Nuiqsut are the primary subsistence users in the project area. The communities of Barrow and Kaktovik also harvest resources that pass through the area of interest but do not hunt in or near the Northstar area. Subsistence hunters from all three communities conduct an annual hunt for autumn-migrating bowhead whales. Barrow also conducts a bowhead hunt in spring. Residents of all three communities hunt seals. Other subsistence activities include fishing, waterfowl and seaduck harvests, and hunting for walrus and beluga, polar bears, caribou, and moose. Relevant harvest data are summarized in Tables 5 to 7.

TABLE 5. NUMBERS OF MARINE MAMMALS OTHER THAN BOWHEAD WHALES TAKEN BY THE COMMUNITIES OF BARROW, NUIQSUT AND KAKTOVIK (AVERAGE ANNUAL TAKE).

	BELUGA WHALES	RINGED SEALS	BEARDED SEALS	SPOTTED SEALS
Barrow	5 **	394 *	174*	3
Nuiqsut	N/A	N/A	N/A	N/A
Kaktovik	5**	70***	30**	N/A

* Average annual harvest for years 1987-90 (Braund et al. 1993).

** Average annual harvest for years 1962-82 (MMS 1996).

*** Indicated total is for "hair" seals; may include some spotted seals (MMS 1996).

TABLE 6. INTERNATIONAL WHALING COMMISSION BOWHEAD QUOTAS FOR ALASKA, 1978-2007 (FROM BURNS ET AL. 1993; IWC 1995).

YEAR	LANDED WHALES	ALLOWED STRIKES
1978	14	20
1979	18	27
1980	18	26
1981-1983	45 total	65 total
1984-1985	-	43 total
1986-1988	-	32/yr
1989-1991	41/yr	44/yr
1992-1994	41/yr	54/yr
1995-1998	avg. 51/yr *	avg. 66.5/yr *
1999-2002	avg. 56/yr *	avg. 67/yr *
2003-2007	avg. 56/yr *	avg. 67/yr *

* Annual quotas for whales landed and strikes were adjusted to three-year blocks in 1995, thus the average annual harvest is based on the total 3-year quota divided by 3. The annual harvest could exceed this average as long as the 3-year total harvest did not exceed the combined 3-year total.

TABLE 7. BOWHEAD LANDINGS AT BARROW, NUIQSUT AND KAKTOVIK, 1978-2003 (FROM BURNS ET AL. 1993; VARIOUS ISSUES OF *REPORT OF THE INTERNATIONAL WHALING COMMISSION*, ALASKA ESKIMO WHALING COMMISSION, AND J.C. GEORGE, NSB DEP. WILDL. MANAGE.)

VILLAGE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Barrow [1]	4/0	3/0	9/0	4/0	0/0	2/0	4/0	5/1	8/0	7/2	11/3	10/7	11/5
Nuiqsut	0	0	0	0	1	0	0	0	1	1	0	2	0
Kaktovik	2	5	1	3	1	1	1	0	3	0	1	3	2

VILLAGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Barrow [1]	13/4	22/20	23/7	16/1	20/11	24/19	31/21	25/16	24/6	18/13	26/7	20/17	16/6
Nuiqsut	1	2	3	0	4	2	3	4	3	4	3	4	4
Kaktovik	2	3	3	3	4	1	4	3	3	3	4	3	3

[1] For Barrow, numbers given are “total landings/autumn landings”; for Nuiqsut and Kaktovik, all landings were in autumn.

The annual take of bowhead whales has varied due to (a) changes in the allowable quota level and (b) year-to-year variability in ice and weather conditions, which strongly influence the success of the hunt. Locations of bowhead whale strikes and kills are available through the North Slope Borough, Alaska Eskimo Whaling Commission, and Galginaitis and Funk (2004).

Nuiqsut is the community closest to the Northstar development. Nuiqsut hunters harvest bowhead whales only during the fall whaling season (Long 1996). In recent years, Nuiqsut whalers have typically landed three or four whales per year (4 in 2000; 3 in 2001, 4 in 2002, and 4 in 2003). In general, there has been a trend toward larger harvests in recent years (Table 8). Nuiqsut whalers concentrate their efforts on areas north and east of Cross Island, generally in water depths greater than 20 m (65 feet; Galginaitis and Funk 2004). Cross Island is the principal base for Nuiqsut whalers while they are hunting bowheads (Long 1996). Cross Island is located approximately 17.5 mi. east of Northstar.

Kaktovik whalers search for whales east, north and occasionally west of Kaktovik. Kaktovik is located approximately 200 km east of Northstar Island. The western-most reported harvest location was about 21 km (13 mi.) west of Kaktovik, near 70º10'N, 144º11'W (Kaleak 1996). That site is about 180 km east of Northstar Island.

Barrow whalers search for whales much farther from the Northstar construction area—about 250+ km (175+ mi.) to the west. However, given the westward migration of bowheads in autumn, Barrow (unlike Kaktovik) is “downstream” from the Northstar region during that season. Barrow hunters have expressed concern about the possibility that bowheads might be deflected offshore by Northstar and then remain offshore as they pass Barrow.

Effects of Routine Production Operations, Repair and Maintenance

Bowhead Whale Harvest

The disturbance and potential displacement of bowhead whales and other marine mammals by sounds from vessel traffic or on-island activities are the principal concerns related to subsistence use of the area. The harvest of marine mammals is central to the culture and subsistence economies of the coastal North Slope communities. In particular, if elevated noise levels displace migrating bowhead whales farther offshore, this could make harvest of these whales more difficult and dangerous for hunters. The harvest could also be affected if bowheads are more "skittish" when exposed to vessels or impact hammering noise.

Few bowhead whales approach the project area before the end of August, and autumn whaling at Cross Island generally does not begin until after 1 September. Whaling at Cross Island is usually completed by late September, and the bowhead migration usually ends by late October. Insofar as possible, BP's vessel traffic near areas of particular concern for whaling will be completed before the end of August.

Drilling at Northstar began in December 2000 and production operations began in late October 2001. After commencement of oil production, drilling continued until all of the reservoir wells were completed. Production will occur for about 15 years at Northstar.

Underwater sounds from drilling and production operations on an artificial gravel island are not very strong, and are not expected to travel more than about 10 km. Vessel sounds account for the highest sound levels at Northstar, and at times they are detectable considerably farther away. However, harvests have remained high at Cross Island in recent years despite sounds from Northstar, and in most recent years the quota has been filled quickly. In 2003, the four-bowhead quota was filled during the 1–6 September period.

Northstar is west of the main hunting area for Nuiqsut hunters. On most occasions, even the bowheads traveling along the southern edge of the migration corridor are not expected to hear sounds from Northstar until the whales are well west of the main hunting area. (Times with considerable vessel activity at Northstar would be the exception.) As noted above, when industrial sounds at Northstar were high, some bowheads traveling in the southern part of the migration corridor appeared to have been deflected a few kilometers farther offshore, at least in 2001 (Richardson et al. 2004). This effect would not be expected to occur offshore of Cross Island, 27 km east of Northstar.

In addition to activities at Northstar, drilling and production operations will include slow-moving vessels, a hovercraft, and limited helicopter activity. Overt whale reactions to slow-moving vessels and to helicopters traveling in a straight line are limited to close distances and short durations. In addition, whenever possible, helicopters will fly at a minimum altitude of 1,000 feet. Most vessel and helicopter traffic will be well inshore of the bowhead migration corridor. Bowhead whales will rarely be approached by these vessels and helicopters, any such approaches will not be within the area where Nuiqsut hunters usually search for bowheads, and any whale reactions to these approaches will be brief and localized.

In summary, it is not expected that routine production activities will affect the accessibility of bowhead whales to hunters. Nonetheless, BP recognizes that it is difficult to determine the maximum distance at which whale reactions to industry activities occur, and that effects may extend to distances somewhat greater than those demonstrated in scientific studies. Inupiat whalers believe that some migrating bowheads are deflected by seismic and drillship operations at distances greater than documented by earlier scientific studies (MMS 1997). In the case of seismic surveys, recent intensive monitoring has confirmed that avoidance does extend to greater distances than documented in previous scientific studies (Miller et al. 1999). However, the activities planned here will generate much less noise than open water seismic and drillship operations, and whale reactions will be limited to much shorter distances. The planned Northstar operations in 2005–2010 will be similar to those in 2003 and 2002, when any effects on the bowhead migration corridor were equivocal, and when the hunt at Cross Island was successful and quick. Also, BP is discussing a plan of cooperation with the whalers (Section 12) to reduce any potential interference with the hunt. The timing and characteristics of production, drilling and other operations at Northstar, and of barge and aircraft traffic west and south of Cross Island, will be addressed in that agreement.

The monitoring implemented during 2000–2003 (Richardson and Williams [eds.] 2004) has provided data that resolve many of the previous uncertainties about the characteristics and propagation of construction and operational noises, and about their effects on bowhead whales. Sounds from most of BP's activities associated with Northstar have been recorded and the resulting acoustic data have been described in Section 7 above and in previous reports and papers (Richardson and Williams [eds.] 2001, 2002, 2003, 2004). The whale migration in the area just west of Cross Island and offshore of Northstar has been monitored, and the migration corridor has been found to be no more than slightly and locally affected by Northstar. These results from intensive monitoring, along with the successful harvests at Cross Island in recent years, indicate that any effects of Northstar on bowheads have not reduced the availability of bowheads for the Nuiqsut subsistence hunters.

Pinniped and Beluga Harvests

Coastal communities in the Beaufort Sea also take seals plus small numbers of walruses and beluga whales. The seal harvest during winter and spring is principally of ringed seals. During the open water period both ringed and bearded seals are commonly taken. Belugas are not a significant subsistence resource at Nuiqsut, given the offshore migration routes and the lack of any coastal concentrations in that area. Subsistence issues relating to walruses (and polar bears) are considered in separate incidental take regulations of the U.S. Fish and Wildlife Service, and are not discussed further here.

Nuiqsut hunters may hunt seals year-round, but during recent years most of the seal harvest has been during the early summer in open water (Thomas Napageak, pers. comm.). In summer, boat crews hunt ringed, spotted and bearded seals. The most important seal hunting area for Nuiqsut hunters is off the Colville Delta, extending as far west as Fish Creek and as far east as Pingok Island (149º40'W). Pingok Island, the closest edge of the main sealing area, is approximately 17 mi. (27 km) west of Northstar. Sealing occurs in this area by snow machine before breakup, and by boat during the summer. Cross Island is a productive area for seals, but is too far from Nuiqsut to be used on a regular basis. During the whaling season, the hunters at Cross Island concentrate on bowhead whales, not seals.

Drilling and oil production activities at Northstar have little potential to influence seal hunting activities by residents of Nuiqsut, given the distance of these development sites from areas where Nuiqsut residents usually hunt seals. In winter and spring, a small number of ringed seals may be disturbed and possibly displaced from areas near Northstar, and from locations near ice roads. During the open water season, displacement of seals would also be highly localized. Effects of support traffic (vessels and helicopters) on seals are expected to be minor and to be limited to the areas along the routes of travel, most of which will be well to the east of the main hunting area. Thus, it is unlikely that drilling and production activity, or associated traffic, would have a significant negative impact on Nuiqsut seal hunting. Concerns about this are addressed in the plan of cooperation (Section 12).

Effects of Oil Spills

Oil spills might affect the hunt for bowhead whales. The harvest period for bowhead whales is probably the time of greatest risk that a relatively large-scale spill would reduce the availability of bowhead whales for subsistence uses. Pipeline spills are possible for the total production period of Northstar. Spills could occur at any time of the year. However, spills at most times of year would not affect bowheads, as bowheads are present near Northstar for only several weeks during late summer and early autumn. Bowheads travel along migration corridors that are far offshore of the planned production islands and pipelines during spring, and somewhat offshore of those facilities during autumn. Under the prevailing east-wind conditions, oil spills from Northstar would not move directly into the main hunting area east and north of Cross Island. However, oil spills could extend into the hunting area under certain wind and current regimes (Anderson et al. 1999).

Even in case of a major spill, it is unlikely that more than a small minority of the bowheads encountered by hunters would be contaminated by oil. However, disturbance associated with reconnaissance and cleanup activities could affect whales and thus accessibility of whales to hunters. In the very unlikely event that a major spill incident occurred during the relatively short fall whaling season, it is possible that hunting would be affected significantly.

Ringed seals are more likely than bowheads to be affected by spill incidents, because they occur in the development areas throughout the year and are more likely than whales to occur close to Northstar. Small numbers of bearded seals could also be affected, especially by a spill during the open-water season. Potential effects on subsistence use of seals will still be relatively low, as the areas most likely to be affected are not areas heavily used for seal hunting. However, wind and currents could carry spilled oil west from Northstar to areas where seal hunting occurs. It is possible that oil-contaminated seals could be harvested.

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 and thus tainting or other impacts on the mammals.

One of the most persistent effects of EVOS was the reduced harvest and consumption of subsistence resources, due to the local perception that they had been tainted by oil (Fall and Utermohle 1995). The concentrations of petroleum-related aromatic compound (AC) metabolites in the bile of harbor seals were greatly elevated in harbor seals from oiled areas of Prince William Sound. Mean concentrations of phenanthrene (PHN) equivalents for oiled seals from PWS was over 70 times greater than for control areas, and over 20 times higher than for presumably unoiled areas of PWS (Frost et al. 1994b). Concentrations of hydrocarbons in harbor seal tissues collected in PWS one year after EVOS were not significantly different from seals collected in non-oiled areas; however, average concentrations of AC metabolites in bile were still significantly higher than those observed in un-oiled areas (Frost et al. 1994b). The pattern of reduced consumption of marine subsistence resources by the local population persisted for at least a year. Most affected communities had returned to documented pre-spill harvest levels by the third year after the spill. Even then, some households in these communities still reported that subsistence resources had not recovered to pre-spill levels. Harvest levels of subsistence resources for the three communities most affected by the spill still were below pre-spill averages even after three years. By then, the concern was mainly about smaller numbers of animals rather than contamination. However, contamination remained an important concern for some households (Fall and Utermohle 1995). As an example, an elder stopped eating local salmon after the spill, even though salmon is the most important subsistence resource and he ate it every day up to that point. Similar effects could be expected after a spill on the North Slope, with the extent of the decline in harvest and use, and the temporal duration of the effect, dependent upon the size and location of the spill. This analysis reflects the local perception that oil spills pose the greatest potential danger associated with offshore oil production.

In summary, direct effects of routine drilling and oil production activities upon subsistence uses of marine mammals (mainly ringed seals and bowhead whales) will be minimal. In winter, the ringed seal is the only relevant species present. Winter use of the development areas by subsistence hunters is limited or nil. No seal hunting or harvests were observed during the intensive marine mammals monitoring from 1997-2002 or subsequent observations of seals by island personnel. Seals are also present near Northstar throughout the open water season, but are not hunted in those locations to any significant extent. Bowhead whales are absent in the early part of the open water season. Bowheads migrate through the general area during late summer and autumn, mainly offshore of Northstar. Ongoing production and maintenance activities, and possible resumption of drilling activities, are not expected to affect the bowhead migration corridor or bowhead behavior in the hunting areas used by Nuiqsut, Kaktovik, or Barrow whalers. Recent concerns about possible offshore deflection of the migration corridor just east of Barrow, where Barrow residents hunt in autumn, are primarily related to vessel activity that occurred closer to Barrow than is Northstar. That vessel traffic had no connection with Northstar or with BP.

Local concerns about these issues will be addressed in the updated Plan of Cooperation (Section 12) and by ongoing monitoring (Section 13). An acoustic and marine mammal monitoring program is planned for 2005–2010. This program is expected to verify that sounds from Northstar are no stronger in future production years than documented by the previous intensive monitoring studies during construction and drilling. The future monitoring will also provide a basis for determining if there are major changes in utilization of the Northstar area by marine mammals (which are not expected). It is planned that the results from previous and ongoing monitoring will be reviewed by the North Slope Borough's Science Advisory Committee (NSB-SAC). The future monitoring program will be revised as necessary based on guidance from the NSB-SAC and NMFS.

The only situation in which there could be identifiable effects on subsistence would be in the unlikely event of a large oil spill (>1,000 barrels) during whaling. The probability of such a spill occurring over the life of the field is low (S.L. Ross Environmental Research Ltd. 1998). However, because subsistence harvests are socio-culturally based, perception is an important component that cannot be adequately addressed by biological studies alone (Fall and Utermohle 1995).

9. ANTICIPATED IMPACT ON HABITAT

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

Foods of Seals and Whales

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. Spotted seals feed on pelagic and demersal fish, as well as shrimp and cephalopods. They are known to feed on a variety of fish including herring, capelin, sand lance, Arctic cod, saffron cod, and sculpins.

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 [eds.] 2002). When feeding in relatively shallow areas such as those where oil development may occur, bowheads feed throughout the water column. However, feeding is concentrated at depths where zooplankton is concentrated (Würsig et al. 1984, 1989; Richardson [ed.] 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 to 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 [eds.] 2002). However, in some years, sizable groups of bowhead whales 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 bowheads fed widely across the Alaskan Beaufort Sea, including higher numbers in the area east of Barrow than reported in any previous year (S. Treacy and D. Hansen, MMS, pers. comm.).

Beluga whales feed on a variety of fish, shrimp, squid and octopus (Burns and Seaman 1985). Very few beluga whales occur near Northstar; their main migration route is much further offshore.

Gray whales are primarily bottom feeders, and benthic amphipods form the majority of their summer diet, at least in the main summering areas west of Alaska (Oliver et al. 1983; Oliver and Slattery 1985). Farther south, gray whales have also been observed feeding around kelp beds, presumably on mysid crustaceans, and on pelagic prey such as small schooling fish and crab larvae (Hatler and Darling 1974).

Marine Fishes

Two kinds of fish inhabit marine waters in the study area: (1) true marine fish that spend all of their lives in salt water, and (2) anadromous species that reproduce in fresh water and spend parts of their life cycles in salt water.

Most arctic marine fish species are small, benthic forms that do not feed high in the water column. The majority of these species are circumpolar and are found in habitats ranging from deep offshore water to water as shallow as 5-10 m (16-30 ft) (Fechhelm et al. 1995). The most important pelagic species, and the only abundant pelagic species, is the Arctic cod. The Arctic cod is a major vector for the transfer of energy from lower to higher trophic levels (Bradstreet et al. 1986). In summer, Arctic cod can form very large schools in both nearshore and offshore waters (Craig et al. 1982; Bradstreet et al. 1986). Locations and areas frequented by large schools of Arctic cod cannot be predicted, but can be almost anywhere. The Arctic cod is a major food source for beluga whales, ringed seals, and numerous species of seabirds (Frost and Lowry 1984; Bradstreet et al. 1986).

Anadromous Dolly Varden char and some species of whitefish winter in rivers and lakes migrate to the sea in spring and summer, and return to fresh water in autumn. Anadromous fish form the basis of subsistence, commercial, and small regional sport fisheries.

Dolly Varden char migrate to the sea from May through mid-June (Johnson 1980) and spend about 1.5 to 2.5 months there (Craig 1989). They return to rivers beginning in late July or early August with the peak return migration occurring between mid-August and early September (Johnson 1980).

At sea, most anadromous corregonids (whitefish) remain in nearshore waters within several kilometers of shore (Craig 1984, 1989). They are often termed "amphidromous" fish in that they make repeated annual migrations into marine waters to feed, returning each fall to overwinter in fresh water.

Marine Invertebrates

Benthic organisms are defined as bottom dwelling creatures. Infaunal organisms are benthic organisms that live within the substrate and are often sedentary or sessile (bivalves, polychaetes). Epibenthic organisms live on or near the bottom surface sediments and are mobile (amphipods, isopods, mysids, and some polychaetes). Epifauna, which live attached to hard substrates, are rare in the Beaufort Sea because hard substrates are scarce there. A small community of epifauna, the Boulder Patch, occurs in Stefansson Sound.

The benthic environment near Northstar appears similar to that reported in various other parts of the Arctic (Ellis 1960, 1962, 1966; Dunbar 1968; Wacasey 1975). Many of the nearshore benthic marine invertebrates of the Arctic are circumpolar and are found over a wide range of water depths (Carey et al. 1975). Species identified include polychaetes (*Spio filicornis*, *Chaetozone setosa*, *Eteone longa*), bivalves (*Cryrtodaria kurriana*, *Nucula tenuis*, *Liocyma fluctuosa*), an isopod (*Saduria entomon*), and amphipods (*Pontoporeia femorata*, *P. affinis*).

Nearshore benthic fauna has been studied in lagoons west of Northstar and near the mouth of the Colville River (Kinney et al. 1971, 1972; Crane and Cooney 1975). They found that the waters of Simpson Lagoon, Harrison Bay, and the nearshore region support a number of infaunal species including crustaceans, mollusks and polychaetes. In areas influenced by river discharge, seasonal changes in salinity can greatly influence the distribution and abundance of benthic organisms. Large fluctuations in salinity and temperature that occur over a very short time period, or on a seasonal basis, allow only the very adaptable, opportunistic species to survive (Alexander et al. 1974). Since shorefast ice is present for many months, the distribution and abundance of most species depends on annual (or more frequent) recolonization from deeper offshore waters (Woodward Clyde Consultants 1995). Due to ice scouring, particularly in water depths of <2.4 m (<8 ft), infaunal communities tend to be patchily distributed. Diversity increases with water depth until the shear zone is reached at 15-25 m (50-80 ft) (Carey 1978). Biodiversity then declines due to ice gouging between the landfast ice and the polar pack ice (Woodward Clyde Consultants 1995).

Effects of Routine Production Operations

Noise Effects on Foods of Seals and Whales

Construction activities produced both impulsive 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 airgun. When the airgun was fired, the fish dove from 25 to 55 m (80-180 feet) 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 of strong noise pulses on several species of rockfish off the California coast. They used an airgun 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 to 199 dB for other species;
- an overall threshold for the above behavioral response at about 180 dB;
- an extrapolated threshold of about 161 dB for subtle changes in the behavior of rockfish; and
- 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 of 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.

The reactions of fish 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 side of the ship (Misund et al. 1996). Because of 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 to 350 m (Misund 1997), though reactions probably will depend on the species of fish. In some instances, fish will avoid the ship by swimming away from the path and will become relatively concentrated to the side of the ship (Misund 1997). Most schools of fish will show avoidance if they are not in the path of the vessel. 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 nil, depending on the type of animal. Impacts on zooplankton behavior are predicted to be negligible and this would translate into negligible impacts on feeding bowheads.

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 ~ 500 m and effects are likely indistinguishable from naturally occurring disturbances to the benthos by sea ice, river outflow, and coastal erosion (MBC 2003). Trefry et al. (*In* MBC 2003) suggests the nearshore Beaufort (i.e., near Northstar) is not a high depositional area, and sediment from rivers, erosion, or other sources would be carried offshore, thus impacts on benthos will be short-term and negligible. In addition, the island slope protection system introduced hard bottom structures for possible colonization by arctic kelp species.

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. A recent reanalysis of worldwide oil spill data indicates the probability of a large oil spill (>1,000 barrels) during the lifetime of Northstar is low (S.L. Ross Environmental Research Ltd. 1998). 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 length of pipeline times the amount of time the pipeline is in service. The calculated probability of 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%), which were 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 fishes are a principal food item for beluga whales and 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 species (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 and whales 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 (ed., 1987). Zooplankton populations in the open sea are unlikely to be depleted by the effects of 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, concentrations of zooplankton in near-surface waters generally are low compared to those in deeper water (Bradstreet et al. 1987; Griffiths et al. 2002).

Some bowheads feed in shallow nearshore waters (Bradstreet et al. 1987; Richardson and Thomson [eds.] 2002). Wave action in nearshore waters could cause high concentrations of oil 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 of 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, 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. 1990). There could be mortality of benthic animals and elimination of some benthic feeding habitat. During the ice-free period, 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.

Effects of 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. Effects of 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 to 10 meters 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 and an oil spill would not be expected to have a significant impact on the growth of the kelp communities.

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.

Oil Spill Response Activities

Oil spill response activities would include ship, boat and aircraft traffic. The effects of noise produced by these activities would be similar to those described above for transportation activities associated with oil production. Bowheads and seals may avoid the area, and seals may be displaced from the immediate area surrounding the activities.

Burning of oil and use of oil dispersants may have toxic effects on bowheads. Effects on populations are undocumented (USACE 1998b) but expected to be negligible. Effects on seals are assumed to be similar. The noise produced by oil response activities would likely cause bowheads and perhaps some seals to avoid the area. Consequently, they may not be exposed to concentrated dispersants or products of burnt oil.

Spill response activities are not likely to disturb the prey items of whales or seals sufficiently to cause more than negligible effects.

Overall, the continuation of ongoing Northstar activities is not expected to cause significant impacts on habitats used by marine mammals, or on the food sources that marine mammals utilize. 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 at least local and short-to-medium term effects on habitat availability, especially for seals occupying nearshore waters near the development site where the spill occurred.

10. ANTICIPATED IMPACT OF HABITAT LOSS OR MODIFICATION

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The footprint for Northstar Island covers ~25 acres of benthic habitat and ~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 as a result of the construction of Seal Island at the same site in 1982. The small additional area covered and excavated was not known to influence marine mammal use.

Exclusion of Marine Mammals from Habitat

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 that will be altered by Northstar construction activities is minimal compared to the overall habitat available in the region. Densities of ringed seals on the ice near Northstar during late spring are similar to those elsewhere in the region (Miller et al. 1998b; Link et al. 1999; Moulton et al. 2002b, 2003b). 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 away (Williams et al. 2002). Active seal structures were found within 10s of meters of thickened ice (Williams et al. 2004b, MS). A few ringed seals occur within areas of artificially thickened ice if cracks that can be exploited by seals form in that thickened ice.

Bowheads 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 and continuing until late October, a small number or bowheads may travel close enough to Northstar to hear sounds from Northstar Island or to encounter vessel traffic to and from the island. Some of these migrating bowhead whales might be displaced seaward by the planned activities (Richardson et al. 2004). However, the numbers of bowheads subject to displacement of 2-5 km (or more) are small in relation to the population size (McDonald and Richardson 2004). Also, feeding does not appear to be an important activity by bowheads migrating 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 bowheads from parts of the Northstar development area is not expected to have any significant or long-term consequences for individual bowheads or their population. Bowheads or other whales are not predicted to be excluded from any habitat.

11. MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

To minimize the likelihood that impacts will occur to the species, stocks and subsistence use of marine mammals, all activities associated with the Northstar development will be conducted in accordance with all Federal, state and local regulations. BP will coordinate all activities with the relevant Federal and state agencies. These will include the National Marine Fisheries Service, U.S. Fish and Wildlife Service, Minerals Management Service, Biological Resources Division of the U.S. Geological Survey, and Alaska Department of Fish and Game. BP will also coordinate all activities with local authorities (North Slope Borough), communities (Barrow, Nuiqsut, and Kaktovik), and whaling captains and their representatives (Alaska Eskimo Whaling Association (AEWC), and the Barrow (BWCA), Nuiqsut (NWCA), and Kaktovik (KWCA) Whaling Captains Associations. A plan of cooperation was developed between BP and the subsistence users in the region during the previous 5-yr regulations. We anticipate annual renewal/renegotiation of these documents during the subsequent period. This will ensure efforts have been made by BP to minimize the possibility that operational, maintenance, and training activities interfere with the fall hunt for bowheads, 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 and monitoring methods and results of studies. BP plans to participate in future peer-review workshops sponsored by NMFS.

Mitigation During Production, Facilities Repair and Maintenance

Ice-Covered Season

During winter and spring activities on the sea ice, the ringed seal is the only marine mammal species under the jurisdiction of NMFS 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 of 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 of some activities (Kelly et al. 1986). However, if displacement occurs it is limited to a distance of, at most, 500 m for activities such as those proposed for Northstar (Williams et al. 2004b, MS).

Female ringed seals establish their birth lairs before pupping in late March to April. It was not anticipated (prior to construction of Northstar) that female seals would establish birth lairs in close proximity to on-going activities associated with Northstar. However, the closest suspected birth lairs were found ~1600 m and 54 m from the island and ice road, respectively in 2001 (Williams et al. 2004b, MS). To date, results of all studies of structure location and seal distribution indicate that no more than limited displacement of ringed seals has occurred.

In the event that work is required after mid-March in a previously undisturbed area of floating landfast ice, a survey with dogs will be completed to delineate an area where activities may proceed without disturbing lairs. The LoAs issued to BP by NMFS for the three ice-covered seasons of 2001–02, 2002–03, and 2003–04 required on-ice searches for seal structures only if BP's activities moved onto previously undisturbed landfast ice after 1 March. BP's activities have not moved into such areas during late winter in recent years. Consequently, no on-ice searches were done during the winters of 2001–02, 2002–03, or 2003–04. Recently the cut-off date after which searches for structures are required has been set as 20 March (NMFS 2003, 2004), nearly 3 weeks later than the requirement that has applied for BP at Northstar. The exact date after which surveys with dogs are required will be determined by NMFS and should be consistent with corresponding dates associated with other activities by other operators on the floating sea ice. Covered breathing holes are indistinguishable from lairs until excavated by investigators; therefore all structures (to the maximum extent possible) will be found. This survey will include two searches with dogs of all floating sea ice for any ringed seal birthing lairs or suspected lairs. Those surveys will be done prior to the new activity on the floating sea ice, to provide information needed to prevent injury or mortality of young seals. Breathing holes will not be avoided during subsequent BP activities, but lairs will be avoided by 100 m, when practicable. A subset of lairs may be identified as birth lairs or lairs being used by pups (i.e., identification of lanugal hairs or lateral excavations). These structures will be avoided by at least 100 m.

A report will be prepared describing the area searched, activities that occurred, and methods of any surveys with dogs that BP conducts to locate ringed seal lairs that 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 requirement in Section 13.

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 1,000 ft 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 will 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 ongoing Northstar operations and maintenance is small relative to their regional populations. Past monitoring has indicated that effects of 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 and spotted seals, and beluga or gray whales, though there is no indication of effects on those species as a result of Northstar activities to date.) These behavioral changes have resulted in no greater than negligible impacts on individuals or on the species or stocks. Effects of future (2005–2010) Northstar activities are expected to be no greater than those during initial production in 2002–2003, and probably 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 sheetpile 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. Under present

NMFS criteria, pinnipeds are not to be exposed to pulses with received levels above 190 dB re 1 μPa (rms), and whales are not be exposed to levels above180 dB_{rms} (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 marine mammal monitoring/mitigation program will be conducted near any source predicted to result in received levels underwater above 180 dB_{rms} (see Section 13).

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 sheetpile walls (Blackwell et al. 2004a). We anticipate that received levels for any pile driving that might occur within the sheetpile walls of the island in future would also be less than 180 dB at all locations in the water around the island. If impact pile driving were planned in areas outside the sheetpile walls, it is possible that received levels underwater might exceed the 180 dB level, so the aforementioned marine mammal observations and mitigation measures would be implemented.

If observations and mitigation are required, 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. See Section 13 for a detailed description of the observer program. If pinnipeds are seen within the 190 dB re 1 μPa contour (the "safety radius") during impact hammer use, then operations will be shut down immediately until the mammals move beyond the "safety radius" around the activity. Whales are very unlikely to be present close to hammering operations. However, if they are observed within the 180 dB re 1 μPa (rms) radius, operations will shut down. If no mammal is seen within the “safety radius” for fifteen minutes, it will be assumed to have moved beyond the "safety radius", and the impact hammer activity can resume. During the lifetime of the requested Letter of Authorization, safety criteria different from the provisional 180 and 190 dB criteria of NMFS (2000) may be accepted by NMFS. If so, the new criteria would apply.

A Communications Plan and Conflict Avoidance Agreement (see Section 12) have been negotiated with subsistence hunters and their representatives, and implemented, in previous years. BP expects that these plans will be further discussed and refined in subsequent years. This will confirm that efforts have been made by BP to minimize the possibility that Northstar operations, including vessels, helicopters and other ancillary operations, interfere with the subsistence hunt of bowhead whales.

Contingency Plan for Oil Spills

An oil spill prevention and contingency response plan has been developed and submitted to the Alaska Department of Environmental Conservation, U.S. Department of Transportation, U.S. Coast Guard, and U.S. Minerals Management Service. The plan has been amended since its initial approval. Major changes to the plan since 1999 include the following: seasonal drilling restrictions from June to freeze-up; a single barge and tug outfitted and dedicated to oil spill response; deletion of the summer blowout scenario as a result of seasonal drilling restrictions; change the standard of response planning for a well blowout resulting from a reduction in the well production rates; and deletion of ice auguring for monitoring potential sub-sea oil pipeline leaks during winter following demonstration of the LEOS leak detection system. Future standards for spill response preparedness may be expected in response to changes in well production rates and pipeline throughput. Upon renewal in 2007, the plan can be expected to comply with revisions in the State's regulatory requirements for response planning, which became effective on 26 May 2004.

The plan consists of four parts:

- Response Action Plan

  Identifies initial emergency response actions.

- Prevention Plan

  Provides a detailed description of all prevention measures and policies employed at the facility.

- Supplemental Information

  Provides background information on the facility, receiving environment for potential spills, protection of environmentally sensitive areas, types of equipment available for response.

- Best Available Technology (BAT)

  Provides a rationale for the prevention technology in place at the facility and a determination of whether or not it is BAT.

The plan includes a detailed map atlas that summarizes the resources that might be at risk from an oil spill on a seasonal basis, sensitive shoreline types, and key hydrographic, topographic and facility information.

12. PLAN OF COOPERATION

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken and/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

The AEWC and BP established a conflict avoidance agreement to mitigate the noise and/or traffic impacts of offshore oil and gas production related activities on subsistence whaling.

In addition, the NSB and residents from Barrow, Nuiqsut, and Kaktovik participated in the development of the Final Environmental Impact Statement (FEIS) for the Northstar project. Local residents provided traditional knowledge of the physical, biological, and human environment that has been incorporated into the Northstar FEIS. Also included in the Northstar FEIS is information gathered from the 1996 community data collection, along with relevant testimony during past public hearings in the communities of Barrow, Nuiqsut, and Kaktovik. This data collection has helped ensure that the concerns of NSB residents about marine mammals and subsistence are taken into account in the development of the project designs, permit stipulations, monitoring programs, and mitigation measures.

BP meets annually with communities on the North Slope to discuss the Northstar Development project. Stakeholder and peer review meetings convened by NMFS have been held at least annually from 1998 to the present to discuss proposed monitoring and mitigation plans, and results of completed monitoring and mitigation. Those meetings have included representatives of the concerned communities, the AEWC, the NSB, federal, state, and university biologists, the Marine Mammal Commission, and other interested parties. One function of those meetings has been to coordinate planned construction and operational activities with subsistence whaling activity. More recently, BP has agreed to work with the North Slope Borough and NMFS to convene the NSB's Science Advisory Committee to review the future monitoring and past results of monitoring for Northstar.

The conflict avoidance agreement may address the following:

- Operational agreement and communications procedures

  Where/when agreement becomes effective

  General communications scheme, by season

  Northstar Island operations, by season

- Conflict avoidance

  Seasonally sensitive areas

  Vessel navigation

  Air navigation

  Marine mammal and acoustic monitoring activities

  Measures to avoid impacts to marine mammals

  Measures to avoid conflicts in areas of active whaling

- Emergency assistance
- Dispute resolution process

13. MONITORING AND REPORTING PLAN

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

This monitoring program **is a starting point for developing a plan that meets the requirements of the North Slope Borough zoning ordinance and NMFS Letter of Authorization**. BP anticipates that changes to the plan will be made as this application is processed and guidance is provided by the NSB Science Advisory Committee and through future consultation with the NSB, NMFS, and AEWC.

A comprehensive analysis of the results of the acoustical and marine mammal monitoring program to date has recently been completed (Richardson and Williams [eds.] 2004). Results of this intensive monitoring suggest that (1) there are no measurable effects on seals from Northstar activities, and (2) there are limited but measurable effects on movement patterns of bowhead whales passing Northstar. The effects on bowheads are limited to the southernmost part of the migration corridor during periods with relatively noisy operations (generally boat and barge operations). The new monitoring plan proposes annual monitoring for changes in (1) the relative numbers of ringed seals near Northstar, (2) the relative numbers of bowhead whale calls near Northstar during September, and (3) sound levels emanating from Northstar during September. The September monitoring effort for bowheads and sound levels will coincide with the bulk of the bowhead whale migration past Northstar, terminating before the onset of freeze-up. Also, BP proposes additional monitoring as a contingency under two conditions, described below. Results from monitoring will be reported in a single annual report. In addition, a five-year comprehensive report will be prepared in 2009.

No monitoring is proposed specifically for bearded or spotted seals or for gray or beluga whales, as their occurrence near Northstar is extremely limited. Few, if any, observations of these species were made during the intensive monitoring from 1999 to 2004 and biological effects are not suspected. However, if sightings of these (or other) species are made, those observations will be included in the monitoring reports that will be prepared.

Annual Monitoring

1. Ringed Seal Monitoring

BP proposes a long-term observer program, conducted by island personnel, of ringed seals during the spring, summer, and early autumn. This program is intended to assess the continued long-term stability of ringed seal abundance and habitat use near Northstar as indexed by counts obtained on a regular and long-term basis.

During the basking season, the proposed approach is two pronged:

(1) Seals will be counted three times each week (weather permitting) from Northstar island by Northstar staff using spotting scopes and following a standardized protocol. The protocol will dictate the area to be surveyed (areas visible from two existing work platforms on the Northstar production module), the time of day for surveys (10:00-12:00), the duration of surveys (15 minutes), and the spotting scope resolution and magnification (a spotting scope will be purchased and used only for this project to ensure that all observations are made with the same scope). Counts will only be made during periods with visibility exceeding one mile.

(2) Seals will be counted by hovercraft operators and/or vehicle passengers (traveling on the ice road) during their regular transits to and from Northstar when weather and safety conditions allow, typically three or more times each week.

During the open-water season, seals will be counted by hovercraft operators during their regular transits to and from Northstar when weather and safety conditions allow, typically three or more times each week.

2. Bowhead Whale Monitoring

BP proposes to monitor the bowhead migration in 2005 and subsequent years for ~30 days each September. BP proposes to use a DASAR (Directional Autonomous Seafloor Acoustic Recorder, Greene et al. 2004) at an offshore location about 10 statute miles north of Northstar, consistent with the center-point of the array of DASARs used in past years. The DASAR will record bowhead whale calls. Data from the DASAR will provide information on the total number of calls detected and the temporal pattern of the calling over the course of the recording period. These data can be compared with corresponding data from the same site in previous years. If substantially higher or lower numbers of calls are recorded than were recorded at that site in previous years, further analyses and additional monitoring will be considered in consultation with NMFS and North Slope Borough scientists. A second DASAR will be deployed to provide a reasonable level of redundancy.

3. Acoustic Monitoring of Northstar Sounds

BP proposes to install a DASAR about 450 m north of Northstar, in the same area where sounds have been recorded over the past several years. This DASAR will be installed for ~30 days each September, corresponding with deployment of a DASAR in an offshore location. This nearshore DASAR will be used to record and quantify sound levels emanating from Northstar. If near-island sounds are found to be significantly stronger or more variable than in the past, and if it is expected that the stronger sounds will continue in subsequent years, then further consultation with NMFS and NSB will occur to determine if more analyses or changes in monitoring strategy are appropriate. A second DASAR will be employed to provide a reasonable level of redundancy.

Contingency Monitoring

If BP needs to conduct an activity capable of producing pulsed underwater sound with levels ≥180 or ≥190 dB re 1 µPa (rms) at locations where whales or seals could be exposed, BP proposes to monitor safety zones defined by those levels. One or more on-island observers, as necessary to scan the area of concern, will be stationed at location(s) providing an unobstructed view of the predicted safety zone. The observer(s) will scan the safety zone continuously for marine mammals for 30 minutes prior to the operation of the strong source. Observations will continue during all periods of operation. If whales and seals are detected within the (respective) 180 or 190 dB distances, a shutdown or other appropriate mitigation measure (as agreed upon with NMFS) would be implemented. The shutdown or other agreed measure would continue until such time as the mammal(s) are clear of the safety radius. When the observer has determined that no marine mammals have been within the safety zone for 15 minutes, the sound source will be allowed to operate again. If marine mammal safety criteria recognized by NMFS change before or during the 5-year period under consideration, BP will adopt new monitoring and mitigation measures in consultation with NMFS.

If BP initiates significant on-ice activities (e.g., construction of new ice roads, trenching for pipeline repair, or projects of similar magnitude) in previously undisturbed areas after 20 March, trained dogs will be used to search for seal structures. If lairs are found within 100 m of the proposed area of operations, BP will adjust the area of operations or adopt appropriate mitigation measures. Those mitigation measures will be defined in consultation with NMFS and North Slope Borough Biologists.

Reports

BP proposes the submission of **a single annual monitoring report**, with the first report to cover the activities from May through October 2005, and subsequent reports to cover activities from November of one year through October of the next year. It is proposed that the first report, concerning May–October 2005, would be due on 1 June 2006. For subsequent years, it is proposed that the annual report (to cover monitoring during a 12-month November–October period) would be submitted on 1 June of the following year.

The annual reports will provide summaries of BP's Northstar activities. These summaries will include the following: dates and locations of ice-road construction, on-ice activities, vessel/hovercraft operations, oil spills, emergency training, and major repair or maintenance activities thought to alter the variability or composition of sounds in a way that might have detectable effects on ringed seals or bowhead whales. The annual reports will also provide details of ringed seal and bowhead whale monitoring, the monitoring of Northstar sound via the nearshore DASAR, estimates of the numbers of marine mammals exposed to project activities, descriptions of any observed reactions, and documentation concerning any apparent effects on accessibility of marine mammals to subsistence hunters.

BP also proposes to submit **a single comprehensive report** on the monitoring results from mid-2005 to mid-2009 no later than 240 days prior to expiry of the renewed Regulations, i.e., by September 2009. That date assumes renewal in May 2005 and expiry in May 2010.

If specific mitigation is required for activities on the sea ice initiated after 20 March (requiring searches with dogs for lairs), or during the operation of strong sound sources (requiring visual observations and shut-down), then **a preliminary summary of the activity, method of monitoring, and preliminary results will be submitted within 90 days** after the cessation of that activity. The complete description of methods, results and discussion will be submitted as part of the annual report.

Any observations concerning possible injuries, mortality, or an unusual marine mammal mortality event will be transmitted to NMFS within 48 hours.

14. COORDINATING RESEARCH TO REDUCE AND EVALUATE POTENTIAL INCIDENTAL TAKE

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

BP coordinated the past marine mammal monitoring programs for the open-water and ice-covered seasons during construction and initial operation of Northstar with MMS, NMFS, ADF&G, University of Alaska, WesternGeco, and other industrial groups conducting related work.

The Minerals Management Service has been supporting or conducting aerial surveys of endangered whales in the Alaskan Beaufort Sea during autumn since 1979 and plans to continue these surveys.

The Minerals Management Service is continuing a monitoring study ("cANIMIDA") to document and assess the environmental effects of the Northstar and similar developments. This project has included acoustical measurements and documentation of the subsistence harvest of bowhead whales, among other components. BP and its monitoring contractors will coordinate with MMS and its contractors to maximize the combined results of the BP and MMS efforts.

It is possible that MMS will initiate one or more additional field projects of marine mammals or related topics in the Beaufort Sea during the five-year span of the requested authorization. If so, BP will coordinate with them as appropriate. In addition, MMS is initiating a project to develop a protocol to deflect migrating bowhead whales in the event of an oil spill. BP will coordinate with MMS and its contractor for that work.

BP has supported studies of ringed seals through the Coastal Marine Institute of the University of Alaska (Kelly et al. 2004). BP will coordinate its proposed seal monitoring during the ice-covered season with any ongoing monitoring of on-ice seismic work or any other related research on seals in the area surrounding Northstar.

BP plans to involve Inupiat personnel as well as biologists and acousticians in the monitoring and research programs proposed here. This will provide more opportunities for exchange of traditional and scientific knowledge.

BP anticipates that NMFS and peer reviewers will comment on the draft final reports on the marine mammal and acoustical monitoring work. BP will provide copies of draft monitoring reports to the North Slope Borough, the Alaska Eskimo Whaling Commission, and the Minerals Management Service for their review. Comments received as a result of the review processes will provide additional opportunities for input from and coordination with other groups with interests and experience in the area.

BP is continuing to actively pursue engineering and operational options to reduce noise levels associated with Northstar construction activities. (The recent adoption of a hovercraft for transport to and from Northstar is an example.)

III. CONCLUSION

Six species of marine mammals under the jurisdiction of the NMFS occur with varying degrees of regularity in the central Alaskan Beaufort Sea. Only the ringed seal is common within the project area year-around. Bearded seals occur in the near-shore waters occasionally during the open-water season and less commonly during the ice-covered season. Small numbers of spotted seals may be present during the open-water season. Bowhead, gray, and beluga whales migrate through the region. However, few migrating bowheads or especially belugas are likely to occur in immediate proximity to the project area during the fall in any given year, as their main migration corridors are north of Northstar. Gray whales are rare in the area. Other species of cetaceans and seals occur in the area only on an extralimital basis.

BP requests that a Letter of Authorization be issued to authorize the potential "taking" of small numbers of seals and whales incidental to drilling, production operations, transportation, maintenance and training associated with BP's Northstar offshore oil and gas development in the Alaskan Beaufort Sea. BP is requesting authorization for potential non-lethal incidental take by harassment during its planned production and ancillary activities associated with the Northstar Development. In the unexpected event of accidental destruction of one or more ringed seal lairs, BP requests authorization for a potential lethal take of very small numbers of ringed seals. BP has proposed specific monitoring and mitigation measures to reduce the likelihood of impacts to marine mammals as well as to estimate the numbers of seals and whales potentially "taken" during planned activities at Northstar.

The potential impacts of the planned offshore oil developments at Northstar on marine mammals involve both acoustic and non-acoustic effects. Acoustic effects involve sounds produced by activities such as power generation and oil production on Northstar Island, heavy equipment operations on ice, impact hammering, drilling, and camp operations. Some of these sounds were more prevalent during the construction and drilling periods, and sound levels emanating from Northstar are expected to be reduced during the ongoing production period. The presence of facilities and personnel, and the unlikely occurrence of an oil spill, are potential sources of non-acoustic effects. During average ambient conditions, some activities are expected to be audible to marine mammals at distances up to 10 km away. However, because of the poor coupling of on-island sounds into the water, and their low effective source levels, sounds from production operations are not expected to disturb marine mammals at distances beyond a few kilometers from the Northstar development.

Responses by pinnipeds to noise are highly variable. Responses observed to date by ringed seals during the ice-covered season are limited to short-term behavioral changes in close proximity to activities at Northstar. During the open-water season responses by ringed seals are expected to be even less than during the ice-covered season. A major oil spill is unlikely, but the impact of an oil spill on seals could be lethal to some heavily oiled pups or adults. However, even in the unlikely event of a major spill, the overall impacts to seal populations will be minimal due to the small fraction of those exposed to recently spilled oil that are likely to be seriously affected.

Responses to Northstar by migrating bowhead and beluga whales will be short-term and limited due to the typically small proportion of whales that will migrate near Northstar and the relatively low levels of underwater sounds propagating seaward from the island at most times. The limited deflection effects that may occur will happen mainly when vessels are operating for prolonged periods near Northstar. An oil spill is unlikely and it is even less likely to disperse into the main migration corridor for either whale species. The effects of oiling on bowhead and beluga whales are unknown, but could include fouling of baleen, irritation of the eye, skin, and respiratory tract (only if heavily oiled).

A plan of cooperation has been negotiated between BP, the Alaska Eskimo Whaling Commission, and the North Slope Borough in past years, and discussions regarding future agreements are on-going. This plan will address concerns relating to the subsistence harvest of marine mammals in the region surrounding Northstar. Impacts to marine mammal food resources or habitat are not expected from any of the continued drilling or operational activities at Northstar.

Mitigation proposed includes avoidance of seal lairs by 100 m if new activities occur on the floating sea ice after 20 March or such other date in March specified by NMFS. In addition BP proposes to mitigate potential acoustic effects that might occur due to exposure of whales or seals to strong pulsed sounds. Activities producing underwater sound levels ≥180 or ≥190 dB re 1 μPa (rms) would be temporarily shut down if whales and seals, respectively, occur within the relevant radii. The purposes of these mitigation measures are to minimize impacts to marine mammals and their habitat, and to ensure the availability of marine mammals for subsistence purposes.

The monitoring proposed includes some aspects to be implemented annually and others to be implemented on a contingency basis. Basking and swimming ringed seals will be counted annually by Northstar personnel in a systematic fashion to document the long-term stability of ringed seal abundance and habitat use near Northstar. BP proposes to monitor the bowhead migration in 2005 and subsequent years using two DASARs to record near-island sounds and two to record whale calls. If BP needs to conduct an activity capable of producing pulsed underwater sound with levels ≥180 or ≥190 dB re 1 μPa (rms) at locations where whales or seals could be exposed, BP proposes to monitor safety zones defined by those levels. The monitoring proposed would be used in estimating the numbers of marine mammals that may potentially be disturbed ("taken by harassment") incidental to operation of Northstar. The results of more intensive studies and analyses to date suggest that the biological effects of Northstar are subtle and equivocal, and small in the context of natural variation of the marine ecosystem.

For reasons set forth above and in the record of the rulemaking proceedings underlying this request for a Letter of Authorization, it is apparent that the continued oil and gas production operations of the Northstar offshore island in arctic waters of the United States will have no greater than a negligible impact on ringed, spotted, and bearded seals, and bowhead, gray, or beluga whales. Additionally, continued Northstar operations will cause no unmitigable adverse impacts on the availability of these species for subsistence uses in arctic waters. Accordingly, BP Exploration (Alaska) Inc. requests that NMFS issue a letter of authorization allowing potential taking of small numbers of seals and whales incidental to the continued production (and ancillary) activities of the Northstar offshore oil and gas development in arctic waters of the United States in 2005 and subsequent years.

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