Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales *(Balaena mysticetus)*, Fin Whales (*Balaenoptera physalus)*, and Humpback Whales (*Megaptera novaeangliae)*

Prepared in Accordance with Section 7 of the Endangered Species Act of the United States of 1973, as amended

Minerals Management Service
Alaska OCS Region

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I. INTRODUCTION AND CONSULTATION BACKGROUND

The Minerals Management Service (MMS) of the Department of the Interior manages the Nation's natural gas, oil, and other mineral resources on the outer continental shelf (OCS). Endangered whales under the jurisdiction of the National Marine Fisheries Service (NMFS) occur seasonally in waters within and adjacent to the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas and may be exposed to oil- and gas-related exploration, development, and production activities that may occur in those areas. Oil- and gas-related activities in the Beaufort Sea and Chukchi Sea OCS could adversely affect such species occurring in or adjacent to these areas due to noise and disturbance, altered habitat, and spilled oil or other contaminants (such as discharges of drilling muds and cuttings) resulting from those activities. The MMS assumes that crude oil would not be released during exploration activities, but acknowledges that oil spills potentially could occur during development/production activities.

Congress enacted the Endangered Species Act (ESA) "…to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved" and "to provide a program for the conservation of such…species." To achieve this general goal, Congress specified the responsibilities of Federal Agencies prior to taking actions that might affect threatened or endangered species. Section 7(a)(2) of the ESA specifies:

> Each federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded or carried out by such agency is not likely to jeopardize the continued existence of any endangered species and threatened species or result in the destruction or adverse modification of habitat of such species which is determined…to be critical, unless such agency has been granted an exemption for such action…pursuant to subsection (h) of this chapter.

As part of such consultation, Federal Agencies proposing an action in an area are required to clarify whether and what listed, proposed, and candidate species or designated or proposed critical habitats may be in the action area. The action area is defined as "all areas to be affected directly or indirectly by Federal action and not merely the immediate area involved in the action [50 CFR §402.02]."

If it is determined that listed, proposed, and candidate species or designated or proposed critical habitat may be in the action area, the Federal Agency proposing the action is required to identify what endangered species or threatened species are likely to be affected by the Proposed Action and to help make the determination of whether or not the Proposed Action is "likely to adversely affect" listed species and/or critical habitat.

Consultation Background. Pursuant to requirements under the ESA of 1973, as amended, MMS has previously consulted with the NMFS on potential effects of oil and gas leasing and exploration in the Arctic, including activities in the Beaufort Sea and Chukchi Sea Planning Areas. Between 1980 and 1987, inclusive, MMS and NMFS repeatedly consulted on lease sales in the Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas. Between 1982 and 1987, inclusive, NMFS issued seven Biological Opinions related to OCS lease sales. The conclusions in these opinions varied over time, as additional information became available.

In 1987, MMS requested reinitiation of consultation and amendment of the opinions, where appropriate. In November 1988, the NMFS prepared the Arctic Regional Biological Opinion (ARBO), which concerned leasing and exploration activities in the Arctic Region (Beaufort Sea, Chukchi Sea, and Hope Basin OCS Planning Areas). This 1988 opinion is the most recent opinion that includes proposed oil and gas activities in the Chukchi Sea OCS Planning Area. In this opinion, NMFS concluded that: "Although we have concluded that foreseeable exploration activities are not likely to jeopardize the bowhead or gray whales, NOAA Fisheries is concerned about the potential additive effects of oil and noise from OCS activities in the Arctic Region…."

The NMFS urged MMS to continue studies on the effects of OCS activities on endangered species, so that the necessary information would be available for future consultations. They also provided conservation recommendations.

In the 1988 Biological Opinion, in addition to providing its opinion on the incremental step of leasing and exploration, NMFS provided its views on the entire action, including development and production. The NMFS wrote:

> Under 50 CFR Section 402.14(k) of the Section 7 regulations, there must be a reasonable likelihood that the entire action will not violate Section 7 (a)(2) of the ESA for the Federal agency to proceed with the incremental step. Based on currently available information and technology and the absence of effective mitigating measures, we believe that development and production activities in the spring lead system used by bowhead whales for their migration would be likely to jeopardize the population….

The NMFS provided reasonable and prudent alternatives to the action that MMS could adopt to avoid jeopardy:

> We believe that either (1) the lease blocks within 25 miles of the nearshore lead system should be deferred from the lease sale [for example see the Coastal Deferral Alternative VI (MMS, 1987a) for Lease Sale 109 and the Barrow Deferral Area identified by MMS during consultation for Lease Sale 97] or, (2) if these blocks are leased, development and production activities should not be approved unless and until further consultation results in a no jeopardy conclusion or a reasonable and prudent alternative is developed and adopted that would avoid jeopardy….

In the Beaufort Sea, MMS also previously consulted on Beaufort Sea Planning Area Oil and Gas Lease Sales 144 and 170. The NMFS stated that conclusions and recommendations contained in the 1988 ARBO were applicable to Sales 144 and 170, and they concluded that leasing and exploration activities were not likely to jeopardize the continued existence of endangered whales.

Because of the removal of the gray whale from the list of threatened and endangered species, the availability of new information on the potential impacts of oil and gas-related noise on bowhead whales, the use of new seismic survey technology in the Arctic, and trends in OCS activities in the Arctic Region, MMS proposed to reinitiate consultation with NMFS on November 2, 1999. Due to lack of industry interest in the Chukchi Sea and Hope Basin Planning Areas at that time MMS proposed, and NMFS agreed, to limit the reinitiated consultation to leasing and exploration activities only in the Beaufort Sea Planning Area. A revised Biological Opinion for Oil and Gas Leasing and Exploration Activities in the Beaufort Sea was issued May 25, 2001. This opinion stated that: "Present and foreseeable future oil and gas exploration activities on the Alaskan OCS are likely to occur only in the Beaufort Sea."

Because of this assumption, which was based on the best information available at the time, the action area for NMFS's May 2001 Biological Opinion was defined as the Alaskan Beaufort Sea Planning Area, extending from the Canadian border to the Barrow area. The 2001 Biological Opinion concluded that oil and gas leasing and exploration in the Beaufort Sea is not likely to jeopardize the continued existence of bowhead whales.

In 2002, MMS consulted with NMFS on Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202, including leasing and exploration activities associated with the sales. The NMFS confirmed the bowhead whale as the species under their jurisdiction to be included in MMS's biological evaluation. The NMFS also indicated that separate consultations were under way, or would be initiated, regarding the effects of the Trans-Alaska Pipeline System (TAPS) and the marine transport of oil from the terminal at Valdez. They confirmed that MMS did not need to consult on listed species and critical habitat along the pipeline or out of Valdez.

The MMS requested that NMFS uphold the Biological Opinion issued in May 2001 concerning Beaufort Sea oil and gas leasing and exploration activities (the ARBO) for proposed Lease Sales 186, 195, and 202.

To assist NMFS in its consideration of this request, MMS submitted to NMFS the draft environmental impact statement (EIS) for Lease Sales 186, 195, and 202 (the Beaufort Sea multiple-sale EIS), which contained MMS's Biological Evaluation of the Proposed Action on bowhead whales.

In a letter dated July 23, 2002, NMFS concluded that:

> We find the May 2001 opinion addresses these sales, in terms of the listed species and habitats present, the legal status of these species under the ESA having been unchanged, the anticipated actions associated with these sales being consistent with those actions considered in the opinion, and the sale area being consistent with that previously assessed. We also affirm that the…opinion supercedes all existing biological opinions for leasing and associated exploration activities in the Beaufort Sea Planning Area. We have not applied this conclusion to Sales 195 and 202 at this time however, as the logic which MMS has used in determining the need for supplemental analysis under NEPA for these sales would also apply to ESA consultation. The applicability of the…opinion will be reconsidered prior to these subsequent sales.

After reviewing available information, MMS requested by letter dated December 10, 2003, that NMFS concur that the conclusions, conservation recommendation, and all other sections of the May 25, 2001, Biological Opinion for oil and gas leasing in the Beaufort Sea apply to proposed Lease Sale 195 and were valid for inclusion in the Environmental Assessment (EA) for the sale. The MMS also requested concurrence on ESA-listed species that might occur within or near the lease-sale area. In a letter dated March 8, 2004, NMFS reiterated the positions they had previously stated that they did not apply their conclusion about the applicability of the 2001 opinion to Sale 195, as the need for supplemental analysis under the National Environmental Policy Act (NEPA) for that proposed sale would also extend to ESA consultation. The NMFS stated that they would provide further comment on the applicability of the May 2001 opinion and the need for further consultation, pending their review of the EA prepared for the sale. In an email dated March 26, 2004 (Smith, 2004, pers. commun.), NMFS informed MMS that:

> There have been no additions or changes to ESA-listed species or critical habitat for which the USDOC bears responsibility within the project area of Sale 195 since publication of the 2001 Regional Opinion. The bowhead whale remains the only such species likely to occur within the U.S. Beaufort Sea, and no critical habitat has been designated for this species.

The MMS prepared a Biological Evaluation for consultation with NMFS regarding Beaufort Sea Lease Sale 195 and sent this to NMFS on June 9, 2004, for their consideration of the applicability of the 2001 Biological Opinion to Sale 195. By letter dated June 28, 2004, NMFS responded that, after review of the document and other information, they believed that the 2001 opinion continued to reflect the best available scientific information and is not inconsistent with findings from applicable research that has occurred since 2001. The NMFS concluded that the conclusions and recommendations within the 2001 opinion remain appropriate and applicable. They reaffirmed that that the May 2001 opinion supercedes all others for leasing and associated exploration activities in the Beaufort Sea Planning Area. This correspondence contains the most recent opinion from NMFS regarding the potential effects of OCS oil and gas leasing in the Alaska Beaufort Sea Planning Area.

Due to industry response to MMS' recent Beaufort Sea lease sales and call for information and nominations in the Chukchi Sea, and based on discussions with industry, MMS realized that the aforementioned assumption that present and foreseeable oil and gas exploration activities on the Alaskan OCS are likely to occur only in the Beaufort Sea is no longer valid. Therefore, by letter of August 12, 2005, MMS informed NMFS that MMS expected to reinitiate consultation with NMFS on leasing and exploration activities that could occur within the entire Beaufort Sea Planning Area and within the Chukchi Sea Program Area, as delineated in the final EIS for MMS' current 5-Year OCS Leasing Program. The current 5-Year Leasing Program excludes the nearshore polynya area from leasing consideration in the Chukchi Sea.

The MMS notified NMFS that due to wording in the 1988 ARBO and, in some cases, other information suggesting the possible occurrence of other listed species in areas within or near these two planning areas, and with NMFS' concurrence, MMS expected to include five species of cetaceans (bowhead, fin, humpback, right, and sei whales) in the Biological Evaluation. However, MMS noted that, based on previous correspondence with NMFS on this issue and based on its review of available information, MMS was aware of only one listed species, the endangered bowhead whale, that commonly occurs in these two planning areas. The MMS noted that it was not aware of any designated or proposed critical habitat for any species that is under the jurisdiction of NMFS and that occurs within, near, or that could potentially be affected by leasing or exploration activities within the Beaufort Sea or Chukchi Sea.

By letter of September 30, 2005, NMFS notified MMS that bowhead whales are found in the Alaskan Beaufort Sea and Chukchi Sea OCS Areas and that humpback whales and fin whales, found in waters of the Chukchi Sea and Bering Sea outside of these two planning areas, could be impacted secondarily by OCS activities. The NMFS recommended their inclusion in MMS's assessment of OCS activities on ESA-listed species.

Based on the aforementioned correspondence and considerations, MMS has prepared this Biological Evaluation under Section 7 of the ESA to assist NMFS in preparation of their Biological Opinion as to whether the proposed oil and gas leasing and exploration activities are likely to jeopardize the continued existence of endangered bowhead, fin, and humpback whales that may be affected by oil and gas activities within the Beaufort Sea and Chukchi Sea Planning Areas (see Figure 1).

In this Biological Evaluation, we evaluate potential impacts on bowhead, fin, and humpback whales that could occur due to oil and gas leasing and pre- and postlease exploration activities in the Beaufort Sea and Chukchi Sea Planning Areas that may reasonably be expected to occur over the next 5 years. We also provide information about potential impacts of oil and gas development, production, and abandonment in these two areas to allow NMFS to make its determination as to whether the entire action will violate Section 7(a)(2) of the ESA and, thus, whether MMS can proceed with the incremental step of leasing and pre- and post-leasing exploration activities.

This Biological Evaluation includes all information on bowhead whales, and the potential effects of the proposed actions on this species, that was contained within our 2002 multiple sale EIS for the Beaufort Sea (USDOI, MMS, 2003a), EA for proposed Sale 195 (USDOI, MMS, 2004), and the Biological Evaluation we prepared for consultation for Sale 195 (USDOI, MMS, 2004:Appendix C). However, in this evaluation, MMS has summarized and updated relevant information about reasonably foreseeable, existing, and past activities in the Beaufort Sea as well as included information about activities that could occur within the Chukchi Sea Planning Area. We also have summarized and updated relevant and available information on the bowhead whale and potential effects and cumulative effects on this species. Thus, this evaluation brings together both the new information on bowhead biology and potential effects that has become available since the writing of the 195 EA, the information provided in the Sale 195 EA and Biological Evaluation, and much of that provided previously in the Beaufort Sea multiple-sale final EIS. It provides a complete, single source for evaluation of the potential effects of the oil and gas leasing and exploration in these OCS planning areas on the bowhead whales. This document also evaluates whether the humpback and the fin whale could be adversely affected by oil and gas leasing and exploration that occurred within the Beaufort Sea and Chukchi Sea Planning Areas.

Appendix I of this Biological Evaluation contains copies of the primary consultation communications to date.

The analyses contained in this Biological Evaluation are based on assumptions about exploration and development scenarios presented in Section II. The reader is referred to this section for a discussion of assumptions MMS has made about seismic survey activities, exploratory drilling, resource-recovery rates and quantities, timing of infrastructure development, platform emplacement, wells that may be drilled, resource production timeframes, and other information about oil and gas activities that represent our best evaluation about what activities may occur.

In the following sections, we provide the following information:

- a description of reasonably foreseeable oil and gas activities in the Beaufort Sea and Chukchi Sea OCS Planning Areas;
- available information on aspects of the biology, population ecology, history, regulatory history, etc., of the bowhead whale that facilitates assessing potential effects of the Proposed Action on this listed species;
- an analysis of the potential effects of the action on the bowhead whale based on biological studies, review of the literature, and the views of species and subject matter experts; and
- an environmental baseline and potential cumulative effects on the species.

Guidance for the content of this section was taken from the *Endangered Species Handbook* (USDOI, Fish and Wildlife Service [FWS], and NMFS, 1998) and from 50 CFR Section 402.12.

II. INFORMATION ABOUT LISTED SPECIES THAT MAY BEAFFECTED BY THE PROPOSED ACTION IN THE ALASKAN BEAUFORT SEA AND CHUKCHI SEA PLANNING AREAS

II.A. Background.

Section 3(15) of the ESA, as amended, states: "(T)he term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment of any vertebrate fish or wildlife which interbreeds when mature" (16 U.S.C. § 1532). Thus, under the ESA, distinct population segments and subspecies are included along with biological species in the definition of "species," and such entities can be listed separately from other subspecies and/or distinct population segments of the same biological species.

Based on the best available information, and on the guidance provided by the NMFS in their letter of September 30, 2005, there are three species of cetaceans that are listed as endangered under the ESA that can occur within or near one or both of the Beaufort Sea and Chukchi Sea OCS Planning Areas or that could potentially be affected secondarily by activities within these planning areas. The common and scientific names of these species are:

Bowhead whales (*Balaena mysticetus*)
Fin whales (*Balaenoptera physalus*)
Humpback whales (*Megaptera novaeangliae*)

These are the species we have included in this Biological Evaluation. There is no designated critical habitat for any species for which NMFS has jurisdiction that potentially could be affected by these Proposed Actions.

The MMS also informed NMFS that during an informal discussion following a public meeting in January 2006 in Point Hope, Alaska, MMS staff were told by an Alaskan Native whale hunter that a right whale had been harvested relatively recently. The MMS has contacted NMFS protected resources staff regarding this communication, and the agencies will follow up with the hunter to see if additional information is available. We expect to keep NMFS updated on any additional information regarding the potential presence of right whales in the Chukchi Sea, and we will follow NMFS' guidance regarding whether we should evaluate the potential for this species to be affected by the Proposed Action. We are unaware of other information that indicates that right whales occur in areas that could be affected.

In the following pages, we also refer to and discuss specific "population stocks" of threatened and endangered marine mammal species. The Marine Mammal Protection Act (MMPA) mandates management of marine mammal population stocks. Under Section 3 of the MMPA, the "…term 'population stock' or 'stock' means a group of marine mammals of the same species, or smaller taxa in a common spatial arrangement, that interbreed when mature" (16 U.S.C. § 1362 (11)). "Population stock" (usually referred to simply as "stock") designations of many groups of marine mammals have changed over the past two decades, in large part due to focused efforts to define the stocks coupled with the availability of relatively new tools with which to examine patterns of genetic variability from the field of molecular genetics. Thus, because of new information, many species of marine mammals that were formerly treated as if comprised of only a single stock, now may be subdivided into multiple stocks, or there may be discussion of whether multiple stocks exist. In the cases of marine mammals for which separate stocks have been delineated, we focus our description and evaluation of potential effects on those stocks that may occur within or near the Beaufort Sea or Chukchi Sea Planning Area. However, we bring in information on the biological species as a whole if it enhances the understanding of the relevant stock(s) or aids in evaluation of the significance of any potential effects on the stock that occurs within or near these areas.

Because it is clear both from the aforementioned September 30, 2005, letter to MMS from NMFS and from our own review that the bowhead is the species most likely to be impacted by oil and gas activities in the Beaufort Sea and Chukchi Sea Planning Areas, we provide more detail on this species than on fin or humpback whales. Because of their distribution, effects on the other two endangered whale species are limited to potential far-field effects, including oil spills. However, while we provide considerable detail about bowhead whales to NMFS sufficient to enable evaluation of our conclusions, we have tried to ensure that key facts, assumptions, and uncertainties are not lost by highlighting these in portions of the text and through the use of summaries.

II.B. Summary of Important Pertinent Information about Listed Species that Underlies our Analyses.

II.B.1. Bowhead Whales. There is one ESA-listed species under the jurisdiction of the NMFS, the bowhead whale, which regularly seasonally occurs within multiple areas of both the Chukchi Sea and Beaufort Sea OCS Planning Areas and which occurs in areas that could be impacted from far-field (e.g., oil spill) events. This population stock of bowheads is the most robust and viable of surviving bowhead populations and, thus, its viability is critical to the long-term future of the biological species as a whole. There is scientific uncertainty about the population structure of bowheads that use the Beaufort and Chukchi Seas. Data indicate that what is currently referred to as the Western Arctic stock (by NMFS) or as the Bering-Chukchi-Beaufort (BCB) Seas stock (by the International Whaling Commission [IWC]) of bowheads is increasing in abundance and has increased in abundance substantially since the last ESA consultation between MMS and NMFS involving the Chukchi Sea Planning Area (see Figure 2). There are scientific analyses indicating that BCB Seas bowheads may have reached or are approaching, the lower limit of their historic population size. There are related analyses supporting their removal from the list of threatened and endangered species. The cause of the historic decline of this species was overharvesting by commercial whalers. The primary known current human-related cause of mortality is a regulated subsistence hunt by Alaskan Natives. Conservation concerns include: the introduction of noise and related disturbance from existing, but especially potential future, oil and gas activities, shipping, other vessel traffic, and hunting in calving, migration, and feeding areas; contamination of their habitat by pollutants from planned and potential future oil and gas activity and by other local and distant pollution sources; uncertain potential impacts of climate warming; vessel strikes; and entanglement. No data are available indicating that, other than historic commercial whaling, any previous human activity has had a significant adverse impact on the current status of BCB Seas bowheads or their recovery. The uncertainty of the stock structure adds some uncertainty to summaries of the status of bowheads that may be impacted by the proposed action. Currently available information indicates that bowheads that use the Alaskan Beaufort Sea and Chukchi Sea Planning Areas are resilient at least to the level of human-caused mortality and disturbance that currently exists, and has existed since the cessation of commercial whaling, within their range. Data indicate that at least some bowheads are extremely long-lived (100+ years or more), and this longevity can affect the potential for a given individual to be exposed to a high number of disturbance and pollution events in its lifetime. Within or near areas where the proposed actions could occur, geographic areas of particular importance to this stock include the areas of the spring lead system in both the Chukchi and Beaufort Seas and areas that are used for feeding by large numbers of individuals in some years, but not in all years. Available information indicates that most or much of the total calving of the bowheads, which comprise most of the bowhead whales in the world, occurs during the spring migration in, and adjacent to, especially the eastern Chukchi Sea and also the Beaufort Sea spring lead systems. Features of its biology that particularly influence potential effects on this species from the proposed action are its dependence on the lead system as its migratory pathway between wintering and summering grounds and its extreme longevity. Recent data to evaluate bowhead use of the Chukchi Sea OCS Planning Area, or adjacent areas to the south, are lacking.

II.B.2. Fin whales. Fin whales may occur seasonally in the southwestern Chukchi Sea, north of the Bering Strait along the coast of Chukotka. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea along the Asian coast. This species' current use of parts of its range is probably modified due to serious population reduction during commercial hunting. However, there is no indication that fin whales typically occur within the Chukchi Sea Planning Area or in areas directly adjacent to that area, or that they will tend to occur there even if full population recovery occurs. There have been only rare observations of fin whales into the eastern half of the Chukchi Sea. Data indicate they do not typically occur in the northeast Chukchi Sea and this species has not been observed in the Alaskan Beaufort Sea. The NMFS has concluded that there is no reliable information about population abundance trends, and that reliable estimates of current or historical abundance are not available, for the entire Northeast Pacific fin whale stock. Fin whales are a widely distributed species. Ranges of population estimates from the 1970's for the entire North Pacific are 14,620-18,630 (Ohsumi and Wada, 1974). There are no recent data to confirm their lack of use of the Chukchi Sea Planning Area, or adjacent areas to the south.

II.B.3. Humpback whales. The northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback whale. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea. Historically, large numbers of humpbacks were seen feeding near Cape Dezhnev. Humpback whale use of portions of their range also has been influenced by their severe population reduction due to historic commercial hunting. Available information does not indicate humpback whales inhabit the Chukchi Sea or Beaufort Sea Planning Areas. There are no recent data to confirm their lack of use of the Chukchi Sea Planning Area, or adjacent areas to the south.

II.C. Bowhead Whale.

II.C.1. Introduction. Information provided in this section provides, updates and, in some cases, summarizes information from the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), the Biological Evaluation for Lease Sale 195, and the EA for Lease Sale 195 (USDOI, MMS, 2004) and supplements this information with more recent information on the Western Arctic stock of the bowhead whale. All available information is considered in our update of our analyses of the potential effects of the Proposed Action on bowhead whales. Additionally, we provide an update of baseline information and information related to evaluating potential cumulative anthropogenic impacts on this population, as defined under the ESA. As noted in the beginning of this document, we incorporate by reference all information provided previously in the Beaufort Sea multiple-sale final EIS, which provided a detailed evaluation of the bowhead whale and its habitat, the potential effects of three lease sales in the Beaufort Sea Planning Area and related activities on this stock of whales, and an evaluation of cumulative effects on this population stock.

The NMFS issued their *Biological Opinion on Issuance of Annual Quotas Authorizing the Harvest of Bowhead Whales to the Alaska Eskimo Whaling Commission for the Period 2003 through 2007* (NMFS, 2003a). Relatedly, in February 2003 the NMFS published the *Final Environmental Assessment for Issuing Subsistence Quotas to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2003 through 2007* (NMFS, 2003b). The NOAA and the North Slope Borough (NSB) convened the first Workshop on Bowhead Whale Stock Structure Studies in the Bering-Chukchi-Beaufort Seas: 2005-2006 (USDOC, NOAA and NSB, 2005). The second meeting of this group is scheduled for spring 2006. The Scientific Committee of the IWC reviewed and critically evaluated new information available on the bowhead whale at their 2003 and 2005 meetings (IWC, 2003a, 2005a,b) and conducted an in-depth status assessment of this population in 2004 (IWC, 2004a,b). The MMS published *Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2002-2004* (Monnett and Treacy, 2005). The *Final 2003 Alaska Marine Mammal Stock Assessment* (Angliss and Lodge, 2003) for this stock remains the most recent finalized stock assessment available, as no stock assessment was finalized in 2004. There is a revised draft stock assessment for 2005 available for this population (Angliss and Outlaw, 2005). The NMFS published the *Notice of Determination - Endangered and Threatened Species; Final Determination on a Petition to Designate Critical Habitat for the Bering Sea Stock of Bowhead Whales* (67 *FR* 55767). Details on bowheads that might lie outside the scope of the material provided here, in our multiple-sale EIS, or in our EA for proposed Lease Sale 195, may be provided in one or more of these documents. We have reviewed and considered information in these documents and other available information in our evaluation of potential environmental impacts.

II.C.2. ESA Listing History, Current Status, and Possible Delisting of the Western Arctic Stock of Bowhead Whale. The bowhead whale was listed as endangered on June 2, 1970. No critical habitat has been designated for the species. The NMFS received a petition on February 22, 2000, requesting that portions of the U.S. Beaufort and Chukchi Seas be designated as critical habitat for the Western Arctic stock (Bering Sea stock) of bowhead whales. On August 30, 2002, the NMFS made a determination not to designate critical habitat for this population of bowheads (67 *FR* 55767) because: (1) the population decline was due to overexploitation by commercial whaling, and habitat issues were not a factor in the decline; (2) the population is abundant and increasing; (3) there is no indication that habitat degradation is having any negative impact on the increasing population; and (4) existing laws and practices adequately protect the species and its habitat.

All available information (e.g., Shelden et al., 2001; IWC, 2004a,b, 2005a,b; NMFS, 2003a,b); indicates that the BCB Seas population of bowheads is increasing, resilient to the level of mortality and other adverse effects that are currently occurring due to the subsistence hunt or other causes, and may have reached the lower limit of the estimate of the population size that existed prior to intensive commercial whaling.

Shelden et al. (2001) proposed that the bowhead whale species should be listed under the ESA as five distinct population segments, based on the distinct population segment definition developed by the NMFS and FWS in 1996. The five separate stocks of bowhead whales are the Bering Sea stock (referred to in IWC documents as the BCB Seas bowhead and as the Western Arctic stock in the NMFS's Alaska Marine Mammal stock assessments), the Spitsbergen stock, the Davis Strait stock, the Hudson Bay stock, and the Okhotsk stock. Shelden et al. (2001) evaluated each proposed distinct population segment to determine whether one or more should be reclassified. The authors presented two models to evaluate the status of bowhead whale stocks, one that they developed based on World Conservation Union criterion D1 and E (World Conservation Union, 1996, as referenced in Shelden et al., 2001), and a model developed by Gerber and DeMaster (1999) for ESA classification of North Pacific humpback whales. Under each of these classification systems, the authors determined that the Bering Sea population of bowhead whales should be delisted, whereas the other four populations of bowheads should continue to be listed as endangered (see also criticism of this determination by Taylor, [2003], the response of Shelden et al. [2003] and discussion by the IWC's Scientific Committee [IWC, 2003a]).

II.C.3. Bowhead Population Structure and Current Stock Definitions. The IWC currently recognizes five stocks of bowheads for management purposes (IWC, 1992), with one of them being the BCB Seas stock. The BCB Seas bowheads are the largest of all surviving bowhead populations and the only stock to inhabit U.S. waters. All of the stocks except for the BCB Seas bowhead stock are "comprised of only a few tens to a few hundreds of individuals" (Angliss and Outlaw, 2005:209). Thus, the BCB Seas bowheads are the most robust and viable of surviving bowhead populations. **The viability of bowheads in the BCB Seas stock is critical to the long-term future of the biological species as a whole**.

The Scientific Committee of the IWC previously concluded that the BCB Seas bowheads comprise a single stock (DeMaster et al., 2000, as cited in IWC, 2003a). However, after an in-depth evaluation of available data, the Scientific Committee (IWC, 2004a) concluded that there is temporal and spatial heterogeneity among these bowheads, but analyses do not necessarily imply the existence of subpopulations with limited interbreeding; it was premature to draw conclusions about the relative plausibility of any hypotheses about stock structure or to reject any of them. Subsequently, "The Bowhead Group" (USDOC, NOAA and NSB, 2005) created a set of five stock-structure hypotheses, modified this set, and currently recommends testing of the following hypotheses: (1) one stock of BCB Seas bowheads as described and previously accepted by the IWC (Rugh et al., 2003); (2) one stock with generational gene shift; (3) temporal migration—there are two stocks and two putative wintering area, with the two stocks migrating separately in the spring but together in the fall; (4) segregation of stocks; spatial segregation of stocks; and (5) Chukchi Circuit—one population migrates from the Bering Sea to the Beaufort Sea in spring and back again in the fall, whereas the second leaves the Bering Sea, heads northwest along the Chukotka coast, heads towards the Barrow Canyon and then back to the Bering Sea (see USDOC, NOAA and NSB, 2005 for detailed descriptions and discussions). After more recent information provided to the IWC Subcommittee on Bowhead, Right and Gray Whales (IWC, 2005b), the subcommittee agree that what is termed the "Oslo Bump" (a significant increase in genetic difference between pairs of whales sampled approximately 1 week apart at Barrow during the fall migration) appears to be a real pattern within the data that are available. However, additional data are needed to determine if these data actually typify the bowhead population, and there is no single hypothesis adequate to explain the pattern. **Stock structure is unclear at the time of writing of this Biological Evaluation** (see IWC, 2004b, 2005a,b; USDOC, NOAA and NSB, 2005 for detailed descriptions and discussions). The IWC will be conducting an Implementation Review focusing on the stock structure of the BCB Seas bowhead with the goal of completing this at the 2007 annual meeting (IWC, 2005a). Two related intersessional workshops, one that occurred in 2005 and one that will occur in spring 2006, are focusing on this topic (IWC, 2005a,b).

The uncertainty about the stock structure of bowheads that inhabit the Chukchi and Beaufort seas adds uncertainty to the analysis of potential effects. It is not currently clear whether one or more population stocks of bowheads potentially could be impacted by the proposed activities. If more than one population may be affected, it may be that the areas in which the two stocks are likely to be vulnerable to adverse effects varies. If there is more than one stock, it is not clear what the estimated population sizes of the potentially affected population stocks are.

II.C.4. Bowhead Past and Current Population Abundance. Woody and Botkin (1993) estimated that the historic population abundance of bowheads in the Western Arctic stock was between 10,400 and 23,000 whales in 1848 before the advent of commercial whaling, which severely depleted bowhead whales. They estimated that between 1,000 and 3,000 animals remained in 1914 near the end of the commercial-whaling period.

Based on both survey data and the incorporation of acoustic data, the abundance of the Western Arctic stock of bowhead whales was estimated between 7,200 and 9,400 individuals in 1993 (Zeh, Raftery, and Schaffner, 1995), with 8,200 as the best population estimate. This estimate was recently revised by Zeh and Punt (2004) to 8,167 (CV= 0.017) and is the estimate used by the NMFS in their draft 2005 stock assessment (Angliss and Outlaw, 2005). An alternative method produced an estimate of 7,800 individuals, with a 95% confidence interval of 6,800-8,900 individuals. Data indicate that the Western Arctic stock increased at an estimated rate of about 3.1% (Raftery, Zeh, and Givens, 1995) to 3.2% (Zeh, Raftery, and Schaffner, 1995) per year from 1978-1993. The estimated increase in the estimated population size most likely is due to a combination of improved data and better censusing techniques, along with an actual increase in the population.

George et al. (2004) estimated abundance in 2001 to be 10,470 (SE = 1,351) with a 95% confidence interval of 8,100-13,500. This estimate indicates a substantial increase in population abundance since 1993 and suggests that population abundance may have reached the lower limits of the historical population estimate. Zeh and Punt (2004, cited in Angliss and Outlaw, 2005) provided a slightly revised population estimate of 10,545 CV(N) =0,128 to the IWC in 2004. George et al. (2004) estimated that the annual rate of increase (ROI) of the population from 1978-2001 was 3.4% (95% CI 1.7%-5%) and Brandon and Wade (2004) estimate an ROI of 3.5% (95% CI 2.2-4.9%). The number of calves (121) counted in 2001 was the highest ever recorded for this population and this fact, when coupled with the estimated rate of increase, suggests a steady recovery of this population (George et al., 2004). This steady recovery is likely due to low anthropogenic mortality, a relatively pristine habitat, and a well-managed subsistence hunt (George et al., 2004).

II.C.5. Bowhead Reproduction, Survival and Non-Human Sources of Mortality. Information gained from the various approaches at aging BCB Seas bowhead whales and estimating survival rates all suggest that **bowheads are slow-growing, late-maturing, long-lived animals with survival rates that are**

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

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

Discussion during the in-depth assessment by the IWC (2004b) also indicated that differences in lipid content between females of the same length and size are attributable to pregnant versus nonpregnant females. This may imply a high biological cost of reproduction, a fact noteworthy in considering the potential impact of excluding females from feeding areas. George et al. (2004, cited in IWC, 2004b) estimated pregnancy rates of 0.333/year and an estimated interbirth interval of 3.0 years using data from postmortem examinations of whales landed at Barrow and Kaktovik in the winter.

There is little information regarding causes of natural mortality for BCB Seas bowhead whales. Bowhead whales have no known predators except, perhaps, killer whales and subsistence whalers. The frequency of attacks by killer whales probably is low (George et al., 1994). A relatively small number of whales likely die as a result of entrapment in ice (Philo et al., 1993). Little is known about the effects of microbial or viral agents on natural mortality.

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

Using aerial photographs of naturally marked bowheads collected between 1981 and 1998, Zeh et al. (2002:832) estimated "the posterior mean for bowhead survival rate…is 0.984, and 95% of the posterior probability lies between 0.948 and 1." They noted that a high estimated survival rate is consistent with other bowhead life-history data.

II.C.6. Migration, Distribution, and Habitat Use. As available information permits, we provide detailed summary and discussion about the migration, distribution, and habitat use of bowheads to provide insight into areas where bowheads might be exposed to oil- and gas-related activities, when they might be exposed, and what the significance of their exposure in certain geographic areas might be relative to that in other areas. We include information, as available, about female with calves. This aids our evaluation of potential effects and informs potential mitigations of effects.

The BCB Seas bowheads generally occur north of 60° N. and south of 75° N. (Angliss and Outlaw, 2005) in the Bering, Chukchi, and Beaufort seas. They have an affinity for ice and are associated with relatively heavy ice cover and shallow continental shelf waters for much of the year.

II.C.6.a. Winter and Other Use of the Bering Sea. Bowhead whales of the BCB Seas stock overwinter in the central and western Bering Sea. Most mating probably occurs in the Bering Sea. The amount of feeding in the Bering Sea in the winter is unknown as is the amount of feeding in the Bering Strait in the fall (Richardson and Thomson, 2002). In the Bering Sea, bowheads frequent the marginal ice zone, regardless of where the zone is, and polynyas. Important winter areas in the Bering Sea include polynyas along the northern Gulf of Anadyr, south of St. Matthew Island, and near St. Lawrence Island. Bowheads congregate in these polynyas before migrating (Moore and Reeves, 1993).

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

During their southward migration in the autumn, bowheads pass through the Bering Strait in late October through early November on their way to overwintering areas in the Bering Sea. Large numbers of bowheads were taken in June and July during commercial whaling over large portions of the northwestern and northcentral Bering Sea (Figure 1b in Dahlheim et al., 1980, from Townsend, 1935).

II.C.6.b. Spring Migration. Some, or nearly all (see stock discussion above), of the bowheads that winter in the Bering Sea migrate northward through the Bering Strait to the Chukchi Sea and through the Alaskan Beaufort Sea to summer feeding grounds in the Canadian Beaufort Sea. The bowhead northward spring migration appears to coincide with ice breakup and probably begins most years in April (possibly late March depending on ice conditions) and early May. It is thought to occur after the peak of breeding, which is believed to occur in March-April (C. George, cited in IWC, 2004b).

Bowheads congregate in the polynyas before migrating (Moore and Reeves, 1993; Mel'nikov, Zelensky, and Ainana, 1997). Large numbers of bowheads were taken in June and July during commercial whaling over large portions of the northwestern and northcentral Bering Sea (Figure 1b in Dahlheim et al., 1980, from Townsend, 1935). Bowheads migrate up both the eastern and western sides of the Bering Strait in the spring (Mel'nikov, Zelensky, and Ainana, 1997; Mel'nikov et al., 2004). They pass through the Bering Strait and eastern Chukchi Sea from late March to mid-June through newly opened leads in the shear zone between the shorefast ice and the offshore pack ice. During spring aerial surveys in the late 1980's, bowheads were documented to be migrating in shorefast leads and polynyas up the coast of northwestern Alaska (see Figures 4 and 5 in Mel'nikov, Zelensky, and Ainana, 1997).

Based on shore-based surveys in 1999-2001, Mel'nikov et al. (2004) observed that the start of spring migration from the Gulf of Anadyr varies between cold and mild years by up to 30 days, but in both instances, continues at least until June 20. Mel'nikov et al. (2004) also reported that weather influenced migration, with migration seeming to stop when there were storms or high winds in the western Bering Strait or at the exit from the Gulf of Anadyr.

The migration past Barrow takes place in pulses in some years (e.g., in 2004) but not in others (e.g., 2003) (Koski et al., 2004, cited in IWC, 2004b). At Barrow, the first migratory pulse is typically dominated by juveniles. This pattern gradually reverses and by the end of the migration, there are almost no juveniles. Currently, the whales are first seen at Barrow around April 9-10. In later May (May 15-June), large whales and cow/calf pairs are seen (H. Brower, in USDOC, NOAA and NSB, 2005; IWC, 2004b). Koski et al.

(2004b) found that **females and calves constituted 31-68% of the total number of whales seen during the last few days of the migration. Their rate of spring migration was slower and more circuitous than other bowheads.** Calves had shorter dive duration, surface duration, and blow interval than their mothers. Calf blow rate was nearly 3 times that of their mothers. Most calving probably occurs in the Chukchi Sea. Some individuals or subset of the population may summer in the Chukchi Sea.

Several studies of acoustical and visual comparisons of the bowhead's spring migration off Barrow indicate that bowheads also may migrate under ice within several kilometers of the leads. Data from several observers indicate that bowheads migrate underneath ice and can break through ice 14-18 centimeters [cm] (5.5-7 inches [in]) thick to breathe (George et al., 1989; Clark, Ellison, and Beeman, 1986). Bowheads may use cues from ambient light and echoes from their calls to navigate under ice and to distinguish thin ice from multiyear floes (thick ice). After passing through Barrow from April through mid-June, they move easterly through or near offshore leads. East of Point Barrow, the lead systems divide into many branches that vary in location and extent from year to year. The spring-migration route is offshore of the barrier islands in the central Alaskan Beaufort Sea.

II.C.6.c. Summer. Bowheads arrive on their summer feeding grounds near Banks Island from mid-May through June (July: IWC, 2005b) and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September (Moore and Reeves, 1993). Bowhead whales are seen also in the central Chukchi Sea and along the Chukotka coast in July and August. They may occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore, 1992; USDOC, NOAA, and NSB, 2005), but it is unclear if these are "early-autumn" migrants or whales that have summered nearby (Moore et al., 1995) or elsewhere. Bowhead whales have been observed near Barrow in the mid-summer (e.g., Brower, as cited in USDOI, MMS, 1995). Eight bowheads were observed near Barrow on July 25, 1999, 2 at 71° 30' N., 155° 40'W. to 155° 54' W. from a helicopter during a search, and six at 71° 26' N., 156° 23' W. from the bridge of the icebreaker *Sir Wilfrid Laurier* (Moore and DeMaster, 2000). Moore and DeMaster (2000:61) noted that these observations are consistent with Russian scientist suggestions that "…Barrow Canyon is a focal feeding area for bowheads and that they 'move on' from there only when zooplankton concentrations disperse (Mel'nikov et al. 1998)" and consistent with the time frame of earlier observations summarized by Moore (1992.)

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

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

Recent systematic data about bowhead distribution and abundance in the Chukchi Sea OCS Planning Area are lacking. The MMS funded large-scale surveys in this area when there was oil and gas leasing and exploration, but while surveys in the Beaufort Sea have continued, the last surveys in the Chukchi Sea were about 15 years ago. These data were summarized by Mel'nikov, Zelensky, and Ainana (1997), Moore (1992), Moore and Clarke (1990), and Moore, DeMaster, and Dayton (2000). We have plotted counts of bowheads observed in the Chukchi Sea during those surveys (Figure 3), because they visually provide limited insight into areas where bowheads may be exposed to oil and gas activities should they occur in the Chukchi Sea Planning Area. However, we caution against over-interpretation of these data out of context of survey effort, because these data were collected between 1979 and 1991. They should not be interpreted as indicating current use of the Chukchi Sea by bowhead whales. However, they are the best data that are available.

Bowheads found in the Bering and Chukchi Seas in the summer may be part of the expanding Western Arctic stock (DeMaster et al., 2000, as referenced in Angliss, DeMaster, and Lopez, 2001).

Evidence indicates that the number of bowheads that inhabit the BCB Seas has increased substantially since the time of the surveys (Brandon and Wade, 2004, cited in IWC, 2004b). Temporal and spatial patterns of distribution also may be modified. Conversely, earlier information may have inferred less variability in distribution than actually existed.

II.C.6.d. Fall Habitat Use and Migration. Those bowheads that have been summer feeding in the Canadian Beaufort Sea begin moving westward into Alaskan waters in August and September. While few bowheads generally are seen in Alaskan waters until the major portion of the migration takes place (typically mid-September to mid-October), in some years bowheads are present in substantial numbers in early September (Greene and McLennan, 2001; Treacy, 1998). In 1997, Treacy (1998) reported sighting 170 bowheads, including 6 calves, between Cross Island and Kaktovik on September 3 during the first flight of the survey that year. In 1997, Treacy (1998) observed large numbers of bowheads between Barrow and Cape Halkett in mid-September. Large numbers were still present between Dease Inlet and Barrow in early October (although they may not have been the same individuals).

There is some indication that the fall migration, just as the spring migration, takes place in pulses or aggregations of whales (Moore and Reeves, 1993). Eskimo whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham et al., 1984, as reported in Moore and Reeves, 1993). During the autumn migration Koski and Miller (2004, cited in IWC, 2004b) found decreasing proportions of small whales and increasing proportions of large whales as one moved offshore. "Mothers and calves tended to avoid water depths less than (<) 20 m." (Koski and Miller, cited in IWC, 2004b:14). These authors also found that in the Central Beaufort Sea in late August, the vast majority of the whales were subadults and this percentage declined throughout the autumn to about 35% by early October. They reported that mother/calf pairs "arrived in September and were common until early October" (Koski and Miller, 2004, cited in IWC, 2004b).

Inupiat whalers estimate that bowheads take about 2 days to travel from Kaktovik to Cross Island, reaching the Prudhoe Bay area in the central Beaufort Sea by late September, and 5 days to travel from Cross Island to Point Barrow (T. Napageak, 1996, as cited in NMFS, 1999).

Individual movements and average speeds (approximately 1.1-5.8 kilometers per hour [km/h]) vary widely (Wartzog et al., 1990; Mate, Krutzikowsky, and Winsor, 2000). Much faster speeds (e.g., up to 9.8 $\pm$ 4.0 km/h) were estimated for bowheads migrating out of the Gulf of Anadyr during the northward spring migration (Mel'nikov et al., 2004).

Wartzog et al. (1989) placed radio tags on bowheads and tracked the tagged whales in 1988. One tagged whale was tracked for 915 km as it migrated west at an average speed of 2.9 km/h in ice-free waters. It traveled at an average speed of 3.7 km/h in relatively ice-free waters and at an average speed of 2.7 km/h through eight-tenths ice cover and greater. Another whale traveled 1,291 km at an average speed of 5.13 km in ice-free waters but showed no directed migratory movement, staying within 81 km of the tagging site. Additional tagged whales in 1989 migrated 954-1,347 km at average speeds of 1.5-2.5 km/h (Wartzog et al., 1990). Mate, Krutzikowsky, and Winsor (2000) tagged 12 juvenile bowhead whales with satellite-monitored radio tags in the Canadian Beaufort Sea. The whale with the longest record traveled about 3,886 km from Canada across the Alaskan Beaufort Sea to the Chukchi Sea off Russia and averaged 5.0 km/h. This whale's speed was faster, though not significantly faster, in heavy ice than in open water.

Oceanographic conditions can vary during the fall migration from open water to more than nine-tenths ice coverage. The extent of ice cover may influence the timing or duration of the fall migration. Miller, Elliot, and Richardson (1996) observed that whales within the Northstar region (long. 147°-150° W.) migrate closer to shore in light and moderate ice years and farther offshore in heavy ice years, with median distances offshore of 30-40 km (19-25 miles [mi]) in both light and moderate ice years and 60-70 km (37-43 mi) in heavy ice years. Moore (2000) looked at bowhead distribution and habitat selection in heavy, moderate, and light ice conditions in data collected during the autumn from 1982-1991. This study concluded that bowhead whales select shallow inner-shelf waters during moderate and light ice conditions and deeper slope habitat in heavy ice conditions. During the summer, bowheads selected continental slope waters and moderate ice conditions (Moore, DeMaster, and Dayton, 2000). Interseasonal depth and ice-cover habitats were significantly different for bowhead whales. Ljungblad et al. (1987) observed during the years from 1979-1986 that the fall migration extended over a longer period, that higher whale densities were estimated, and that daily sighting rates were higher and peaked later in the season in light ice years as compared to heavy ice years.

Fall aerial surveys of bowhead whales in the Alaskan Beaufort Sea have been conducted since 1979 by the Bureau of Land Management and the MMS (Ljungblad et al., 1987; Treacy, 1988-1998, 2000). Over a 19-year period (1982-2000), there were 15 years with some level of offshore seismic exploration and/or drilling activity and 4 years (1994, 1995, 1999, and 2000) in which neither offshore activity took place during September or October. The parametric Tukey HSD test was applied to MMS fall aerial-transect data (1982-2000) to compare the distances of bowhead whales north of a normalized coastline in two analysis regions of the Alaskan Beaufort Sea from 140-156° W. longitude (see USDOI, MMS, 003a:Map 7). While the Tukey HSD indicates significant differences between individual years, it does not compare actual levels of human activity in those years nor does it test for potential effects of sea ice and other oceanographic conditions on bowhead migrations (Treacy, 2000). Treacy (2000) showed in a year-to-year comparison that the mean migration regionwide in fall 1998 was significantly closer to shore in both the East and West Regions than in 1999, a year with no offshore seismic or drilling activity during the fall season in the Alaskan Beaufort Sea.

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

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

Further evidence that bowhead whales migrate at varying distances from shore in different years also is provided by site-specific studies monitoring whale distribution relative to local seismic exploration in nearshore waters of the central Beaufort Sea (Miller et al., 1997; Miller, Elliot, and Richardson, 1998; Miller et al., 1999). In 1996, bowhead sightings were fairly broadly distributed between the 10-m and 50-m depth contours. In 1997, bowhead sightings were fairly broadly distributed between the 10-m and 40-m depth contours, unusually close to shore. In 1998, the bowhead migration corridor generally was farther offshore than in either 1996 or 1997, between the 10-m and 100-m depth contours and approximately 10-60 km from shore.

Aerial surveys near the proposed Liberty development project in 1997 (BPXA, 1998) showed that the primary fall-migration route was offshore of the barrier islands, outside the proposed development area. However, a few bowheads were observed in lagoon entrances between the barrier islands and in the lagoons immediately inside the barrier islands, as shown in Figures 4-4 and 4-5 of the Environmental Report submitted by BPXA for the Liberty development project (BPXA, 1998). Because survey coverage in the nearshore areas was more intensive than in offshore areas, maps and tabulations of raw sightings overestimate the importance of nearshore areas relative to offshore areas. Transects generally did not extend south of the middle of Stefansson Sound. Nevertheless, these data provide information on the presence of bowhead whales near the then-proposed Liberty development area during the fall migration. Probably only a small number of bowheads, if any, came within 10 km (6 mi) of the area.

Some bowheads may swim inside the barrier islands during the fall migration. For example Frank Long, Jr. reported that whales are seen inside the barrier islands near Cross Island nearly every year and are sometimes seen between Seal Island and West Dock (U.S. Army Corps of Engineers, 1999). Crews from the commercial-whaling ships looked for the whales near the barrier islands in the Beaufort Sea and in the lagoons inside the barrier islands (Brower, 1980). Whales have been known to migrate south of Cross Island, Reindeer Island, and Argo Island during years when fall storms push ice against the barrier islands (Brower, 1980). Inupiat whaling crews from Nuiqsut also have noticed that the whale migration appears to be influenced by wind, with whales stopping when the winds are light and, when the wind starts blowing, the whales started moving through Captain Bay towards Cross Island (Tuckle, as cited in USDOI, MMS, 1986). Some bowhead whales have been observed swimming about 25 yards from the beach shoreline near Point Barrow during the fall migration (Rexford, as cited in USDOI, MMS, 1996b). A comment received from the Alaska Eskimo Whaling Commission on the Liberty draft EIS indicated that Inupiat workers at Endicott have, on occasion, sighted bowheads on the north side of Tern Island. No specific information was provided regarding the location of the whale.

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

The timing, duration, and location of the fall migration along the Chukotka Peninsula are highly variable and are linked to the timing of freezeup (Mel'nikov, Zelensky, and Ainana, 1997). Whales migrate in "one short pulse over a month" in years with early freezeup, but when ice formation is late, whales migrate over a period of 1.5-2 months in 2 pulses (Mel'nikov, Zelensky, and Ainana, 1997:13.

II.C.6.e. Summary and Evaluation of Known Use of the Beaufort Sea by Bowheads. Bowhead whales may occur in the portions of the Beaufort Sea Planning Area from spring through late fall. Spatial distribution, length of residency, habitat use, and timing of use is variable among years. Currently, the whales are first seen at Barrow around April 9-10, and this early pulse is dominated by juveniles. The size/age composition of whales entering the Beaufort gradually switches so that by later in May (May 15-June) large whales and cow/calf pairs are seen. Most of the herd is believed to have migrated past Barrow by late May. After passing Barrow, whales travel in spring leads through heavy pack ice, generally in a northeasterly direction, eventually heading east toward the southeastern Beaufort Sea, reaching the Canadian Beaufort by July. The number of bowheads observed feeding in Canadian waters is variable as is the distribution and behavior of whale observed there. They range through the Beaufort Sea in the summer. Large numbers of whale have been observed in early September in western portions of the planning area. It is not clear whether these whales migrated west early or did not migrate into the eastern Beaufort. The extent and locations of feeding in portions of the Beaufort Sea Planning Area varies considerably among years. In late summer (typically early September, but sometimes beginning earlier), bowhead whales migrate west. Data indicate that bowheads occupy inner and outer shelf habitat in light and moderate ice years but occur in outer shelf and slope habitat in years of heavy ice.

II.C.6.f. Summary and Evaluation of Known Use of the Chukchi Sea by Bowhead Whales. The Chukchi Sea OCS Planning Area is an integral part of the total range of BCB Seas bowhead whales, and portions of this planning area are either part of or are primary calving ground during the spring for these whales. During the spring (widely bracketed as mid-March to approximately mid-June), bowheads migrate through leads on their way to summer feeding grounds. This lead system is an apparently obligate pathway for this population. Most calving apparently occurs during the spring migration between April and early

June. In some years, parts of the spring lead system in the Chukchi Sea west, northwest, and southwest of Barrow are used as feeding areas over extended periods of time during the spring migration, but this use is inconsistent. Bowhead whales have been observed throughout the summer in waters along the northeastern Chukchi Peninsula of Russia (and along the southeastern portion of the Chukchi Peninsula in the Bering Sea). In the autumn, bowheads are in the Chukchi Sea as part of their autumn migration back to the Bering Sea from about mid-September through October, passing through Bering Strait to the Bering Sea between October and November. Some of the bowheads whales are very far north (e.g., 72° N. latitude) in the Chukchi. After passing Barrow, some of the whales head towards Wrangell Island and then follow the Asian coast southeast to the Bering Sea. Observations indicate bowheads feed along the Russian coast in the autumn. Lee et al. (2005) summarized that both bulk body tissue and baleen isotopic values indicate that the Bering and Chukchi sea regions are the predominant feeding areas for adults and subadults. Some of the feeding in the western Alaskan Beaufort Sea (e.g., west of Harrison Bay) is on prey advected from the Chukchi Sea.

Recent systematic data about bowhead seasonal patterns of distribution, abundance, and habitat use in the Chukchi Sea OCS Planning Area are lacking. The MMS funded large-scale surveys in this area when there was oil and gas leasing and exploration, but the last surveys were about 15 years ago. Since that period, data indicate that the bowhead population has increased substantially (about 3.3-3.4%/year), there have been significant reductions in sea-ice extent and a great decline in average sea-ice thickness ice (see the section on climate warming in the Baseline section). For these reasons, we acknowledge considerable uncertainty about the extent of current use of the Chukchi Sea by bowhead whales, especially during the summer months and the fall migration.

II.C.7. Bowhead Feeding. The importance of the Alaskan Beaufort Sea as a feeding area for bowheads is an issue of concern to Inupiat whalers and is a major issue in evaluating the potential significance of any effect that may occur as a result of oil and gas activities in the Beaufort Sea and Chukchi Sea Planning Areas. Both MMS and the NSB believe that, with regards to understanding bowhead feeding within the Alaskan Beaufort Sea, there are major questions that remain to be answered (Stang and George, 2003).

Because of the importance of this topic in past discussions and evaluations, we provide considerable detail about available information.

Bowheads are filter feeders, filtering prey from the water through baleen fibers in their mouth. They apparently feed throughout the water column, including bottomfeeding as well as surface skim feeding (Würsig et al., 1989). Skim feeding can occur when animals are alone and conversely may occur in coordinated echelons of over a dozen animals (Würsig et al., 1989). Food items most commonly found in the stomachs of harvested bowheads include euphausiids, copepods, mysids, and amphipods. Euphausiids and copepods are thought to be their primary prey. Lowry, Sheffield, and George (2004) documented that other crustaceans and fish also were eaten but were minor components in samples consisting mostly of copepods or euphausiids.

Available data indicate that bowhead whales feed in both the Chukchi and Beaufort Sea Planning Areas and that this use varies in degree among years, among individuals, and among areas. It is likely that bowheads continue to feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea, similar to what they are thought to do during the spring migration.

Observations from the 1980's documented that some feeding occurs in the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (e.g., Ljungblad et al., 1987; Carroll et al., 1987). Stomach contents from bowheads harvested between St. Lawrence Island and Point Barrow during April into June also indicated it is likely that some whales feed during the spring migration (Carroll et al., 1987; Shelden and Rugh, 1995, 2002). Carroll et al. (1987) reported that the region west of Point Barrow seems to be of particular importance for feeding, at least in some years, but whales may feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant food. Lowry (1993) reported that the stomachs of 13 out of 36 spring-migrating bowheads harvested near Point Barrow between 1979 through 1988 contained food. Lowry estimated total volumes of contents in stomachs ranged from less than 1 to 60 liters (L), with an average of 12.2 L in eight specimens. Shelden and Rugh

(1995) concluded that "In years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring (Carroll et al., 1997)." Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring.

It is known that bowhead whales feed in the Canadian Beaufort in the summer and early fall (e.g., Würsig et al, 1985), and in the Alaskan Beaufort in late summer/early fall (Lowry and Frost, 1984; Ljungblad et al., 1986; Schell and Saupe, 1993; Lowry, Sheffield, and George, 2004; summarized in Richardson and Thomson, 2002). Available information indicates it is likely there is considerable inter-annual variability in the locations where feeding occurs during the summer and fall in the Alaska Beaufort Sea, in the length of time individuals spend feeding, and in the number of individuals feeding in various areas in the Beaufort Sea.

In at least some years, some bowheads apparently take their time returning westward during the fall migration, sometimes barely moving at all, with some localities being used as staging areas due to abundant food resources or social reasons (Akootchook, 1995, as reported in NMFS, 1). The Inupiat believe that whales follow the ocean currents carrying food organisms (e.g., Napageak, 1996, as reported in NMFS, 2001). Bowheads have been observed feeding not more than 1,500 feet (ft) offshore in about 15-20 ft of water (Rexford, 1979, as reported in NMFS, 2001). Nuiqsut Mayor Nukapigak testified at the Nuiqsut Public Hearing on March 19, 2001, that he and others saw a hundred or so bowhead whales and gray whales feeding near Northstar Island (USDOI, MMS, 2002). Some bowheads appear to feed east of Barter Island as they migrate westward (Thomson and Richardson, 1987).

Interannual variability in the use of areas of the Beaufort Sea by bowheads for feeding also has been observed during aerial surveys by MMS and others. Ljungblad et al. (1986) reported that feeding bowheads comprised approximately 25% of the total bowheads observed during aerial surveys conducted in the Beaufort Sea from 1979 through 1985. Miller, Elliott, and Richardson (1998) reported observing many aggregations of feeding whales in nearshore waters near or just offshore of the 10-m depth contour during late summer/autumn 1997. In some years (e.g., 1997) (Miller, Elliot, and Richardson, 1998; Treacy, 2002), many aggregations have been seen feeding (e.g., between Point Barrow and Smith Bay), whereas in other years very little feeding was observed. Bowheads occasionally have been observed feeding north of Flaxman Island.

Treacy (2002) summarized data regarding the frequency of feeding and milling of bowhead whales observed on transect during aerial surveys conducted by MMS in the Beaufort Sea between 1982 and 2001. Because whales exhibiting milling behavior also may be feeding whales, whales with milling behavior were included with whales with apparent feeding behavior, even though some milling whales may have been engaged in other forms of social behavior. Feeding and milling whales observed per unit effort for each fall season (1982-2001) were mapped for visual comparison of relative occurrence of these behaviors in the Alaskan Beaufort Sea. Treacy (2002) summarized that a greater relative occurrence of feeding and/or milling behavior in bowhead whales was detected on transect near the mouth of Dease Inlet during aerial surveys of bowhead whales in the Beaufort Sea in 6 out of 20 years (1984, 1989, 1997, 1998, 1999, and 2000). In 4 of those years (1989, 1997, 1998, and 1999), Treacy also reported that a similar frequency of feeding and/or milling behavior was observed on transect near Cape Halkett, Alaska. During this 20-year period, there were 9 years when feeding and/or milling behaviors were noted on transect, but not in or near either Dease Inlet or Cape Halkett (1982, 1983, 1985, 1986, 1988, 1990, 1993, 1995, and 1996). In 1987, 1991, 1992, 1994, and 2001, Treacy (2002) reported that neither feeding nor milling behaviors were noted on transect at any location in the study area. Interannual and geographic variation in prey availability likely accounts for opportunistic feeding aggregations in particular years and locations (Treacy, 2002).

Of 245 whales observed during 2003 during MMS BWASP, 31% were classified as milling but none as feeding (Monnett and Treacy, 2005). Monnett and Treacy (2005) reported concentrations of milling whales nearshore north and northwest of Oliktok Point on September 20, 2003. In 2004, 29% of 253 bowheads observed were classified as feeding and 10% as milling. Locations of feeding whales included northeast of Barrow, in Smith Bay, and to the west of Kaktovik. Milling whales were in the far eastern portions of the study area.

Data from MMS's BWASP surveys (e.g., Treacy, 1998, 2000) shows high numbers of whales, many of which were feeding, in some areas over relatively long periods (e.g., weeks) of time in some years (e.g., 1997) in areas in the western Alaskan Beaufort) but not in others.

In the years that feeding whales are seen in a given area over a period of time, if the same individuals are staying in the areas and feeding, for these lengths of time, in those years they could be deriving a higher than typical percentage of their yearly energetic requirements from the Alaskan Beaufort Sea.

Based on stomach content data supplemented by behavioral evidence, far more than 10% of the bowheads that passes through the eastern Alaskan Beaufort Sea during late summer and autumn feed there. Based on examination of the stomach contents of whales harvested in the autumn between 1969-2000, Lowry, Sheffield, and George (2004) found that there were no significant difference in the percentages of bowheads that had been feeding between those harvested near Kaktovik (83%), Barrow (75%), or between subadults (78%) versus adults (73%). Twenty-four out of 32 whales taken during the fall at Kaktovik from 1979-2000 and included in this analysis were considered to have been feeding (Lowry and Sheffield, 2002). The status of three other whales was uncertain. Copepods were the dominant prey species by volume. Seventy-seven out of 106 whales harvested during the fall near Barrow from 1987-2000 and included in this analysis were considered to have been feeding. The status of two other whales was uncertain. There was no estimate of stomach contents for 61 whales. Of the 77 whales classified as feeding whales, there were estimates of stomach volume for 16 autumn-feeding whales. Euphausiids were the dominant prey species by volume.

Stomach volumes are reported for 34 of 90 whales harvested in the autumn at Kaktovik and Barrow. The stomach of the harvested whales contained highly variable amounts of food (range=2-150 L at Kaktovik, with 39% containing with >20 L and 11% containing >100 L; n=18) (range =1-189 L at Barrow, with 56% containing with >20 L and 31% containing >100 L; n=16) (Table 6 in Lowry, Sheffield, and George, 2004:219). Four out of five whales taken during the fall at Cross Island from 1987-2000 were considered to have been feeding (at least 10 items or 1 L of prey). Length-girth relationships show that subadult bowheads, and possibly adults, gain weight while in the Beaufort Sea in summer and lose weight while elsewhere. Lipid content of blubber, at least in subadults, is higher when they leave the Beaufort in fall than when they return in spring. This evidence suggests the importance of feeding in the Beaufort Sea during summer and early autumn. They do not show what fraction of the annual feeding occurs in the eastern and central Beaufort Sea. Lowry, Sheffield, and George (2004:221) concluded that:

> …Bowhead whales feed regularly in the nearshore waters of the eastern, central and western Alaskan Beaufort Sea during September and October…this entire region should be considered an integral part of the summer-autumn feeding range of bowhead whales. Results of stomach contents analysis, aerial observations, and traditional knowledge suggest that reference to the passage of bowhead whales through this region as a 'westward autumn migration' is misleading…it is a very incomplete description of their activities in the region. Second, feeding near Barrow during the spring migration is not just occasional, but rather a relatively common event…However, the amount of food in the stomachs tends to be lower in spring than in autumn….
>
> However, examination of stomach contents only showed whether or not bowhead whales had fed and what prey were eaten, and it does not directly address the relative significance of feeding in various regions…This unresolved issue remains important in the evaluation of possible cumulative effects of oil and gas development on bowhead whales…..

Because the standard for classifying a whale as feeding is set so low, but prey volumes are rarely reported, we find it difficult to critically evaluate these findings relative to the issue of assessing the importance of various areas as bowhead feeding area, either to the population as a whole or to segments of the population. As pointed out by Thomson, Koski, and Richardson (2002), there is a large difference between a stomach with a small amount of prey (10 prey items) and one that is full.

It is unclear how important this feeding is in terms of meeting the annual food needs of the population or to meeting the food needs of particular segments of the population (e.g., see discussion in Richardson and Thomson, 2002). Many assumptions, such as those about residence time and approximations, influence current conclusions. Because marked individuals have not been studied, it is unclear how much variability also exists among classes of individuals or individuals within a class in habitat residency times, or what factors influence residency times.

Richardson and Thomson (2002) pointed out that bowhead activity throughout the year needs to be considered when evaluating the importance of feeding in the eastern Alaskan Beaufort Sea in late summer and autumn.

Although numerous observations have been made of bowheads feeding during both the spring migration north to the Beaufort Sea and the fall migration west across the Alaskan Beaufort Sea, quantitative data showing how food consumed in the Alaskan Beaufort Sea contributes to the bowhead whale population's overall annual energy needs is fairly limited.

A study by Richardson (1987) concluded that food consumed in the eastern Beaufort Sea contributed little to the bowhead whale population's annual energy needs, although the area may be important to some individual whales. **The study area for this 1985-1986 study extended from eastern Camden Bay to the Alaska/Canada border from shore to the 200-m depth contour for the intensive study area, and beyond this contour only for aerial survey data (Richardson and Thomson, 2002).** The conclusion was controversial. The NSB's Science Advisory Committee (1987) believed the study was too short in duration (two field seasons, one of which was limited by ice cover), suboptimal sampling designs, and difficulties in estimating food availability and consumption. The Committee did not accept the conclusion that the study area is unimportant as a feeding area for bowhead whales.

Richardson and Thomson (2002) finalized the report from the MMS-funded feeding study entitled *Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea: Update of Scientific and Traditional Information*, which compiled and integrated existing traditional and scientific knowledge about the importance of the eastern Alaskan Beaufort Sea for feeding by bowhead whales. The project was an extension, with additional fieldwork (mainly in September of 1998, 1999, and 2000), of the previous study conducted in 1985 and 1985. The primary study area for this study extended the westward boundary about 1° longitude from that of the 1985-1986 study. Thus the boundary for the latter study was near the middle of Camden Bay (145° W. longitude). With the concurrence of the NSB Scientific Review Board, efforts in deep offshore areas were de-emphasized in this latter study so as to concentrate efforts in shallow areas of particular concern to Kaktovik hunters and, potentially, to oil industry. Boat-based zooplankton sampling in 1998-2000 was limited to areas seaward of the 50-m contour. Aerial surveys extended to the 200-m contour, and MMS surveys extended further.

Griffiths (1999) noted that the average zooplankton biomass in the study area was higher in 1986 than in 1998. Habitat suitable for feeding appears to have been less common in the eastern Alaskan Beaufort Sea in 1998 than it was in 1986. In 1998, the principal feeding area within the eastern study area appeared to have been near Kaktovik. Griffiths, Thomson, and Bradstreet (2002) discussed zooplankton biomass samples collected in the Canadian Beaufort Sea during the 1980's and in the Alaskan Beaufort Sea in 1986, 1998, and 1999, where bowhead whales were either observed feeding or where whales had been observed feeding the previous day. Bowhead whales feed in areas with a higher than average concentration of zooplankton. The distribution of biomass values at locations with feeding bowheads indicates that the feeding threshold for bowheads may be a wet biomass of ~800 milligrams per cubic meter (mg/m^3).

Most whales observed where zooplankton were sampled were subadults. "Adult bowheads tend to feed where large copepods predominate" (Richardson and Thomson, 2002:xxv.

Koski (2000) summarized that the most common activity of bowheads in the eastern Alaskan Beaufort Sea during late summer and autumn was feeding. Bowhead use of the eastern Alaskan Beaufort Sea during late summer and autumn can be highly variable from year to year, with substantial differences in the numbers, size classes, residence times, and distributions of bowheads recorded there during 1985, 1986, 1998, and 1999.

Although various types of evidence (with the exception of isotope ratios) (see below) indicate that the eastern Beaufort Sea as a whole, including the Canadian Beaufort, is important to bowhead whales for feeding, the eastern Alaskan Beaufort Sea is only a small fraction of that area (Richardson and Thomson, 2002.

Similarly, data indicate that the amount of time bowheads spend feeding in the fall in the eastern Alaskan Beaufort Sea is highly variable among years. Available evidence indicates that in many years, the average bowhead does not spend much time in the eastern Alaskan Beaufort Sea and, thus, does not feed there extensively. Bowhead whales moved quickly through the area in 1998 and did not stop to feed for any great period of time. In contrast, during 1986, subadult whales stopped to feed in the study area for periods of at least several days. In 1999, adult whales stopped to feed in the Flaxman-to-Herschel zone for extended periods (Koski et al., 2002). In 1999, the main bowhead feeding areas were 20-60 km offshore in waters 40-100 m deep in the central part of the study area east and northeast of Kaktovik, between Kaktovik and Demarcation Bay (Koski, Miller, and Gazey, 2000). In 1999, one bowhead remained in the study area for at least 9 days, and 10 others remained for 1-6 days. Their mean rate of movement was about one-eighth of the rate observed in 1998.

Koski et al. (2002) used six calculation methods to estimate residence time for whales in the eastern Alaskan Beaufort Sea area, from Flaxman Island to Herschel Island. The annual residence time varied from 2.1-8.3 days and averaged 5.1 days. Of the individual bowheads that traveled through this portion of the Alaskan Beaufort Sea, some spent at least 7 days.

Miller et al. (2002) pointed out that it is difficult to recognize feeding behavior during typical aerial surveys. More focused observations are usually needed to obtain evidence of feeding below the surface.

Baleen from bowhead whales provides a multiyear record of isotope ratios in prey species consumed during different seasons, including information about the occurrence of feeding in the Bering Sea and Chukchi Sea system. The isotopic composition of the whale is compared with the isotope ratios of its prey from various geographic locations to make estimates of the importance of the habitat as a feeding area.

Carbon-isotope analysis of bowhead baleen has indicated that a significant amount of feeding may occur in wintering areas (Schell, Saupe, and Haubenstock, 1987).

Carbon-isotope analysis of zooplankton, bowhead tissues, and bowhead baleen indicates that a significant amount of feeding may occur in areas west of the eastern Alaskan Beaufort Sea, at least by subadult whales (Schell, Saupe, and Haubenstock, 1987). Subadult whales show marked changes in the carbon isotope over the seasons, indicating that carbon in the body tissues is replaced to a large extent from feeding in summer and feeding in the autumn-winter months. In contrast, adult animals sampled show very little seasonal change in the carbon isotope and have an isotopic composition best matched by prey from the western and southern regions of their range, implying that little feeding occurs in summer (Schell and Saupe, 1983).

The importance of the Alaskan Beaufort Sea as a bowhead feeding area also may have changed, or be changing, due to changes in prey availability elsewhere in their range. Isotope data indicate that primary productivity in the Bering and southern Chukchi seas is declining. Schell (1999a) looked at baleen from 35 bowheads that were archived, in addition to whales from the recent harvest, and constructed an isotopic record that extends from 1947-1997. He inferred from this record that seasonal primary productivity in the North Pacific was higher over the period from 1947-1966, and then began a decline that continues to the most recent samples from 1997. Isotope ratios in 1997 are the lowest in 50 years and indicate a decline in the Bering Sea productivity of 35-40% from the carrying capacity that existed 30 years ago. If the decline in productivity continues, the relative importance of the eastern Beaufort Sea to feeding bowheads may increase (Schell, 1999b).

Lee and Schell (2002) analyzed carbon isotope ratios in bowhead whale muscle, baleen, and fat, and in bowhead food organisms. They found that the isotopic signatures in zooplankton from Bering and Chukchi waters, which sometimes extend into the western Beaufort Sea, are similar and cannot be differentiated from one another. Zooplankton from the eastern Beaufort Sea (summer and early autumn range) has an isotopic signature that is distinct from that in Bering/Chukchi zooplankton. Lee and Schell compared these isotopic signatures in zooplankton to isotopic signatures in bowhead tissues.

Lee and Schell (2002) found that carbon isotopes in the muscle sampled in the fall were not significantly different from those in muscle sampled in the spring. Carbon isotopes in the muscle during both seasons closely matched the isotope ratios of zooplankton from the Bering and Chukchi waters, indicating most of the annual food requirements of adults and subadults are met from that portion of their range. Based on the comparison of carbon isotopes in the zooplankton and in bowhead tissues, they estimate that 10-26% of the annual bowhead feeding activity was in the eastern and central Beaufort Sea waters, roughly east of Prudhoe Bay.

Isotope data from baleen showed different feeding strategies by adult and subadult whales. Subadults acquired sufficient food in the eastern Beaufort Sea to alter the carbon isotope ratios in baleen relative to baleen representing feeding in Bering and Chukchi waters. Baleen plates from subadults showed a wider range in isotope ratios than those from adults, suggesting active feeding over all parts of their range.

Much of the isotopic evidence seems to indicate that especially adult bowhead whales feed primarily on prey from the Bering and/or Chukchi Sea (Schell, Saupe, and Haubenstock, 1987; Schell and Saupe, 1993; Lee and Schell, 2002). Hoekstra et al. (2002) found seasonal values were consistent for all age classes of bowhead whales and suggested that the Bering and Beaufort seas are both important regions for feeding.

In contrast, Hoekstra et al. (2002) concluded that seasonal fluctuations in carbon isotope values was consistent for all age classes of bowhead whales and suggests that the Bering and Beaufort seas are both important regions for feeding. Hoekstra et al. (2002) included data on isotope ratios in tissue subsamples from some of the same individual bowheads from Kaktovik and Barrow that were analyzed by Lee and Schell. There was an apparent discrepancy in the data from these two studies and somewhat different conclusions. The source of the discrepancy related to differences in the results from the Kaktovik whale-muscle samples. Hoekstra et al. (2002) suggest the percentage of annual feeding activity in the eastern Beaufort Sea could be on the order of 37-45% (compared to 10-26%). This discrepancy was considered critical in assessing the importance of feeding in the eastern Beaufort Sea. Lee and Schell subsequently repeated their isotopic analyses on additional subsamples from the same Kaktovik whales and obtained the same results they obtained initially (Lee and Schell, 2002). These re-analyses confirm the accuracy of the measurements reported by Lee and Schell in their draft report. Hoekstra et al. have not repeated their isotopic analyses at this time; therefore, the reason for the discrepancy between the two sets of data remains uncertain.

Recently, Lee at al. (2005) published data from isotope ratio analyses of bowhead baleen from whales all of whom except one had been harvested in the autumn of 1997-1999 (Barrow: n=4; Kaktovik: n=10) and muscle (Barrow: n=14; Kaktovik: n=10). Results of these samples were compared to data from baleen collected in past studies from both spring (predominantly) and autumn whales in 1986-1988 (see Table 1 in Lee et al., 2005:274). Lee et al. (2005:285) concluded that the new data continue to indicate that the BCB Seas "bowhead whale population acquires the bulk of its annual food intake from the Bering-Chukchi system…. Our data indicate that they acquire only a minority of their annual diet from the eastern and central Beaufort Sea…although subadult bowheads apparently feed there somewhat more often than do adults."

Thomson, Koski, and Richardson (2002) tried to reconcile the low estimates of summer feeding, as indicated by the isotope data of Lee and Schell, with other data: behavioral observations showing frequent feeding in the eastern Beaufort Sea during the summer and early autumn; zooplankton sampling near bowheads feeding in those areas shows that whales concentrate their feeding at locations with much higher than average biomasses of zooplankton; frequent occurrence of food in the stomachs of bowheads harvested in the Alaskan Beaufort Sea during late summer and autumn; and length-girth relationships show that subadult bowheads, and possibly adults, gain weight while in the Beaufort Sea in summer and lose weight while elsewhere; and lipid content of blubber, at least in subadults, is higher when they leave the Beaufort in fall than when they return in spring. Although some of this evidence suggests the importance of feeding in the Beaufort Sea during summer and early autumn, those types of data on summer and early fall feeding in the Beaufort Sea do not specifically show what fraction of the annual feeding occurs in the eastern and central Beaufort Sea. No comparable data on feeding, girth, or energy content have been obtained during and after the whales feed in the Chukchi sea in mid- to late fall.

They concluded that bowheads fed for an average of 47% of their time in the eastern Alaskan Beaufort Sea during late summer and autumn. A substantial minority of the feeding occurred during travel. Among traveling whales, feeding as well as travel was occurring during a substantial percentage of the time, on the order of 43%.

Assumptions about residence times influence these energetics-related estimates. As noted, available data indicate there is variability in habitat use among years. Because marked individuals have not been studied, it is unclear how much variability also exists among individuals in habitat residency times or what factors influence residency times.

Estimated food consumption by bowheads in the eastern Alaskan study area (Flaxman Island to the Alaska/Canada border) was expressed as a percentage of total annual consumption by the population (Thomson, Koski, and Richardson, 2002). This was done separately for each year of the study and averaged for the 5 years of the study.

The amount of feeding in the Chukchi Sea and Bering Strait in the fall is unknown as is the amount of feeding in the Bering Sea in the winter (Richardson and Thomson, 2002). Richardson and Thomson (2002:xxxviii) concluded that: "…behavioral, aerial-survey, and stomach-content data, as well as certain energetics data…show that bowheads also feed widely across the eastern and central Beaufort Sea in summer and fall."

They also concluded (Richardson and Thomson, 2002:xliii) that:

> In an average year, the population of bowhead whales derives an estimated 2.4% of annual energetic requirements" in the eastern part of the Alaskan Beaufort Sea studied.
>
> In 1 of 5 years of study, the population may have derived 7.5% or more of annual energetic requirements from the area. Utilization of the study area varies widely in time and space depending on zooplankton availability and other factors. In 4 of 5 study years, the bowhead population was estimated to consume <2% of its annual requirements within the eastern Alaskan Beaufort Sea during late summer and autumn….

Sensitivity analysis indicated that the upper bound of the 95% confidence interval was below 5% in four of the years. This upper bound was 16.5% in 1999, when the best estimate was 7.5%. Richardson and Thomson (2002) stated that they suspected the whale-days figure for 1999 was overestimated, and that the 16.5% upper bound on that confidence interval was unrealistically high. Richardson and Thomson (2002:xliv) concluded that: "It is implausible that the population would consume more than a few percent of its annual food requirements in the study year in an average year."

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

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

Richardson and Thomson (2002) pointed out that the isotopic and behavioral and stomach content data might not be in conflict, if prey availability in the Chukchi and/or Bering Sea were "notably better" than in the eastern Beaufort Sea. However, they also point out that: "…it is difficult to understand why bowheads would migrate from the Bering-Chukchi area to the Beaufort Sea if feeding in the Beaufort Sea were unimportant."

Richardson and Thomson (2002) note that while the study has provided many new data about bowhead feeding ecology and related biology, "…there are still numerous approximations, assumptions, data gaps, and variations of opinion regarding the interpretation of data. This is inevitable…. The authors do not claim that the project has resolved all uncertainty about the importance of the eastern Alaskan Beaufort Sea for feeding by bowhead whales…."

Thus, the aforementioned study acknowledges certain limitations and the results of this study confirmed that the eastern Alaskan Beaufort Sea is used by bowhead whales for feeding (Stang and George, 2003). Richardson and Thomson (2002) summarized that this use varies widely in degree among years and individuals.

II.C.8. Summary of Information about Bowhead Whale Status, Abundance, Distribution, Habitat Use and Ecology Relevant to Assessing Effects of the Proposed Action. Available new information does not indicate that there has been any significant negative or other change in the population status of the Bering-Chukchi-Beaufort Sea bowhead whale population since MMS consulted with NMFS in 2003 regarding Beaufort Lease Sale 195 (USDOI, MMS, 2004) or the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a). All recent available information indicates that the population has continued to increase in abundance over the past decade and may have doubled in size since about 1978. The estimated current annual rate of increase is similar to the estimate for the 1978-1993 time series. There is discussion in the scientific and regulatory communities regarding the potential delisting of this population. Bowheads feed in the Alaskan Beaufort Sea, but the extent and location of that feeding varies widely among years and locations. Bowheads are extremely long lived, slow growing, slow to mature, and currently have high survival rates. These features affect their vulnerability to pollution and disturbance in their environment. They are also unique in their ecology and their obligate use of lead systems to transit to summering grounds. This reliance on spring leads, and the fact that they apparently calve during the spring northward migration, also are features of their ecology that heightens their vulnerability to disturbance and oil spills in some areas. There are locations in the Beaufort Sea and the western Chukchi Sea where large numbers of bowheads have been observed feeding in many years. However, the significance of feeding in particular areas to the overall food requirements of the population or segments of the population is not clear. Available new information also does not indicate there has been any significant change in the distribution of this population during the autumn in the Beaufort Sea since NMFS wrote its Biological Opinion in 2001. Recent data on distribution, abundance, or habitat use in the Chukchi Sea Planning Area are not available, and there is little information about summer use in the Beaufort Sea. Since MMS and NMFS consulted on oil and gas leasing in the Chukchi Sea Planning Area, significant changes in the arctic environment have occurred and the population of bowheads has apparently greatly increased in abundance. We have taken available information into account in the update of our analyses of potential effects on this population.

II.D. Fin Whale (*Balaenoptera physalus*) – Endangered

II.D.1. Introduction and Summary. Fin whales are large, fast-swimming baleen whales (Reeves, Silber, and Payne, 1998). Adults range between 20 and 27 m (~65-89 ft) in length (Reeves, Silber, and Payne, 1998; Perry, DeMaster, and Silber, 1999a). They inhabit and feed in the Bering Sea throughout many months of the year and have been observed within the southwestern Chukchi Sea, along the northern coast of Chukotka. This area of the Chukchi was an important part of their historic range. The distribution and relative abundance of fin whales in these areas varies seasonally (see below). We include information about the fin whale in this Biological Evaluation to assess the potential for this species to be adversely affected by oil- and gas-related activities in the Chukchi Sea or Beaufort Sea Planning Areas.

The MMS previously provided extensive information to NMFS about this species and its potential to be affected by oil and gas activities during our Section 7 consultation concerning potential oil and gas activities in Federal waters within lower Cook Inlet. For that consultation, MMS provided NMFS with our draft EIS for the Cook Inlet OCS Lease Sales 191 and 199 (USDOI, MMS, 2003b), which contained our biological evaluation of potential impacts to this species. Information provided herein expands, updates and, in some cases, summarizes information provided in that draft EIS. All available information is considered in our update of our analyses of the potential effects of the Proposed Action on fin whales. We provide an update of baseline information and information related to evaluating potential cumulative anthropogenic impacts on this population, as defined under the ESA.

There is a revised draft stock assessment for 2005 available for this population (Angliss and Outlaw, 2005:rev. 10/24/04). Details on fin whales that might lie outside the scope of the material provided here, or in our Cook Inlet multiple-sale EIS, may be provided in that document. We have reviewed and considered information in these documents and other available information in our evaluation of potential environmental impacts.

II.D.2. ESA Status and Protective Legislation. Fin whales were listed as endangered under the ESA in 1973 (Perry, DeMaster, and Silber, 1999a) and as depleted under the MMPA. Under the 1994 amendments to the MMPA, they are categorized as a strategic stock. They are listed in Appendix I of CITES (Reeves et al., 1998). Hunting of fin whales in the North Pacific was regulated under the 1946 International Convention for the Regulation of Whaling. The IWC began managing the commercial take of fin whales in the North Pacific in 1969 (Allen, 1980; Reeves et al., 1999) and prohibited their harvest in the North Pacific in 1976. In July 1998, NMFS released a joint *Draft Recovery Plan for the Fin Whale Balaenoptera physalus and Sei Whale Balaenoptera borealis* (Reeves, Silber, and Payne, 1998). No critical habitat has been designated or proposed for fin whales in the North Pacific.

II.D.3. Population Structure and Current Stock Definitions. The NMFS (Angliss and Lodge, 2002; Angliss and Outlaw, 2005:rev. 10/24/04) currently considers stock structure in fin whales to be equivocal. There is a lack of consistency among national and international regulatory entities in the number of stocks recognized. The NMFS (Angliss and Outlaw, 2005:rev.10/24/04) currently recognizes three population stocks of fin whales in U.S. Pacific waters: an Alaska or Northeast Pacific Stock, a California/Washington/Oregon Stock, and a Hawaii Stock. Investigators have reached different conclusions about the number and locations of population stocks in the North Pacific. However, tag recoveries (Rice, 1974) indicate that animals whose winter habitat includes the coast of southern California summer in locations from central California to the Gulf of Alaska; and individuals from the North American Pacific coast have been reported at locations as varied as central Baja California to the Bering Sea in the summer. Based on blood typing, morphology, and marking data, Fujino (1960) identified three “subpopulations” of fin whales in the North Pacific: the East China Sea, the eastern sides of the Aleutians, and the western sides of the Aleutians (Donovan, 1991). After examination of histological and tagging data, Mizroch, Rice, and Breiwick (1984) suggested five possible stocks. In 1971, the IWC divided North Pacific fin whales into two management units for the purposes of establishing catch limits: the East China Sea Stock and the rest of the North Pacific (Donovan, 1991).

II.D.4. Past and Current Population Abundance. During visual cetacean surveys in July and August 1999 in the central Bering Sea (CEBS), and in June and July 2000 in the southeastern Bering Sea (SEBS), fin whale abundance estimates were almost five times higher in the CEBS (provisional estimate of 3,368; CV = 0.29) (where most sightings were in a region of particularly high productivity along the shelf break) than in the SEBS (provisional estimate of 683; CV = 0.32) (Moore et al., 2002). During sighting cruises in July-August 2001-2003 of coastal waters (up to 85 km offshore) between the Kenai Peninsula (150° W.

Lat.) to Amchitka Pass (178° W. Lat.), fin whales were observed from east of Kodiak Island to Samalga pass (Zerbini et al., In prep., as cited in Angliss and Outlaw, 2005:rev. 10/24/04). These authors also estimated that 1,652 (95% CI = 1142-2389) fin whales occurred in this area. Based on these data, and those of Moore et al. (2002), NMFS provided an "initial estimate" of abundance of 5,703 fin whales west of the Kenai Peninsula. The NMFS considers this a minimum estimate of abundance for the stock, because no estimate is available east of the Kenai Peninsula (Angliss and Outlaw, 2005:rev. 10/24/04).

The NMFS has concluded that **there is no reliable information about population-abundance trends, and that reliable estimates of current or historical abundance are not available, for the entire Northeast Pacific fin whale stock** (Angliss and Lodge, 2002; Angliss and Outlaw, 2005:rev. 10/24/04). **They provided a Potential Biological Removal for the Northeast Pacific Stock of 11.4.**

Estimates of population abundance in the North Pacific prior to commercial exploitation range from 42-45,000 (Ohsumi and Wada, 1974). Angliss and Outlaw (2005:rev. 10/24/04, p. 197) cite a revised, unpublished February 2003 version of IWC Bureau of International Whaling Statistics data, stating that "Between 1925 and 1975, 47,645 fin whales were reported killed throughout the North Pacific."

II.D.5. Reproduction, Survival, and Non-Human Related Sources of Mortality. Lockyer (1972) reported the age at sexual maturity in fin whales, for both sexes, to range from 5-15 years, while the average length is approximately 17.2 m (see references in Perry, DeMaster, and Silber, 1999a). Mating and calving are believed to occur on wintering grounds (Perry, DeMaster, and Silber, 1999a). A single calf is born after a gestation of about 12 months and weaned between 6 and 11 months of age (Best, 1966; Gambell, 1985). Calving intervals range between 2 and 3 years (Agler et al., 1993). About 35-40% of adult fin whale females give birth in any given year (Mizroch et al., In prep.).

We discuss sources of human mortality and other impacts in the Baseline and Cumulative Effects sections. There is little information about natural causes of mortality (Perry, DeMaster, and Silber, 1999a). The NMFS summarized that "There are no known habitat issues that are of particular concern for this stock" (Angliss and Lodge, 2002, 2005). Perry, DeMaster, and Silber (1999a:51) listed the possible influences of disease or predation as "Unknown."

II.D.6. Migration, Distribution, and Habitat Use. Fin whales are widespread throughout temperate oceans of the world (Leatherwood et al., 1982; Perry, DeMaster, and Silber, 1999a; Reeves, Silber and Payne, 1998). During the "summer" (defined by Mizroch et al., In prep. as April-October) fin whales inhabit temperate and subarctic waters throughout the North Pacific including the Gulf of Alaska, Bering Sea, and the southern Chukchi Sea (Mizroch et al., 1984) (see details provided below for Gulf of Alaska, the Bering Sea, and Arctic) (see Figure 3). The summer southern range in the eastern North Pacific extends as far south to about 32° N., and rarely, even farther south off Mexico. During the historic whaling period, "summer" concentration areas included, but were not limited to, the Bering Sea-eastern Aleutian Ground (60° N.-70° N., 175° E.-180° E., plus 45° N.-65° N., 180°-165° W.) and the Gulf of Alaska Ground (also called the Northwest Coast Ground) (45° N.-55° N., 165° W.-160° W., 45° N.-60° N., 160° W.-134° W.), and the Vancouver Ground (40° N.-55° N., 134° W.-125° W.) (Mizroch et al., In prep.). Mizroch et al.'s (In prep.) summary indicates that the fin whales range across the entire North Pacific from April to October, but in July and August concentrate in the Bering Sea-eastern Aleutian area. In September and October, sightings indicate that fin whales are in the Bering Sea, the Gulf of Alaska, and along the U.S. coast as far as Baja California (in October) (Mizroch et al., In prep.).

Most fin whales are believed to migrate seasonally from relatively low-latitude winter habitats where breeding and calving take place to relatively high latitude summer feeding habitats (Perry, DeMaster, and Silber, 1999a). The degree of mobility of local populations, and perhaps individuals, differs, presumably in response to patterns of distribution and abundance of their prey (Reeves et al., 1991; Mizroch et al., In prep.). Some populations migrate seasonally up to thousands of kilometers, whereas others are resident in areas with adequate prey (Reeves et al., 1999). Data from marked fin whales indicate that at least some individuals make long movements between wintering areas off Mexico and California to summer feeding areas in the Gulf of Alaska (Mizroch et al., In prep.). Angliss and Lodge (2005) reported that fin whales in the North Pacific generally are reported off the North American coast and Hawaii in winter and in the

Bering Sea in summer. Passive acoustic data (McDonald and Fox, 1999) document that Hawaii is used in the winter by fin whales but indicate that densities are likely lower than those in California (Barlow, 1995; Forney, Barlow, and Carretta, 1995).

However, observations summarized by Mizroch et al. (In prep.) and reported elsewhere demonstrate that there are many fin whales in many locations in northerly waters as far north as 60° N. in winter months. For example, in the 1960's, 20 fin whales were sighted in the Gulf of Alaska in January (Berzin and Rovnin, 1966). Fin whales have been observed near Kodiak Island and in Shelikof Strait in all seasons of the year (Mizroch et al, In prep.; Wynne and Witteveen, 2005). In January and February, fin whales have been sighted off Baja California, in the Aleutian area, and Bering Sea. Mizroch et al. (In prep.) point out, however, that fin whales with small calves have not been seen during the winter months, and that it has not been demonstrated that individual whales are year-round residents in the northern areas. Thus, it is clear from their sighting summary that during many different times of the year, fin whales have been observed in widely scattered locations throughout their range in the North Pacific but areas where concentrations have been observed change seasonally.

Reeves, Silber, and Payne (1998) reported that fin whales tend to feed in summer at high latitude and fast, or feed little at winter lower latitude habitats. During visual cetacean surveys in July and August 1999 in the central Bering Sea, "…aggregations of fin whales were often sighted in areas where the…echo sounder…identified large aggregations of zooplankton, euphausiids, or fish" (Angliss, DeMaster, and Lopez, 2001:160). Mizroch et al. (In prep.) concluded that catch densities and sightings show concentrations of fin whales within a highly productive "Bering Sea Green Belt" along the shelf edge (Springer, McRoy, and Flint, 1996). However, recent data on fin whale presence based on calls detected by bottom-mounted hydrophones document high levels of fin whale call rates along the U.S. Pacific coast from August to February (Moore et al., 1998; Watkins et al., 2000). The patterns of fin whale calls detected "…generally corresponded to seasonal productivity in the areas monitored…" (Moore et al., 1998:623) and have been interpreted as a possible indication of the importance of this area for fin whale feeding during winter (Angliss and Lodge, 2002).

The importance of specific feeding areas to populations or subpopulations of fin whales in the North Pacific is not understood. In the North Atlantic, 30-50% of identified individual fin whales returned to specific feeding areas in subsequent years (Clapham and Seipt, 1991). The timing of arrival at feeding habitats can vary by sex and reproductive status, with pregnant females arriving earlier (Mackintosh, 1965).

II.D.6.a. Use of the Chukchi and Beaufort Seas. Available information suggests that the summer range of the fin whale extends as far as the Chukchi Sea (Rice, 1974) (see Angliss and Outlaw, 2005:rev. 10/24/04, Figure 40, replaced here as Figure 6), including portions of the western Chukchi along the Chukotsk Peninsula and areas of the Alaskan Chukchi just north of the Bering Strait. Mizroch et al. (In prep.:14) reported "(T)hey regularly pass through the Bering Strait into the southwestern Chukchi Sea during August and September. They cite Zenkovich, a Russian biologist who wrote that in the 1930's (quoted in Mizroch et al., In prep.) "…areas near Cape Dezhnev" are "…frequented by large schools (literally hundreds…) of fin whales…." and who also reported that fin whales were "encountered from early spring to the beginning of winter." They report that Sleptsov (1961, cited in Mizroch et al., In prep.:14) wrote that fin whales occur "from the Bering Strait to the Arctic ice edge, in the coastal zone as well as the open sea. It…prefers areas free of ice, but also occurs in pools of open water among ice floes." In more recent cruises (1979-1992) no fin whales were found in the Chukchi Sea or north of the Gulf of Anadyr (Vladimirov, 1994, as cited in Mizroch et al., In prep.). The southwestern Chukchi was probably a feeding area for fin whales. Information is not available to us that would permit evaluation of the current use of this area by fin whales.

Mizroch et al. (In prep.) summarized that **there have only been rare observations of fin whales into the eastern half of the Chukchi.** Three (including a mother and calf) fin whales were observed together in the southern Chukchi at 67º 10.5' N., 168º 44.8' directly north of the Bering Strait in July 1981 (Ljungblad et al., 1982). No other sightings of fin whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of 66º N. and east of the International Date

Line, and the Alaskan Beaufort Sea from 157º 01' W. east to 140º W. and offshore to 72º N. (Ljungblad, 1988). Mizroch et al. (In prep.:15) summarized that "No other sightings…of fin whales have ever been reported from the coast of Arctic Alaska…." They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2004 (e.g., Treacy, 2002; Moore, DeMaster, and Dayton, 2000).

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

- Fin whales can occur within the Chukchi Sea, but would be rare in the Alaskan Chukchi except at the far southern regions near the Bering Strait. Within the Chukchi Sea, fin whales are more likely to occur near the Bering Strait, in the southwestern portion, along the coast of the Chukotka Peninsula, and are more likely in open water than in ice-covered waters.
- Fin whales are not expected to occur in the northeastern Chukchi Sea, in the Chukchi Sea Planning Area, or in the Alaskan Beaufort Sea.
- If climate changes in the Bering and Chukchi Seas occur over the 30-year timeframe considered such that there is continued reduction in ice thickness or extent of coverage, increased periods of open water, more frequent climatic anomalies such as El Niños and La Niñas, and /or changes in oceanographic currents or other processes, concentrations and distribution of fin whale prey species could occur, as could fin whale distribution and habitat use of these two seas. This possibility requires periodic consideration with regards for the potential of oil and gas activities within the Chukchi or, much less likely, the Beaufort Sea, to affect this species.

II.D.6.b. Use of the Bering Sea. Fin whales have been sighted in the Bering Sea during many different times of the year, including winter and early spring (e.g., January through March), summer (June-August) and in the autumn (September and October). Fin whales have been sighted the Bering Sea in January-March. Sighting data indicate high use of the Bering Sea in June-August. As they concentrate in the Bering Sea-eastern Aleutian area, they may move along the continental shelf edge following the retreating ice. In September and October, sightings indicate there are still fin whales in the Bering Sea (Mizroch et al., In prep.). Observations summarized by Mizroch et al. demonstrate that there are many fin whales, although not with small calves, in northerly waters in winter months.

During visual cetacean surveys in July and August 1999 in the central Bering Sea, and in June and July 2000, fin whale abundance estimates were almost five times higher in the central-eastern Bering Sea (provisional estimate of 3,368, CV = 0.29) (where most sightings were in a region of particularly high productivity along the shelf break) than in the southeastern Bering Sea (provisional estimate of 683, CV = 0.32) (Moore et al., 2002). One aggregation included more than 100 individuals. Aggregations of fin whales often coincided with areas where large aggregations of euphausiids, zooplankton, or fish were detected (Moore et al., 2000). Mizroch et al. (In prep.) concluded that catch densities and sightings show concentrations of fin whales within a highly productive "Bering Sea Green Belt" along the shelf edge (Springer, McRoy, and Flint, 1996). During the NOAA *Miller Freeman* cruise in the Bering Sea from June 5-July 6, 2004, fin whales were only observed in waters northwest of Nelson Lagoon (Waite, 2004).

II.D.6.c. Use of the Gulf of Alaska Region. Whaling records indicate that the fin whales were abundant in this area prior to exploitation. Nemoto and Kasuya (1965) reported that fin and sei whales were the primary species taken in the Gulf of Alaska during Japanese commercial whaling in recent catches. More than 150 fin whales were taken just south of the Kenai Peninsula. Other areas of high take in 1963 were especially southeast Alaska and areas offshore between Prince William Sound and Glacier Bay. Multiple smaller groups were taken offshore of areas south of Kodiak Island and the Alaska Peninsula to Unimak Pass, and large numbers were taken throughout the northern Gulf in an area bounded on the south at approximately 53° N. latitude.

Available sighting data indicate that fin whales inhabit some areas of the Gulf of Alaska in every season and that the distribution and relative abundance of fin whales in this large area varies seasonally. For example, fin whales have been observed in all seasons in Shelikof Strait, bays on Kodiak Island (especially on the west side), and the Gulf of Alaska (Zweifelhofer, 2002, pers. commun.; Mizroch et al., In prep.; Wynne and Witteveen, 2005), but season usage varies (see Mizroch et al., In prep.; Wynne and Witteveen, 2005; Baraff, Foy, and Wynne, 2005). In the 1960’s, 20 fin whales were sighted in the Gulf of Alaska in January (Berzin and Rovnin, 1966). Mizroch et al. concluded that fin whales likely are present in waters of Shelikof Strait, off the Kodiak Archipelago, and other northerly areas in winter because of the presence and distribution of their prey, including forage fish. In January and February, fin whales have been sighted in the Aleutian area. In April, sightings are reported all along the coast of the United States and Canada, but are concentrated around Kodiak Island. In May-July, sighting data indicate high use of the Gulf of Alaska, while August data show fewer sighting in the Gulf of Alaska. Mizroch et al. (In prep.) confirmed that fin whales from both sides of the Pacific concentrate in the Bering Sea-eastern Aleutian Island area in July and August and move along the continental shelf edge following the retreating ice.

II.D.6.d. Foraging Ecology and Feeding Areas. Nemoto and Kasuya (1965) reported that fin whales feed in shallow coastal areas and marginal seas in addition to the open ocean. Citing the IWC (1992), Perry, DeMaster, and Silber (1999a) reported that there is great variation in the predominant prey of fin whales in different geographical areas, depending on which preys are locally abundant. While they “depend to a large extent on the small euphausiids” (see also Flinn et al., 2002) “and other zooplankton” (Perry, DeMaster, and Silber, 1999a:49), reported fish prey species in the Northern Hemisphere include capelin, *Mallotus villosus*; herring *Clupea harengus;* anchovies, *Engraulis mordax*; sand lance, *Ammodytes spp*) (Perry, DeMaster, and Silber, 1999a); and also octopus, squid, and ragfish (Flinn et al., 2002). Stomach-content data from whales killed during commercial whaling in the 1950’s and 1960’s, (Nemoto and Kasuya, 1965) indicated that in the Gulf of Alaska, *Euphausia pacifica, Thysanoessa inermis, T. longipes*, and *T. spinifera* are the primary prey of fin whales. Mizroch et al. (In prep.) summarized fish, especially capelin, Alaska pollock, and herring are the main prey north of 58° N. latitude in the Bering Sea. Reeves, Silber, and Payne (1998) reported the above species as primary prey in the North Pacific and also listed large copepods (mainly *Calanus cristus*), followed by herring, walleye pollock (*Theragra chalcogramma*), and capelin. Mizroch et al. (In prep.) summarize that fin whales appear to be able to make long-distance movements quickly to track prey aggregations and can switch their diet from krill to fish as they migrate northward. They aggregate where prey densities are high (Piatt and Methven, 1992; Piatt et al., 1989; Moore et al., 1998, 2002). Often these are areas with high phytoplankton production and along ocean fronts (Moore et al., 1998). Such areas often are, in turn, associated with the continental shelf and slope and other underwater geologic features such as seamounts and submarine canyons (Steele, 1974; Boehlert and Genin, 1987; Dower, Freeland, and Juniper, 1992; Moore et al., 1998).

II.E. Humpback Whale (*Megaptera novaeangliae*) (Central and Western North Pacific Stocks) – Endangered.

II.E.1. Introduction and Summary. The humpback whale is a medium-sized baleen whale that inhabits a wide range of ocean habitats, including some documented use of the Chukchi Sea. Available information does not indicate that humpback whales typically occur, or have been documented to occur, within either the Chukchi or Beaufort Sea OCS Planning Area. However, we provide information about this species because of its potential occurrence in the southwestern Chukchi Sea.

The MMS previously provided extensive information to NMFS about humpback whales and the potential for humpbacks to be affected by oil and gas activities during our Section 7 consultation concerning potential oil and gas activities in Federal waters within lower Cook Inlet. For that consultation, MMS provided NMFS with our draft EIS for the Cook Inlet OCS Lease Sales 191 and 199, which contained our biological evaluation of potential impacts to this species. Herein, we provide much of the same basic information about humpbacked whales and potential effects of oil and gas activities on them. However, we have focused our attention on the use of this species of areas where they potentially could be exposed to oil and gas activities that may occur within the Chukchi and Beaufort Sea OCS Planning Areas and the potential effects of any such exposure. Additionally, we provide an update of baseline information and information related to evaluating potential cumulative anthropogenic impacts (as defined under the ESA) on humpback stocks that may be affected by oil and gas activities in these two areas. We refer NMFS to the recently revised draft stock assessments for these two stocks (Angliss and Outlaw, 2005:rev. 2/6/05 for western North Pacific stock [WNPS]; rev. 2/12/05 for central NPS) for additional detailed information beyond the scope of this biological evaluation.

II.E.2. ESA Status and Protective Legislation. The IWC banned commercial hunting of humpbacks in the Pacific Ocean in 1965 (Perry, DeMaster, and Silber, 1999b). Humpback whales were listed in 1973 as endangered under the ESA and as depleted under the MMPA. All stocks in U.S. waters are considered endangered (Perry, DeMaster, and Silber, 1999b, citing U.S. Dept. of Commerce, 1994b). All stocks of humpbacks are classified as "Protected Stocks" by the IWC. The NMFS published a Final Recovery Plan for the Humpback Whale in November 1991 (NMFS, 1991b).

On May 3, 2001, NMFS (66 *FR* 29502) published a final rule that established regulations applicable in waters within 200 nmi of Alaska that made it unlawful for a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yd (91.4 m) of a humpback whale. To prevent disturbance that could adversely affect humpbacks and to reduce threats from whale watching activities, NMFS also implemented a "slow, safe speed" requirement for vessels transiting near humpbacks. Exemptions to the rule were for commercial-fishing vessels during the course of fishing operations; for vessels with limited maneuverability; and for State, local, and Federal vessels operating in the course of official duty.

II.E.3. Population Structure and Current Stock Definitions. There is "no clear consensus" (Calambokidis et al., 1997:6) about the population stock structure of humpback whales in the North Pacific due to insufficient information (Angliss and Lodge, 2002) (see further discussion in USDOI, MMS, 2003a,b). For management purposes, the IWC lumps all humpback whales in the North Pacific Ocean into one stock (Donovan, 1991).

Recently, NMFS (Angliss and Lodge, 2002; Angliss and Outlaw, 2005) concluded that, based on aerial, vessel, and photo-identification surveys, as well as genetic analyses, there are at least three populations within the U.S. Exclusive Economic Zone that move seasonally between winter/spring calving and mating areas and summer/fall feeding areas:

1. a California/Oregon/Washington and Mexico stock;
2. a Central North Pacific stock, which spends the winter/spring in the Hawaiian Islands and migrates seasonally to northern British Columbia, Southeast Alaska, Prince William Sound, and west to Unimak Pass; and
3. a western North Pacific Stock, which spends the winter/spring in Japan and migrates to spend summer and fall to areas west of Unimak Pass (the Bering sea and Aleutian Islands) and possibly to the Gulf of Anadyr (NMML unpublished data, cited in Angliss and Lodge, 2004).

Additionally, there is a winter/spring population of humpback whales in the Revillagigdeo Archipelago near Mexico's offshore islands but the summer/fall destinations of these whales are not well-defined (Calambokidis et al., 1997). We are not aware of information that defines what population those humpbacks that enter the Chukchi Sea belong to. However, based on the breakdown presented above, it is most likely that these whales would belong to the Western North Pacific stock. We assume that the California/Oregon/Washington stock would not be affected. We assume it is unlikely that whales from the Central North Pacific stock would be present in the northernmost Bering Sea near Bering Strait or seasonally be present within the southwestern Chukchi Sea.

II.E.4. Past and Current Population Abundance in the North Pacific. The reliability of pre- and postcommercial exploitation and of current abundance estimates is uncertain. Based on whaling records (Perry, DeMaster, and Silber, 1999b), Rice (1978b) estimated there were above 15,000 humpbacks in the North Pacific prior to commercial exploitation. It is known that Soviet whalers under-reported their takes of certain species of whales in the North Pacific (Yablokov, 1994). Johnson and Wolman (1984) and Rice (1978a) made reported rough estimates of 1,200 and 1,000, respectively, of the numbers of humpback surviving in the North Pacific after the cessation of commercial whaling for humpbacks in 1966. However, Perry, DeMaster, and Silber (1999b) caution that it is unclear whether these estimates are for the entire North Pacific or only the eastern North Pacific. With respect to the estimate of Johnson and Wohlman and another postcommercial exploitation estimate of 1,400 by Gambell (1976), Calambokidis et al. (1997) concluded that "…the methods used for these estimates are uncertain and their reliability questionable."

Calambokidis et al. (1997) estimated the abundance of humpback whales in the mid-1990s in the wintering areas to be as follows: 394 (CV = 0.084) for the Western North Pacific Humpback whale stock; 4,005 (CV = 0.095) for the entire Central North Pacific stock on the wintering grounds in Hawaii; and about 1,600-4,200 for Mexico. Based on aerial surveys of the Hawaiian Islands, Mobely et al. (2001) estimated abundance in 2000 to be 4,491 (95% CI = 3,146-5,836) with an estimated rate of increase of 7% for the period 1993-2000). Based on surveys in the eastern Bering Sea in 2000, Moore et al. (2002) provided an abundance estimate of 102 (95% CI = 40-262). In the central Bering Sea, 315 individual humpbacks have been identified in Prince William Sound between 1977-2001 (von Ziegesar et al., 2004, as cited in Angliss and Lodge, 2004). Waite et al (1999) estimated that the annual abundance of humpbacks in the Kodiak area to be 651 (95% CI: 356-1523). Based on mark-recapture estimates of humpbacks to the west of Kodiak, Witteveen, Wayne, and Quinn (2005) estimated 410 (95% CI = 241-683) humpbacks in this area. Straley, Quinn, and Gabriele (2002) estimated that the abundance of humpback whales in Southeast Alaska is 961. Angliss and Outlaw (2005) stated that: "There are no reliable estimates for the abundance of humpback whales at feeding areas for this stock" (the Western North Pacific Stock) "because surveys of the known feeding areas are incomplete, and because not all feeding areas are known."

Additional data regarding estimates for feeding areas in more southerly regions of Alaskan waters, British Columbia, and elsewhere are provided in Angliss and Outlaw (2005:183).

There are not conclusive (Perry, DeMaster, and Silber, 1999b) or reliable (Angliss and Outlaw, 2005) data on current population trends for the western North Pacific stock. However, based on aerial surveys on the wintering grounds in Hawaii during 1993-2000, Mobely et al. (2001) estimated that the Central North Pacific stock is increasing by about 7%.

Angliss and Outlaw (2005) provided a Potential Biological Removal (PBR) of 1.3 and 12.9 animals for the Western North Pacific Humpback Whales population and the entire Central North Pacific Stock, respectively. We note that the PBR for the Western North Pacific stock is based on the conservative minimum population estimate of 367 for this stock. Angliss and Outlaw (2005) provided a PBR of 9.9 for the northern portion of the Central North pacific stock and 3.0 animals for the Southeast Alaska portion.

Based on the estimates for the three wintering areas, Calambokidis et al. (1997) reported that their best estimate for humpbacks in the North Pacific was 6,010 (SE ± 474). Adjusting for the effects of sex bias in their sampling and use of the higher estimate for Mexico yielded an estimate of about 8,000 humpback whales in the North Pacific. Perry, DeMaster, and Silber (1999b) concluded that the Calambokidis et al. (1997) estimate of about 6,000 probably was too low.

II.E.5. Reproduction, Survival and Non-Human Related Sources of Mortality.

II.E.5.a. Reproduction. Humpbacks give birth and presumably mate on their wintering ground. Perry, DeMaster, and Silber (1999b) summarized that calving occurs along continental shelves in shallow coastal waters and off some oceanic islands (e.g., Hawaii). Calving in the Northern Hemisphere takes place between January and March (Johnson and Wolman, 1984). Information about age of sexual maturity is of uncertain reliability (Perry, DeMaster, and Silber, 1999b). While calving intervals very substantially, most female humpbacks typically calve at 1- to 2-year intervals (Glockner-Ferrari and Ferrari, 1990; Straley, 1994). Gestation is about 12 months, and calves probably are weaned after about a year (Rice, 1967; Perry, DeMaster, and Silber, 1999b).

Causes of natural mortality in humpbacks in the North Pacific are relatively unknown, and rates have not been estimated. There are documented attacks by killer whales on humpbacks, but their known frequency is low (Whitehead, 1987; Perry, DeMaster, and Silber, 1999b). Lambertsen (1992) cited giant nematode infestation as a potential factor limiting humpback recovery.

Based on sighting histories of individually identified female humpback in the North Pacific compiled between 1979 and 1995, Gabriele et al. (2001) calculated minimal and maximal estimates of humpback whale calf survival in the North Pacific of 0.150 (95% confidence intervals = 0.032, 0.378) and 0.241 (95% confidence intervals = 0.103, 0.434), respectively.

Human sources of mortality, disturbance, and other effects on humpbacks, including commercial whaling are discussed in the cumulative effects section of this Biological Evaluation.

II.E.6. Migration, Distribution and Habitat Use.

II.E.6.a. General Information. Humpback whales range throughout the world's oceans, with lower frequency use of Arctic waters (Perry, DeMaster, and Silber, 1999b; Angliss and Lodge, 2002, 2005). Knowledge of their movements and the interrelations of individuals seen on different summer feeding grounds and those on different winter calving/breeding grounds is based on the recovery of whaling records about harvest locations, discovery marks used in commercial-whaling operations, photoidentification, genetic analyses, and comparison of songs (Perry, DeMaster, and Silber, 1999b). In the North Pacific each year, most (but not all individuals in all years) humpbacks undergo a seasonal migration from wintering habitats in tropical and temperate regions (10°-23° N. latitude), where they calve and mate, to more northern regions, where they feed on zooplankton and small schooling fish species in coastal and inland waters from Point Conception, California, to the Gulf of Alaska and then west along the Aleutian Islands, the Bering Sea, the Amchitka Peninsula and to the southeast into the Sea of Okhotsk (Angliss and Lodge, 2002, 2005; Nemoto, 1957). During the period of commercial whaling, there are reports of this species in the southwestern Chukchi Sea (see information provided below in the section on use of the Arctic Subregion section). Feeding areas tend to be north of about 30° N. latitude, along the rim of the Pacific Ocean basin from California to Japan. In the most recent draft stock assessment for the western North Pacific stock, NMFS (as reported by Angliss and Outlaw, 2005) summarized that: "…new information…indicates that humpback whales from the western and Central North Pacific stocks mix on summer feeding grounds in the central Gulf of Alaska and perhaps the Bering Sea" (see Figure 5).

Individuals tend not to move between feeding areas. Mizroch et al. (2004) summarized that, based on all sightings, fewer than 2% of all individuals sighted were observed in more than one feeding area.

II.E.6.b. Use of the Beaufort Sea and the Chukchi Sea. The NMFS (1991b) (citing Nikulin, 1946 and Berzin and Rovin, both in Russian), summarized that the northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback (see also Johnson and Wolman, 1984). However, neither Figure 38 of the most recent stock assessment for the Western North Pacific stock nor Figure 39 for the central North Pacific stock (Angliss and Outlaw-2005) depict the Chukchi Sa as part of the "approximate distribution" of humpback whales in the North Pacific. The draft assessment for the WNPS strikes reference to the Chukchi Sea. However, there are other references that indicate that both the historical and current summer feeding habitat of the humpback included, and at least sometimes includes, the southern portion, especially the southwestern portion, of the Chukchi Sea. Mizroch et al. (In prep.:14) cited Zenkovich, a Russian biologist who wrote that in the 1930's (quote in Mizroch et al., In prep.) "The Polar Sea, in areas near Cape Dezhnev…is frequented by large schools (literally hundreds…) of fin whales, humpbacks, and grays." Mel'nikov (2000) wrote that:

> In the fall, humpback whales formed aggregations in the most southern part of the Chukchi Sea, in the Senyavin Strait, and in the northern part of the Gulf of Anadyr. The whales left the area of the survey prior to the start of ice formation. Both in the past and at present, these waters are the summer feeding ground of humpback whales. The regular character of the encounters with the humpback whales points to signs of the restoration in their numbers in the waters off Chukchi Peninsula.

Available information does not indicate they inhabit northern portions of the Chukchi Sea or enter the Beaufort Sea. No sightings of fin whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of 66º N. and east of the International Date Line, and the Alaskan Beaufort Sea from 157º 01' W. east to 140º W. and offshore to 72º N. (Ljungblad et al., 1988). They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2004 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002). Recently, during a research cruise in which all marine mammals observed were recorded from July

5 to August 18, 2003, in the Chukchi and Beaufort seas, no humpback whales were observed (Bengtson and Cameron, 2003).

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

- Humpback whales could occur in the southern Chukchi Sea, especially the southwestern Chukchi Sea. We assume this area is a portion of the summer feeding grounds for this species.
- Humpback whales do not tend to occur further north and are not expected to occur within the Chukchi Sea Planning Area.
- Humpback whales do not occur in the Alaskan Beaufort Sea.

As with the fin whale, continued climate change could result in changes in oceanographic conditions, the distribution of humpback prey species, and the distribution of humpback whales. This possibility requires periodic consideration with regards for the potential of oil and gas activities within the Chukchi or, much less likely, the Beaufort Sea, to affect this species.

II.E.6.c. Use of the Bering Sea and Gulf of Alaska Regions. In the summer, humpback whales regularly are present and feeding in areas near and within the Bering Sea and Gulf of Alaska.

Observations by Mel'nikov (2000) of humpback whales adjacent to the Chukotka Peninsula indicate that humpbacks whales are present and feeding in the most northerly portions of the northwestern Bering Sea in the summer and autumn prior to ice formation.

Thus, for the purposes of our analyses, we assume that humpbacks do occur seasonally just south of the Bering Strait, and that they transit between the Chukchi and Bering seas through the Bering Strait in the summer and autumn.

In the summer, humpback whales regularly are present and feeding in areas near and within the Bering Sea. During ship surveys in the summers of 1999 and 2000, humpbacks were seen only in the central eastern Bering Sea southwest of St. Lawrence Islands and a few sightings occurred in the southeast Bering Sea, primarily north of eastern Aleutian Islands and outside of Bristol Bay (Moore et al., 2002). These sightings indicate that portions of the Bering Sea are important feeding areas for humpbacks (Moore et al., 2002). During ship surveys of 2,032 km in the eastern Bering Sea from June 5-July 3, 2004, humpback whale sightings were scattered, with most seen nearshore from Akutan Island and west along the northern coast of the Alaska Peninsula (Waite, 2004:Figure 3). Waite (2004) reported that the most northerly humpback sighting was about 300 km north of the Pribilof Islands.

In the summer, humpback whales regularly are present and feeding in areas near and within the Gulf of Alaska and adjacent waters. Within the Gulf of Alaska region, evidence indicates that portions of the Kodiak Archipelago area, including the area off Albatross Banks (Waite et al., 1999; Witteveen, Wynne, and Quinn, 2005; Wynne and Witteveen, 2005); Prince William Sound; the Barren Islands (Sease and Fadely, 2001); and adjacent waters are important feeding areas for humpback whales. Acoustic monitoring from May 26-September 11, 2000, of the area south of Kodiak Island detected a large number of humpback whale calls (Waite, Wynne, and Mellinger, 2003). Based on aerial (1985) and vessel (1987) surveys, Brueggeman et al. (1989) suggested that there are discrete groups of humpbacks in the Shumagins, but data are insufficient to characterize numbers or structure of humpbacks in this area (Waite et al., 1999). During a 1994 ship survey in which a zig-zag pattern was followed extending about 200 nmi (370 km) southward between Tanaga Island in the Aleutians and the south end of the Kodiak Archipelago, Forney and Brownell (1996) observed humpback whales throughout the study area, especially in the eastern half, nearer to Kodiak Island and south of the Alaska Peninsula between 152° and 165° W. longitude. In this region, humpbacks were observed in "…scattered aggregations extending many miles" (Forney and Brownell (1996:4) usually offshore in deep water over the Aleutian Trench or Aleutian Abyssal Plain. Humpbacks also were observed scattered throughout the western region surveyed between 167° and 175° W. longitude. Available information indicates that both the Central and Western North Pacific stocks overlap in their feeding areas in the Gulf of Alaska between the Shumagin Islands and Kodiak Island (Angliss and Outlaw, 2005).

Portions of Southeast Alaska, including but not limited to Glacier Bay, Icy Strait, and Frederick Sound, are important feeding habitat for humpback whales with abundance peaking in late summer. Most, but not all, of these whales winter in Hawaii. While humpbacks are present in portions of Southeast Alaska year-round, few individuals are present year-round.

II.E.7. Feeding. Humpbacks tend to feed on summer grounds and to not eat on winter grounds. However, some low-latitude winter feeding has been observed and is considered opportunistic (Perry, DeMaster, and Silber, 1999b). They engulf large volumes of water and then filter small crustaceans and fish through baleen plates. They are relatively generalized in their feeding. In the Northern Hemisphere, known prey includes: euphausiids (krill); copepods; juvenile salmonids, Oncorhynchus spp.; Arctic cod, Boreogadus saida; walleye pollock, Theragra chalcogramma; pollock, Pollachius virens; pteropods; and cephalopods (Johnson and Wolman, 1984; Perry, DeMaster, and Silber, 1999b). Bottom feeding recently has been documented in humpbacks off the east coast of North America (Swingle, Barcho, and Pichford, 1993). Within a feeding area, individuals may use a large part of the area. Two individual humpbacks sighted in the Kodiak area were observed to move 68 km (~42.25 mi) in 6 days and 10 km (~6.2 mi) in 1 day, respectively (Waite et al., 1999). In the Kodiak Archipelago, winter aggregations of humpbacks were frequently observed at the head of several bays where capelin and herring spawn (Witteveen, Wynne, and Quinn, 2005), a pattern similar to that reported to Southeast Alaska where sites occupied in the winter are coincident with areas that have overwintering herring.

III. ACOUSTIC ENVIRONMENT OF THE BEAUFORT AND CHUKCHI SEA PLANNING AREAS

Because of variability in components of environmental conditions such as sea ice, temperature, wind, and snow; presence of marine mammals; presence of industrial, shipping, research, and subsistence activities; and other factors, the acoustic environment and ambient noise levels in the Beaufort and Chukchi Seas can vary dramatically between and within seasons, and between specific areas. During much of the year, in many marine areas in this region, there are few near-field marine noise sources of human origin and limited, but increasing, land-based sources of noise that affect the OCS.

III.A. Influence of Ice on the Acoustic Environment.

The marine waters of the Arctic are a unique noise environment mainly due to the presence of ice, which contributes significantly to ambient noise levels and affects sound propagation. As noted by the National Research Council (NRC) (2001:39): "(A)n ice cover radically alters the ocean noise field…" with factors such as the "…type and degree of ice cover, whether it is shore-fast pack ice, moving pack ice and…floes, or at the marginal ice zone…", and temperature, all affecting ambient noise levels. The NRC (2001, citing Urick, 1984) reported that variability in air temperature over the course of the day can change received sound levels by 30 dB between 300 and 500 Hz (see discussion pages 39-41 of the NRC, 2001 for more detail).

Temperature affects the mechanical properties of the ice and temperature changes can result in cracking. Ice deformation due to wind and currents produces low frequency noises. In winter and spring, landfast ice produces significant thermal cracking noise (Milne and Ganton, 1964). In areas characterized by a continuous fast-ice cover, the dominating source of ambient noise is the ice cracking induced by thermal stresses (Milne and Ganton, 1964). The spectrum of cracking noise typically displays a broad range from 100 hertz (Hz) to 1 kHz, and the spectrum level has been observed to vary as much as 15 decibels (dB) within 24 hours due to the diurnal change of air temperature. Richardson et al. (1995b:93, citing Milne and Ganton, 1964) summarized that the:

> spring noise spectra peaked at ~90 dB re 1 μPa^2/Hz at infrasonic frequencies (0.5-2 Hz). Above 2 Hz, spectrum levels decreased with increasing frequency up to ~ 20 Hz, above which the levels remained essentially constant up to 8 kHz…The winter noises spectra included wind-induced noise as well as thermal cracking sounds.

Data are limited on ice-deformation noise, but at least in one instance, it has been shown to produce noises at frequencies of 4-200 Hz (Greene, 1981). As icebergs melt, they produce additional background noise. While sea ice can produce significant amounts of background noise, it also can function to dampen ambient noise. Areas of water with 100% sea-ice cover can reduce or completely eliminate noise from waves or surf (Richardson et al, 1995b). Because ice effectively decreases water depth, industrial sounds may not propagate as well at the lowest frequencies (Blackwell and Greene, 2002). The marginal ice zone, the area near the edge of large sheets of ice, usually is characterized by quite high levels of ambient noise compared to other areas in large part due to the impact of waves against the ice edge, and the breaking up and rafting of ice floes (Milne and Ganton, 1964). In the Beaufort and Chukchi seas, wind and waves (during the open-water season) are important sources of ambient noise, with noise levels tending to increase with increased wind and sea state, all other factors being equal (Richardson et al., 1995b). Blackwell and Greene (2002) noted that the presence of ice in Cook Inlet could increase low-frequency ambient noise by increasing the turbulence due to tidal flow.

III.B. Marine Mammals.

Marine mammals can contribute significantly to the background noise in the acoustic environment of the Beaufort and Chukchi seas; however, frequencies and levels depend highly on seasons. For example, in the spring, bearded seals contribute to ambient noise (see Richardson et al., 1995b:193 for a description of the call). Source levels of bearded seal songs have been estimated (Cummings et al., 1983) to be up to 178 dB re 1 μPa at 1 m (decibels re 1 microPascal at 1 meter). Ringed seal calls have a source level of 95-130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kilohertz (kHz) (Richardson et al., 1995b). Bowhead whales, which are present in the Arctic Region from early spring to mid- to late fall, produce sounds with source levels ranging from 128-189 dB re 1 μPa at 1 m in frequency ranges from 20-3,500 Hz. Richardson et al. (1995b:160) summarized that most of their calls are "tonal frequency-modulated (FM) sounds at 50-400 Hz. During spring migrations, bowhead whales produce long song notes that cover a broader frequency range (less than 4,000 Hz) (Ljungblad et al., 1982a; Cummings and Holliday, 1987; Würsig and Clark, 1993). There are many other species of marine mammals in the arctic marine environment whose vocalizations contribute to ambient noise in this subregion, including, but not limited to the gray whale, walrus, ringed seal, beluga whale, spotted seal, fin whale, and humpback whale (in the southwestern areas). In air, nonhuman but living sources will include sea birds (especially in the Chukchi Sea near colonies), walruses, and seals. A complete description of all animal noise producers is beyond the scope of his document.

III.C. Vessel Traffic.

Vessel traffic and associated noise in the Beaufort and Chukchi seas is, at present, primarily limited to late spring, summer, and early autumn. In shallow water, shipping traffic more than 10 km away from a receiver generally contributes only to background noise (Richardson et al., 1995b). However, in deep water, traffic noise up to 4,000 km away may contribute to background noise levels (Richardson et al., 1995b). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995b). Barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contributes to overall ambient noise levels in some regions of the Beaufort Sea. Whaling boats (usually aluminum skiffs with outboard motors) contribute noise during the fall whaling periods in the Alaskan Beaufort Sea. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats is typically at a higher frequency, around 300 Hz (Richardson et al., 1995b).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce stronger, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995b). Even with rapid attenuation of sound in heavy ice conditions, the elevation in noise levels attributed to icebreaking can be substantial out to at least 5 km (Richardson et al., 1991). In some instances, icebreaking sounds are detectable from greater than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995b).

Other acoustical systems are associated with some research, military, commercial, or other vessel use of the Beaufort or Chukchi seas. Such systems include multi-beam sonars, sub-bottom profilers, acoustic Doppler current profilers, etc   Descriptions of examples of these types of acoustic sources are provided in LGL Alaska Research Assoc. and LGL Ltd., environmental research assoc. (LGL Ltd., 2005).

III.D. Existing Oil and Gas Activities.

We describe sounds from offshore seismic surveying in the effects section.

Currently, there are a few oil-production facilities on artificial islands in the Beaufort Sea. Recently, Richardson and Williams (2004, and chapters therein) summarized results from acoustic monitoring of the offshore Northstar production facility from 1999-2003. Northstar is located on an artificial gravel island in the central Alaskan Beaufort Sea (see figure in Richardson and Williams, 2004:xiii). In the open-water season, in-air broadband measurements reached background levels at 1-4 km and were not affected by vessel presence. However, Blackwell and Greene (2004) pointed out that "…an 81 Hz tone, believed to originate at Northstar, was still detectable 37 km from the island." During the open-water season, vessels such as tugs, self-propelled barges, and crew boats were the main contributors to underwater sound levels, with broadband sounds from such vessels often detectable approximately 30 km offshore. In 2002, sound levels were up to 128 dB re 1 μPa at 3.7 km when crew boats or other operating vessels were present (Richardson and Williams, 2003:xvii). In the absence of vessel noise, underwater averaged broadband island sounds generally reached background levels 2-4 km from Northstar. Underwater sound levels from a hovercraft, which British Petroleum began using in 2003, were quieter than similarly sized conventional vessels. At about 6.5 m from the hovercraft, underwater broadband levels reached 130 (at 1 m) and 125 (at 7 m) dB re 1 μPa. Sound produced by the hovercraft was of a wide range of frequencies. Based on sounds measurements of noise from Northstar obtained during March 2001 and February-March 2002 (during the ice-covered season), Blackwell (2003) found that background levels were reached underwater at 9.4 km when drilling was occurring and at 3-4 km when it was not. However, irrespective of drilling, in-air background levels were reached at 5-10 km from Northstar. Drilling and production sounds tended to be less variable than those during construction, which had lower minimums but higher maximum sound levels. Shepard et al. (2001) characterized noise conditions during construction with and without a vibrahammer operating. Manmade underwater noise (from the vibrahammer or from vehicle and machinery noise) was higher near the bottom compared to measurements taken at midwater column depth. Noise levels measured 150 m from the island during vibrahammer operations varied from 0-50 dB re 1 μPa per Hz per 1/3 octave band with strong tonal frequencies at 23 and 30 Hz. Vehicle and machinery noise 150 m from the island at the 1/3 octave band spanned 2 Hz to 1 kHz, with levels rising as high as 40 dB above ambient conditions. In general, the noise environment approximately 4 km north of Northstar had hardly any apparent manmade noise contamination. Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995b). Richardson et al. (1995b:17) summarized that while during unusually quiet periods, drilling noise from icebound islands would be audible at a range of about 10 km, "…the usual audible range would be ~2 km." Richardson et al. (1995b:128) also summarized that: "Broadband noise decayed to ambient levels within ~1.5 km. Low-frequency tones were measurable to ~9.5 km under low ambient noise conditions, but were essentially undetectable beyond ~1.5 km with high ambient noise."

III.E. Military Activities.

According to USDOC, NMFS (2002), the Navy does not intend to operate SURTASS LFA sonar in polar waters.

III.F. Potential Effect of Climate Change on the Acoustic Environment

Available evidence indicates that the total extent of arctic sea ice has declined over the past several decades. However, these declines are not consistent across the Arctic (e.g., Gloersen and Campbell 1991; Johannessen, Miles, and Bjorgo, 1995; Maslanki, Serreze, and Barry, 1996; Parkinson et al, 1999;

Vinnikov et al. 1999; see reviews in the IPCC, 2001b). Warming trends in the Arctic (Comiso 2003) appear to be affecting thickness of multiyear ice in the polar basin (Rothrock, Yu, and Maykut, 1999) and perennial sea-ice coverage (declines 9% per decade) (Comiso 2002a; 2002b). The Working Group I of the IPCC (IPCC, 2001b) concluded that: "It is likely that there has been about a 40% decline in arctic sea-ice thickness during late summer to early autumn in recent decades and a considerably slower decline in winter sea-ice thickness" (IPCC (2001b:4).

As discussed above, the presence, thickness, and movement of sea ice contributes significantly to ambient noise levels. The presence of sea ice also affects the timing, nature, and possible locations of human activities such as shipping, research, barging, subsistence hunting, oil- and gas-related exploration (e.g., seismic surveys and drilling), military activities, and other activities that introduce noise into the marine environment. Because of sea ice and its effects on human activities, ambient noise levels in the Beaufort and Chukchi seas as well as in parts of the Gulf of Alaska and Bering Sea, can vary dramatically between seasons and sea-ice conditions. The presence of ice also impacts which marine species are present, another factor that affects ambient noise levels.

If climate warming continues, it is likely that changes in the acoustic environment will also occur in many parts of the waters off of Alaska due to increased human use of the seasonally ice-covered waters (e.g., Tynan and DeMaster, 1997; IPCC, 2001b: Brigham and Ellis, 2004). Climate warming potentially could affect the acoustic environment in ways that include: (a) increased noise and disturbance related to increased shipping and other vessel traffic, and possibly related to increased development; (b) expansion of commercial fishing and/or changes in areas where intensive fishing occurs; (c) decreases in ice cover; (d) potential changes in subsistence-hunting practices; and (e) changes in the distribution of marine mammal species in all subregions within Alaska (e.g., MacLeod et al., 2005). For example, L. Brigham (cited in Brigham and Ellis, 2004:4) stated that "the observed and projected retreat of multi-year ice from the Arctic coastal regions may very well change" conclusions about the requirements and the ability for highly capable icebreakers to operate year-round in the Beaufort and Chukchi seas. Available information indicates that changes in the acoustic environment due to climate change are most likely to occur first in the Arctic.

IV. POTENTIAL EFFECTS OF OIL AND GAS ACTIVITIES IN THE CHUKCHI SEA AND BEAUFORT SEA PLANNING AREAS ON ENDANGERED AND THREATENED BOWHEAD, FIN, AND HUMPBACK WHALES

IV.A. Introduction.

In the following section, we discuss potential effects of the proposed action on bowhead whales, fin whales, and humpback whales. The purpose of our evaluation is to determine whether reasonably foreseeable oil and gas activities in the Beaufort Sea and Chukchi Sea Planning Areas potentially could have adverse effects on endangered bowhead, fin, and humpback whales. While MMS is consulting with NMFS regarding the potential effects of oil and gas leasing and pre- and postlease exploration activities (including G&G permitted exploration activities, ancillary or similar activities in support of plans and permit applications, and exploration drilling) on all current and future leases, we have also considered the potential effects of development, production, and abandonment activities, so that NMFS can determine whether the whole action is likely to jeopardize the continued existence of any of these three endangered species.
We have taken the following approach to our effects analyses:

1. We articulate the general ecological principles and assumptions underlying our analyses.
2. We explicitly state specific assumptions about the action and the potentially affected species underlying the analyses.

3. We systematically go through potential pathways by which endangered cetaceans potentially could be affected by different parts of the proposed action. At the end of this section, we briefly summarize which of these activities occurs during exploration, development, production, and abandonment. These delineations are valid with respect to the purpose of the activity.
4. We evaluate whether any one of the three species has the potential to be exposed to affecters associated with OCS oil and gas activities in the Chukchi Sea and Beaufort Sea evaluation areas (see Figure 1). We give a brief summary of why we believe the species could not be affected. If we conclude the species could be exposed to the potential affecter, we undertake a more in-depth evaluation of potential effects.
5. Because exploration, development, and production could, in future years, occur simultaneously, we have grouped our discussion of potential pathways of impact by those that have common modes of potential impact (e.g., activities that cause noise and disturbance). Once oil and gas activities proceed past the exploration stage in a given area, some of these types of activities can begin to overlap in time and space. For instance, in the general region near the Northstar production facility, additional exploration or development could occur. Within the discussion of activities that can cause types of effects, we begin with background information necessary to understand the way(s) in which the general class of affecter (e.g., marine noise) could cause impacts to endangered whales.
6. We proceed to a review of specific information about the type of affecter (e.g., drilling noise) that could potentially cause impact and then discuss how the potentially exposed species may be impacted.
7. We identify areas and times where and when potential effects might reasonably be expected to be greater than typical.
8. We provide a summary of potential effects and our conclusions by species.

The analyses in this section are based on the exploration, development, production, and abandonment scenarios presented in Appendix II. We note that the uncertainty of effects increases the further into the future we attempt to estimate activities that may occur in the future, especially those that may occur past 2007. At present, MMS is providing NMFS with our best estimates about what level and kinds of leasing and pre- and postlease exploration may occur. To enable determination of whether MMS can proceed with that incremental step of leasing and exploration, MMS is also providing our best assumptions about development, production, and abandonment that may result. Because of the uncertainty about future potential activities, we have tried to make our analyses conservative. For example, we have made assumptions about activity levels that, at least based on historical patterns, may be overestimates. If these estimates are overestimates, we will be overestimating potential effects. Mitigating measures put into place to reduce such potential effects will be precautionary. However, we also acknowledge that there is renewed industry interest in the Alaskan Arctic. As required under provisions of Section 7 of the ESA, if our assumptions prove to be underestimates such that the activities could result in effects to listed species of a kind or to an extent that was not covered in this consultation, we will reinitiate consultation with NMFS prior to taking actions that could result in such unanticipated effects. Regardless, we will reinitiate consultation with NMFS for any future development plan.

IV.B. Assumptions.

IV.B.1. General Principles and Assumptions Underlying Analyses of Potential Effects.

1. ***Potential effects on females with calves, on newborn calves, on all calves over their first year, and on females merit special consideration***. Baleen whales are a relatively long-lived, late-maturing group of species with relatively low reproductive rates, and with extremely high maternal investment in young. A major hypothesis of life history theory is that future survival and reproductive success are affected by early development conditions (e.g., Beauplet et al., 2005). The probability of postweaning survival to age 1 increases with body condition in at least some marine mammals (e.g., Hall, McConnell, and Barker, 2001). In a species such as a bowhead whale, where the periods of body growth, maturation, gestation, maternal care, and intervals between reproductive attempts are all (mostly relatedly) long, the ability of the female to provide adequate care (e.g., through nursing and possibly the teaching of the locations of key resources) to her offspring during its period of dependency is critical to the continued recovery and the long-term viability of the population. In providing guidance on the evaluation of whether ocean noise disturbance of marine mammals should be considered biologically significant, the NRC (2005:82-83:Box 4-1) stated that:

> Different standards for disruption of breeding behavior should be considered for females and males. The ability of a female to select a mate, breed, gestate, and give birth to a viable offspring is so essential to populations that there should be very low tolerance of disturbances that might affect these activities....
>
> Very low thresholds should be considered for any disturbance that might separate a dependent infant from its caregivers.... Both the duration of nursing bouts and the distribution of intervals might be important....

We also acknowledge that the effects of anthropogenic noise and other potential affecters (e.g., oil spills) on baleen (or other cetacean) calves, especially newborn calves, is highly uncertain. Absent direct information on potential effects on baleen calves, we draw on more general mammalian literature about potential effects on very young individuals. Data from other mammalian species, such as humans, indicates that there are deleterious effects on offspring and juvenile hearing and health due to exposure to excessive noise during pregnancy, infancy (e.g., Committee on Environmental Health**,** American Academy of Pediatrics, 1997; Chang and Merzenich, 2003), and even childhood. "Developing mammals are more sensitive to noise…than adults" (Henley and Rybak, 1995; Saunders and Chen, 2006). "Children and unborn children are in certain respects especially vulnerable to environmental effects…" (of noise). "It is not only the dose that is important in determining whether harm will arise but also the development stage when the exposure occurs. Organ systems that develop and mature over a long period are considered to be particularly vulnerable. Examples of such organ systems are the brain, the hormone system, the reproductive organs and the immune system" (K. Victorin, available at http://www.env.go.jp/en/topic/health03/01.pdf). Thus, we believe this information also supports special concern and mitigation aimed at reducing impacts to these age classes of whales. When this information is considered in concert with data indicating potential extreme longevity of bowheads and the potential for repeated exposures throughout a whale's life to seismic and other noise (see below), or to repeated pollution events, this concern is heightened.

Available data also indicate that female mammals with young (e.g., Bergerud, 1974), including female baleen whales (e.g., Tilt, 1985; Bauer et al., 1993; McCauley et al., 2000; NRC, 2003), show a heightened response to noise and disturbance, including seismic noise than do juvenile and adult males. In summarizing the potential effects of noise on marine mammals, the NRC (2003:92) stated that: "Some age and sex classes are more sensitive to noise disturbance, and such disturbance may be more detrimental to young animals…." McCauley et al. (2000) summarized that in their experience, humpback whale cow/calf pairs are more likely to exhibit an avoidance response to a sound to which they are unaccustomed. They recommended that "…any management issues related to seismic surveys should consider the cow/calf responses as the defining limits" (McCauley et al., 2000:697). They also recommended that management decisions distinguish between whales that are in a "…key habitat type" (McCauley et al., 2000:698) and those that are migrating through an area. They list areas used for feeding, resting, socializing, mating, calving, or other key purposes as "key habitats."

Thus, for reasons provided in the paragraphs above, we highlight potential effects on females and on calves in our analyses to inform potential shaping of the action to avoid or to minimize these impacts.

2. ***Potential effects on "key habitat types" such as those used for calving, feeding, breeding, and resting, and those portions of the migratory pathway where the movements of the whales are constrained (e.g., the spring lead and polynya system in bowheads) merit special consideration.*** Whales do not use all portions of their range in a random fashion. Thus, impacts in all portions of the range are not of equal importance. To the extent that information exists, we have highlighted potential effects that could affect the use of areas used for calving, feeding, resting, and breeding by large numbers of whales. We have also highlighted potential effects on areas of the migratory pathway where the whale movements are constrained.

3. ***The considerable potential longevity of the bowhead, coupled with its migratory use of the habitat, is important to consider in evaluating potential effects, and especially cumulative effects, of the proposed action.*** Unlike the situation in shorter lived species, an individual bowhead may experience multiple disturbance effects from the proposed actions at different locations within the same season, at the same general location but at different times during the same year, and/or over different and multiple years. Because of their extreme longevity, should development and production occur in both evaluation areas and over many years, probabilities indicate bowhead whales may be exposed to pollution from multiple events over the course of their lifetime. Many of them already may have been exposed to multiple events (see cumulative section).

4. ***Uncertainty should be acknowledged explicitly, because it may point to areas that require monitoring and consideration of adaptive management.*** The species of whales under consideration in this section are large, endangered, baleen whales. The whale most likely to be exposed to the proposed activities is (are) the stock(s) of bowhead whales that inhabit the Bering-Chukchi-Beaufort Seas. This group of whales is important to the viability of the species as a whole and is a species of very high importance for subsistence and to the culture of Alaskan Native peoples of the northern Bering Sea, the Chukchi Sea, and the Beaufort Sea. Especially because of the significance of any potential impacts (for the reasons given above), it is important to acknowledge what we know and what we do not know. There are multiple sources of uncertainty in our analyses. These include, but are not limited to uncertainty about the action: where seismic surveys will occur; how many surveys will occur; how much noise will be produced purposely by the firing of airguns; what the exact shape of related activities, such as support vessel type and activity will be; where exploration drilling could occur; where leases will be let; where a spill could occur; where production platforms and pipelines may be based; etc. More important, there is acknowledged (e.g., NRC, 2003, 2005; minutes from meetings of the Marine Mammal Commission Sound Advisory Panel [http:/www.mmc.gov/sound/]) scientific uncertainty about the potential effects of noise, especially repeated exposure to loud noise, on baleen whales. There is uncertainty and controversy regarding the potential effects of oil spills on large cetaceans. There are very few, if any, data available about potential effects of either noise or oil spills on cetacean calves. Lastly, and importantly, data are not available sufficient to characterize the current seasonal and temporal use of the Chukchi Sea evaluation area by bowhead and other whales, or to fully understand the importance of parts of the Beaufort Sea to bowhead whales. Thus, it is difficult to predict exposure in some parts of the area where the action could occur, and to understand fully the potential effects of any exposure. However, while some sources of uncertainty cannot be reduced (e.g., long-term exposure to elevated noise levels) **we can reduce overall uncertainty** about potential impacts on baleen whales through requirements for monitoring coupled with an adaptive management approach wherein mitigations are tailored to conditions that are discovered through monitoring.

5. ***Where there is uncertainty, the status of the population that potentially could be affected by our action relative to the species, and other important characteristics of the population, provides guidance into whether the analyses should be conservative and how precautionary the shape of the action should be***. As discussed above and in the affected environment section, the BCB Seas stock of bowhead whale is the only stock of bowheads that is robust and well on its way to recovery from depletion due to commercial whaling. Thus, the population that could be exposed to the proposed actions is important to the long-term viability of the species as a whole. This fact recommends a conservative approach to the analyses and the shaping of the action.

6. ***The bowhead's association with ice and its dependence upon the spring lead and polynya system make it problematic to extrapolate the potential impacts of seismic noise, or other loud noise that could occur, from information available about other species that have been exposed to such potential affecters in open water, or even from information about bowheads that have been exposed to seismic survey noise in open water***. Unlike a species with less constrained migratory pathways, bowhead whales are, over some of their migratory pathway, relatively fixed in at least part of the "road" they travel during spring migration. There will be no drilling activities in the Chukchi Sea polynya before 2011, and depending on future NEPA analysis and decisions, it may not occur in the foreseeable future.

7. *The fact that the BCB stock of bowheads is hunted throughout most of its range needs to be considered in evaluating the potential effects that MMS actions could have on this species*. While we discuss this more fully in the section on cumulative effects, we note that geographic areas that exist in between areas where bowheads are hunted, and temporal periods in hunting areas in between periods when bowheads are hunted, may have more significance (e.g., as resting areas) to bowheads than they would if the species were not hunted. The fact that they are hunted also may heighten their response to oil and gas noise and disturbance at least in some instances.

8. *Current status and response to other perturbations is informative about potential response to the proposed actions*. Based on available information, the bowhead population that may be affected is robust and resilient to a relatively steady lethal take in the subsistence hunt. This level of current mortality is below that which the IWC Scientific Committee believes is sustainable for this population. We do not expect direct mortality on baleen whales from the proposed action but acknowledge that mortality could occur. However, it is clear that this population has continued to recover, despite previous activities that caused disturbance and lethal take. This continued recovery is informative about its resilience at least to the level of disturbance and take that have occurred within the past 20 years.

IV.B.2. Explicit Assumptions Underlying Analyses of Potential Adverse Effects from Oil and Gas-Related Activities in the Beaufort and Chukchi Sea Planning Areas.

For the purposes of our analyses, we make the following explicit assumptions about the proposed action.

1. The MMS assumes monitoring and mitigating measures similar to those required in the last two IHA's dated August 13, 2001 and July 20, 1999 (Appendix VI), related to protection of bowhead whales and the availability of bowhead whales for taking by subsistence hunters during oil and gas activities in the Beaufort Sea. Because there have not been exploration activities in the Chukchi Sea since 1990, we also assume that certain (see below) MMS measures to protect whales in the spring lead system will continue to be applied and that measures developed to protect whales, and the availability of whales to subsistence hunters in the Beaufort Sea will be applied to both the Chukchi and the Beaufort Seas as appropriate to protect bowhead whales. We assume that these measures will be in place unless NMFS, through the process of this consultation, or through the issuance of an IHA, concludes that such measures do not afford protection to the whales or do not afford protection to the availability of bowheads for take by subsistence hunters, or if NMFS identifies other measures that they require or recommend instead of these specific measures. Thus:

- We explicitly assume that MMS will not allow any seismic operation in the spring lead system through the end of June, or as authorized by NMFS as necessary to avoid potential adverse effects on the spring migration of bowhead whales, on calving, on females with newborn calves, and on calves.

2. In the Beaufort Sea, the MMS also has previously identified and applied mitigation for on-lease activities, including seismic surveys, during the bowhead whale migration and the subsistence bowhead whale hunt. We explicitly assume these measures also will continue to be applied and these assumptions underlie our analyses. **Thus, we assume that stipulations 1-6 as numbered in the Beaufort Sea Lease Sale 195 EA will apply to future on-lease actions in the two arctic evaluation areas.** These measures would apply to any on-lease seismic activity, including 3D, 2D, and site-clearance surveys. Under lease stipulation 4, the MMS requires companies to conduct site-specific bowhead whale-monitoring programs to determine when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. The stipulation lists specific timeframes when the migration occurs for specific leases and when the stipulation applies. The requirements of this stipulation may be satisfied by an LOA or IHA from NOAA. In addition, lease stipulation 5 requires companies to also consult with directly affected subsistence communities, the North Slope Borough and the Alaska Eskimo Whaling Commission to discuss potential conflicts with the siting, timing, and methods of proposed operations, as well as safeguards or mitigating measures that could be implemented by the

operator to prevent unreasonable conflicts. Finally, the MMS issues a clear statement of intent by including Information to Lessee clause (d) in the notice of sale:

> The MMS may limit or require operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use. The MMS and NOAA Fisheries will establish procedures to coordinate results from site specific surveys required by Stipulation 4 and NOAA Fisheries LOAs or IHAs to determine if further modification to lease operations are necessary.

IV.B.3. Potential Pathways of Impact. In a recent review evaluating the vulnerability of baleen whales to potential environmental degradation, Clapham and Brownell summarized that "…oil and gas development involves increased shipping traffic, seismic surveys, other noise, and the potential for catastrophic pollution events…" We note that there are multiple potential pathways through which bowhead whales could be impacted by exploration, development, production and abandonment actions in the Beaufort and Chukchi Seas and they include those given below.

IV.B.3.a. Exploration. There are multiple potential pathways through which bowhead whales could be impacted by oil and gas exploration activities in the Beaufort Sea and Chukchi Sea evaluation areas. Noise, potential disturbance, and discharges associated with 2D/3D seismic surveys, high-resolution seismic surveys, emplacement or construction of exploration drilling facilities, exploratory drilling, marine vessel traffic including ships, boats, and icebreakers, and aircraft could be expected to result as part of routine OCS oil and gas exploration activities. Additionally, endangered cetaceans conceivably could be disturbed or struck by ships or boats during exploration. Small fuel spills could occur. Any or all of these factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea or Beaufort Sea Planning Areas during OCS oil and gas exploration.

IV.B.3.b. Development. Based on prior projects, noise and potential disturbance, and possible localized habitat modification due to construction of a production platform, pipeline emplacement, shore-base construction, and production-unit development all could adversely affect bowhead whales. Marine vessel traffic, including sealift and other barges, boats, and icebreakers, and aircraft, could be expected to result as part of routine OCS oil- and gas-development activities. Additionally, endangered cetaceans conceivably could be disturbed or struck by ships or boats during development. Small fuel spills (defined as all spills ranging between a tablespoon and <1,000 barrels [bbl]) could occur. Any or all of these factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea or Beaufort Sea Planning Areas during OCS oil and gas development. There also are potential pathways of impact that are much less likely to occur and/or are not considered part of routine activities but that, based on data from previous development projects, have some estimable but low probability of occurring if a development project resulted from the proposed lease sale. This category would include large oil spills (>1,000 bbl).

IV.B.3.c. Production. During production, noise and disturbance from the platform itself, drilling, marine vessels including crew boats and barges, and aircraft, routinely occur and could adversely affect baleen whales. If oil spills from platforms or pipelines occur, they also could adversely affect baleen whales. There also are potential pathways of impact that are less likely to occur and/or are not considered part of routine activities but that, based on data from previous production projects, have some estimable probability of occurring if a development project resulted from the proposed lease sale. This category would include large oil spills (defined elsewhere as those >1,000 bbl).

IV.B.3.d. Abandonment. During abandonment, noise from platform removal and vessel traffic, habitat alteration, and temporary effects on water quality could result.

In Appendix II, we describe oil and gas leasing, exploration, development, production, and abandonment actions that we assume may occur for the purposes of analyses. Below we provide background information on factors resulting from OCS oil and gas exploration and development that could affect endangered cetaceans. Based on that information and information from studies about the potential impacts of each factor on specific species and on similar species, we evaluate the potential for the bowhead whales, fin whales and humpback whales to be affected by that factor.

IV.C. Potential Effects of Noise and Disturbance from Proposed Actions on Bowhead, Fin, and Humpback Whales

One of the greatest concerns associated with the impacts of oil and gas exploration and development on marine mammals has to do with potential impacts of noise on their ability to function normally and on their health. During OCS oil and gas exploration, development, production, and abandonment activities, human-caused noise is transmitted through the air and through marine waters from a variety of sources including, but not limited to: 2D/3D seismic surveys; pipeline, platform, and related shorebase construction; drilling; platform abandonment; icebreaker and other ship, boat, and barge transit; high-resolution seismic surveys; and helicopter and fixed-winged aircraft traffic.

Because of the importance of this issue, we provide two background sections. The first provides very general information relevant to understanding the fate of noise in the marine environment. The second provides general background about potential types of effects of noise on marine mammals. After these sections, we summarize the potential for each of the three species of whales to be exposed to oil and gas-related noise and disturbance in the Chukchi Sea and Beaufort Sea evaluation areas. We then review specific studies about the potential impacts on these species.

IV.C.1. Background on Noise in the Marine Environment. Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include: its intensity, frequency, amplitude, wavelength, and duration; distance between the sound source and the animal; whether the sound source is moving or stationary; the level and type of background noise; and the auditory and behavioral sensitivity of the species (Richardson et al., 1995a). The frequency of the sound is usually measured in hertz (Hz), pressure level in micropascals (µP) (Gausland, 1998), and intensity levels in decibels (dB) (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000) and others (see references in McCauley et al., 2000) express this in terms of its equivalent energy decibels re 1 μPa^2. The perceived loudness of any given sound is influenced by many factors including both the frequency and pressure of the sound (Gausland, 1998), the hearing ability of the listener, the level of background noise, and the physical environment through which the sound traveled before reaching the animal.

Based on summaries in key references (e.g., Richardson et al, 1995a; Gausland, 1998; and Ketten, 1998), and other references as noted, the following information about sound transmission is relevant to understanding potential impacts of sound on marine mammals:

1. Sound travels faster and with less attenuation in water than it does in air.
2. The fate of sound in water can vary greatly, depending on characteristics of the sound itself, characteristics of the location where it is released, characteristics of the environment through which it travels (Richardson et al., 1995a; McCauley et al., 2000), and the characteristics (for example, depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998).
3. Sound propagation can vary seasonally in the same environment.
4. Extrapolation about the likely impacts of a given type of sound source in a given location within the Chukchi Sea or Beaufort Sea OCS Planning Areas on a particular marine mammal, based on published studies conducted elsewhere, are somewhat speculative because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly impact the propagation of sound horizontally from the source (McCauley et al., 2000; see also Chapter 4 in Richardson et al., 1995a and references provided therein). Richardson et al. (1995a:425) summarized that: "…a site-specific model of sound propagation is needed to predict received sound levels in relation to distance from a noise source." Especially within the Chukchi Sea Planning Area, differences in site characteristics in different parts of the planning area make predictions about sound propagation relatively difficult.
5. There is a great deal of naturally occurring noise in the ocean from volcanic, earthquake, wind, ice, and biotic sources (see Richardson et al., 1995a:Chapter 5). Ambient noise levels affect whether a given sound can be detectable by a receiver, including a living receiver, such as a whale. Ambient noise levels can change greatly throughout the course of a season at a particular site, and vary from site to site (e.g., see acoustic environment section).

6. Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).

IV.C.2. General Background on Potential Effects of Noise and Disturbance on Cetaceans. In this section, we provide background about potential effects of impacts of OCS oil- and gas-related noise and disturbance. This section should not be interpreted as indicating effects that are likely to occur due to the proposed actions on the bowhead whale, humpback or fin whale. Hearing (auditory) systems and perception are species specific and habitat dependent. As noted in the previous section, and elsewhere in this evaluation, the fate of sound after it is produced is also site (especially in the arctic), season, and weather specific. Because of these fundamental facts, the potential for a given sound to cause adverse effects to an animal also is species specific and habitat dependent. Because of differences in bathymetry and seabed characteristics of sites throughout the Chukchi Sea and Beaufort Sea Planning Areas, the distances that sounds of various frequencies, intensities, and pressures will propagate, and the resulting effects such sounds could have, also are expected to differ greatly among specific sites (for example, among specific leasing blocks that differ in seabed properties, bathymetry, and the amount of wave action). Thus, the exact location of any sound source will determine the fate of sound released at that site and, therefore, will affect the possibility of impact on threatened and endangered species in or near the area. The time of year such sound is released will determine whether there is potential for individuals of a species to be exposed to that sound.

Many marine mammals rely primarily on hearing for orientation and communication (e.g., Erbe and Farmer, 1998; NRC, 2003, 2005). The scientific community generally agrees that hearing is an important sense used by cetaceans (for example see Richardson et al., 1995; NRC, 2003, 2005; National Resources Defense Council (NRDC), 1999, 2005; Marine Mammal Commission Sound Advisory Panel Minutes from meetings, MMC website). Marine mammals rely on sound to communicate, to find mates, to navigate, to orient (Erbe et al, 1999), to detect predators, and to gain other information about their environment. Because of their reliance on hearing, there is an increasing concern about the impacts of proliferation of anthropogenic noise on marine mammals, especially cetaceans. The NMFS (Carretta et al., 2001) summarized that a habitat concern for all whales, and especially for baleen whales, is the increasing level of human-caused noise in the world's oceans.

Increased noise levels could interfere with communication among whales, mask important natural sound, cause physiological damage, or alter normal behavior, such as causing avoidance behavior that keeps animals from an important area or displace a migration route farther from shore. Noise from various sources has been shown to affect many marine mammals (e.g., see Olesiuk et al., 1995; Richardson et al., 1995; Kraus et al., 1997; NRC, 2003; 2005) in ways ranging from subtle behavioral and physiological impacts to fatal.

Several important documents that summarize information on this topic include: Richardson et al. (1995a); Hoffman (2002); Tasker et al. (1998); NRC (2003, 2005); National Resources Defense Council (NRDC) (1999, 2005); IWC (2004a). Two particularly relevant summaries by the NRC have occurred within the last few years: *Ocean Noise and Marine Mammals* (NRC, 2003) and Marine *Mammal Populations and Ocean Noise, Determining when Noise Causes Biologically Significant Effects* (NRC, 2005). The IWC (2004) Scientific Committee Standing Working Group on Environmental Concerns held a mini symposium on acoustics with a section of the report dealing with seismic surveying. Lastly, the Marine Mammal Commission (MMC) convened an Advisory Committee on Acoustic Impacts on Marine Mammals which is producing summaries of areas of agreement and disagreement concerning the impacts of noise on marine mammals as well as a summary from a subcommittee on mitigation and management of anthropogenic noise (summaries not available for citation at the time of writing, but minutes of meetings are available on their website).

Results from several experimental studies have been published regarding sound exposure metrics incorporating sound pressure level and exposure duration. Recently, several investigators have examined noise-induced temporary threshold shift (TTS) in hearing in some odontocetes and pinnipeds exposed to moderate levels of underwater noise of various bandwidths and durations. Kastak et al. (2005:3154) summarized that "Because exposure to...noise in the marine environment is sporadic and interrupted, it is necessary to examine variables associated with varying noise sound pressure levels, intermittence of exposure, and total acoustic energy of exposure, in order to accurately predict the effects of noise on marine mammal hearing." However, while there is scientific acknowledgement of this statement, there are few instances where data are sufficient to evaluate the total energy exposure of a marine mammal from a given source. We acknowledge that evaluation of total energy could change our analyses. However, at present, we do not have the data necessary to make such a determination. NMFS (2004) is preparing an EIS to evaluate the impacts of new acoustic criteria for evaluating take under the MMPA.

Despite the increasing concern and attention noted above, there is still uncertainty about the potential impacts of sound on marine mammals, on the factors that determine response and effects, and especially, on the long-term cumulative consequences of increasing noise in the world's oceans from multiple sources (e.g., NRC, 2003, 2005). The NRC (2005) Committee on Characterizing Biologically Significant Marine Mammal Behavior concluded that it is unknown how or in what cases responses of marine mammals to anthropogenic sound rise to the levels of biologically significant effects. This group also developed an approach of injury and behavioral "Take equivalents". These take equivalents use a Severity Index that estimates the fraction of a take experienced by an individual animal. This severity index is higher if the activity could be causing harassment at a critical location or during a critical time (e.g., calving habitat). Because we have uncertainty about exactly where and how much activity will occur in 2006, we incorporate recommendations from the NRC (2005) qualitatively.

Available evidence indicates that reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary depending on whether females have calves accompanying them, or whether individuals are feeding or migrating. It may depend on whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the impacts of sound on a species or on classes of individuals within a species. Because of this, and following recommendations in McCauley et al. (2000), we attempt to take a conservative approach in our analyses and base conclusions about potential impacts on potential effects on the most sensitive members of a population. In addition, we make assumptions that sound will travel the maximums observed elsewhere, rather than minimums.

While there is some general information available, evaluation of the impacts of noise on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by the whales for different functions (Richardson et al., 1995a; Gordon et al., 1998; NRC, 2003, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of the large whales or the impacts of sound on them, especially on them physically. While research in this area is increasing, it is likely that we will continue to have great uncertainty about physiological effects on baleen whales because of the difficulties in studying them. Baleen whale hearing has not been studied directly. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al., 1995a). Thus, predictions about probable impact on baleen whales generally are based on assumptions about their hearing rather than actual studies of their hearing (Richardson et al., 1995a; Gordon et al., 1998; Ketten, 1998). Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz, but the frequency range in bowhead songs can approach 4,000 Hz (Richardson et al., 1995a). Most calls emitted by bowheads are in the frequency range of 50-400 Hz, with a few extending to 1,200 Hz. Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson et al., 1995a). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz, with an upper range of 30 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al., 1995a). Bowhead whales, as well as blue and fin whales, are predicted to hear at frequencies as low as 10-15 Hertz. McDonald, Hildebrand, and Webb (1995) summarize that many baleen whales produce loud low-frequency sounds underwater a significant part of the time. Thus, species that are likely to be impacted by low-frequency sound include baleen whales including bowheads.

Most species also have the ability to hear beyond their peak range. This broader range of hearing probably is related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Ketten (1998:2) summarized that, "The consensus of the data is that virtually all marine mammal species are potentially impacted by sound sources with a frequency of 500 Hertz or higher. This statement refers solely to the probable potential for marine mammal species to hear sounds of various frequencies. If a species cannot hear a sound, or hears it poorly, then the sound is unlikely to have a significant effect. Other factors, such as sound intensity, will determine whether the specific sound reaches the ears of any given marine mammal." Considerable variation exists among marine mammals in hearing sensitivity and absolute hearing range (Richardson et al., 1995; Ketten, 1998). Because of suspected differences in hearing sensitivity, it is likely that baleen whales and pinnipeds are more likely to be harmed by direct acoustic impact from low- to mid-sonic range devices than odontocetes. Conversely, odontocetes are more likely to be harmed by high-frequency sounds.

Little data are available about how most marine mammal species, especially large cetaceans, respond either behaviorally or physically to intense sound and to long-term increases in ambient noise levels, especially over the long term. Large cetaceans cannot be easily examined after exposure to a particular sound source.

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

IV.C.2.a. Potential damage to hearing. Ketten (1998) reported that hearing loss can be caused by exposure to sound that exceeds an ear's tolerance (i.e., exhaustion or overextension of one or more ear components). Hearing loss to a marine mammal could result in an inability to communicate effectively with other members of its species, detect approaching predators or vessels, or echolocate (in the case of the toothed whales).

Hearing loss resulting from exposure to sound often is referred to as a threshold shift. Some studies have shown that following exposure to a sufficiently intense sound, marine mammals may exhibit an increased hearing threshold, a threshold shift, after the sound has ceased (for example, Nachtigall et al., 2004; Kastak et al., 1999; Schlundt et al., 2000; Finneran et al., 2002). Thus, a threshold shift indicates that the sound exposure resulted in hearing loss causing decreased sensitivity. This type of hearing loss is called a temporary threshold shift if the individual recovers its pre-exposure sensitivity of hearing over time, or a permanent threshold shift if it does not.

Ketten (1998) reported that whether or not a temporary threshold shift or a permanent threshold shift occurs will be determined primarily based on the extent of inner ear damage the received sound and the received sound level causes. In general, whether a given species will tend to be damaged by a given sound depends on the frequency sensitivity of the species. Long-lasting increases in hearing thresholds, which also can be described as long-lasting impairment of hearing ability, could impair the ability of the affected marine mammal to hear important communication signals or to interpret auditory signals.

Most experiments have looked at the characteristics (for example, intensity, frequency) of sounds at which temporary threshold shift and permanent threshold shift occurred. However, while research on this issue is occurring, it is still uncertain what the impacts may be of repeated exposure to such sounds and whether the marine mammals would avoid such sounds after exposure even if the exposure was causing temporary or permanent hearing damage if they were sufficiently motivated to remain in the area (for example, because of a concentrated food resource). There are not data on which to determine the kinds or intensities of sound that could cause a TTS in a baleen whale.

Permanent threshold shifts are less species dependent and more dependent on the length of time the peak pressure lasts and the signal rise time. Usually if exposure time is short, hearing sensitivity is recoverable. If exposure to the sound is long, or if the sound is broadband in higher frequencies and has intense sudden onset, loss might be permanent. Repeated long exposures to intense sound or sudden onset of intense sounds generally characterize sounds that cause permanent threshold shift in humans. Ketten (1998) stated that age-related hearing loss in humans is related to the accumulation of permanent-threshold-shift and temporary-threshold-shift damage to the ear. The NRC (2005:31) concluded that: "…there is evidence of age-related hearing loss" in marine mammals. A very powerful sound at close range can cause death due to rupture and hemorrhage of tissues in lungs, ears, or other parts of the body. At greater distance, that same sound can cause temporary or permanent hearing loss. Noise can cause modification of an animal s behavior (for example, approach or avoidance behavior, or startle).

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

IV.C.2.b. Potential Effects on Immune Function. Loud noise may also affect immune function. Romano et al. (2004:1125) summarized that "(A)nthropogenic sound is a potential "stressor" for marine mammals. Not only can loud or persistent noise impact the auditory system of cetaceans, it may impact health by bringing about changes in immune function, as has been shown in other mammals…" These authors (Romano et al., 2004:1131) identified neural immune measurements that may be "implicated as indicates of stress in the white whale and bottlenose dolphin that were either released acutely or changed over time during the experimental period." Specifically, they found significant increases in aldosterone and a significant decrease in monocytes in a bottlenose dolphin after exposure to single impulsive sounds (up to 200 kiloPascals [kPa]) from a seismic water gun. Neural-immune changes following exposure to single pure tones (up to 201 dB re 1 μPa) resembling sonar pings were minimal, but changes were observed over time. A beluga whale exposed to single underwater impulses produced by a seismic water gun had significantly higher norepinephrine, dopamine and epinephrine levels were significantly higher after high-level sound exposure (> 100 kPa) as compared with low-level exposures (<100 kPa) or controls and increased with increasing sound levels. Alkaline phosphatase decreased, but γ-glutamyltransferase increased over the experimental period.

IV.C.2 c. Masking. When noise interferes with sounds used by the marine mammals (for example, interferes with their communication or echolocation), it is said to "mask" the sound (for example, a call to another whale might be masked by an icebreaker operating at a certain distance away). Noises can cause the masking of sounds that marine mammals need to hear to function (Erbe et al., 1999). That is, the presence of the masking noise can make it so that the animal cannot discern sounds of a given frequency and at a given level that it would be able to do in the absence of the masking noise. If sounds used by the marine mammals are masked to the point where they cannot provide the individual with needed information, harm can result (Erbe and Farmer, 1998). In the presence of the masking sounds, the sounds the animal needs to hear must be of greater intensity for it to be able to detect and to discern the information in the sound.

Erbe and Farmer (1998:1386) summarize that in "…the human and dolphin ear, low frequencies are more effective at masking high frequencies than *vice versa*; masking is maximum if the characteristic frequencies of the masker are similar to those of the signal…" They proposed that the factor most important for determining the masking effect of the noises was their temporal structure. The noise that was the most continuous with respect to frequency and time masked the beluga vocalization most effectively, whereas sounds (for example, natural icebreaking noise) that occurred in sharp pulses left quiet bands in between and left gaps through which the beluga could detect pieces of the call. In a given environment, then, the impact of a noise on cetacean detection of signals likely would be influenced by both the frequency and the temporal characteristics of the noise, its signal-to-noise ratio, and by the same characteristics of other sounds occurring in the same vicinity (for example, a sound could be intermittent but contribute to masking if many intermittent noises were occurring).

It is not known whether (or which) marine mammals can (Erbe and Farmer, 1998) and do adapt their vocalizations to background noise. Humans adapt the loudness of their speech according to several factors, including the loudness of the ambient noise (French and Steinberg, 1947). Delhi (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals.

IV.C.2.d. Behavioral Reactions. Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener's sex and reproductive status, possibly age and/or accumulated hearing damage, type of activity engaged in at the time or, in some cases, on group size. For example, reaction to sound may vary depending on whether females have calves accompanying them, whether individuals are feeding or migrating (for example, see discussion of impacts of noise on humpback whales in McCauley et al., 2000, and Section IV.B.1.f(3)(d)2) of the Cook Inlet multiple-sale EIS [USDOI, MMS, 2003b. Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, and following recommendations in McCauley et al. (2000) (discussed above), we attempt to take a conservative approach in our analyses and base conclusions about potential impacts on potential effects on the most sensitive members of a population. In addition, we evaluate the potential for effects on bowheads by making the implicit assumptions that sound may travel the maximums observed, rather than minimums and that whales engaged in a particular activity may respond at the maximum, not the minimum, distances observed in studies to date. However, these assumptions may overestimate potential effect in many cases. However, since at least some of the airgun arrays being proposed for use in the Chukchi and Beaufort Seas in 2006 have greater total output than many of those in previous studies, we may also underestimate impact in some cases.

It is with the aforementioned caveats and level of uncertainty, but based on the best available information about impacts of OCS oil and gas noise on cetaceans from studies conducted elsewhere, that we evaluate potential impacts of oil- and gas-related seismic survey noise and disturbance on ESA listed cetaceans.

IV.C.3 Potential Exposure of Threatened and Endangered Marine Mammals to Seismic Survey Activities in the Chukchi Sea and Beaufort Sea Evaluation Areas. Bowhead whales probably are the most likely of ESA-listed baleen whales to be impacted by OCS oil and gas-related seismic surveys in the Chukchi Sea or Beaufort Sea evaluation areas because they commonly occur seasonally in areas where seismic surveying activity could occur. Bowhead whales have documented use of portions of both the Chukchi Sea and Beaufort Sea evaluation areas for: spring and fall migration; feeding; calving; resting; and limited breeding. Most of the calving for this population probably occurs between the Bering Strait and Point Barrow. Bowhead whales have a demonstrated sensitivity to some noise and disturbance, including noise and disturbance from seismic surveys.

As summarized in Section II of this Biological Evaluation, neither fin whales nor humpback whales are expected to appear at any time of the year within either the Chukchi Sea Planning Area or the Beaufort Sea Planning Area. Available evidence indicates these two species do not typically breed, calve, feed, rest, or migrate through these areas. They do seasonally appear in coastal waters of the southwestern Chukchi Sea, adjacent to the Chukchi Peninsula. However, recent data to confirm their lack of use of areas of the Chukchi Sea evaluation area, except that portion of the evaluation area directly north of Barrow, are lacking. Thus, it is doubtful that they will be exposed to seismic survey noise and disturbance.

IV.C.3.a. Sources of Noise and Disturbance from Seismic Surveys. During OCS oil and gas 2D/3D seismic exploration, human-caused noise can be transmitted through the air and through marine waters from a variety of sources including, but not limited to: the seismic noise sources themselves that purposely release noise into the water; icebreakers, other ships, and boats; high-resolution seismic surveys; and helicopter and fixed-winged aircraft traffic.

Endangered cetaceans conceivably could be disturbed or struck by ships or boats during seismic surveys. Small fuel spills could occur. Any or all of these factors potentially could adversely affect ESA-protected cetaceans in and/or near the Chukchi Sea or Beaufort Sea Planning Areas during OCS oil and gas seismic exploration activities.

Sound from seismic exploration is a potential source of noise disturbance to bowhead whales and other cetaceans in and near areas where the surveys may occur. Marine seismic operations use high-energy airguns to produce a burst of underwater sound from the release of compressed air, which forms a bubble that rapidly expands and then contracts. Typically, seismic sources used in such surveys involve the rapid release of compressed air to produce an impulsive signal that is directed downward through the seabed. Thus, the source for the sound is called an airgun.

Seismic airguns are meant to produce low-frequency noise, generally below 200 Hz. However, the impulsive nature of the collapse of the air bubbles inevitably results in broadband sound characteristics. Goold (1996, cited in Stone, 2001) reported that high-frequency noise is also produced. Goold (1996a) also found significant levels of energy from airguns across the bandwidth up to 22 kilohertz. Seismic surveys using airguns, especially 2D and 3D seismic surveys, produce at the source, underwater sound levels exceeding those of other activities discussed in this section. This means animals sensitive to either low-frequency or high-frequency sounds may be affected. Bowhead whales emit tonal frequency modulated sounds at 50-400 Hz. A few calls have energy extending to 1,200 Hz. Bowheads also emit pulsive sounds in the frequency range of 25-3,500 Hz, as well as songs of about 20-500 Hz (Richardson et al., 1995a:Table 7). Airgun arrays are designed to focus the sound energy downward. Despite this, sound pulses also are projected horizontally, with the distance traveled depending on many factors, such as those discussed by Richardson et al. (1995a) and McCauley et al. (2000).

Airgun arrays produce short-duration (transient) noise pulses with very high peak levels. The high peak level and impulsive nature of airguns have caused concern in the scientific and environmental communities.

McCauley et al. (2000) concluded that the most consistent measure of a received airgun signal was a measure of its energy, as was suggested by Richardson et al. (199a) for pulsed sounds.

In Alaska, 2D/3D seismic surveying, during which large areas are surveyed to obtain information on the subsurface, are generally undertaken before a proposed lease sale. The 2D/3D seismic surveys are also undertaken after lease sales or between one lease sale and the next. On-lease high-resolution seismic profiling usually is undertaken for engineering purposes to determine the suitability of locations for emplacement of seafloor-founded structures (drilling rigs, platforms, pipelines). The energy level in these types of surveys is much lower than that used in the 2D/3D seismic surveys; thus, the radius of noise exposure is many times smaller.

Seismic surveys often employ other activities that may result in an increase in noise and disturbance to whales (see below). Seismic ships have navigational equipment that produces noise, and the ships themselves introduce noise, cause disturbance and may strike cetaceans. Marine vessel traffic and aircraft traffic, in support of the surveys and used in marine mammal monitoring, all introduce noise and disturbance into the marine environment, with potential adverse impacts on the whales.

McCauley et al. (2000) stated that a **precise definition of the seabed to at least 50-100 m is required to accurately predict horizontal propagation along a travel path.** Based on experimental measurement of signals from a single airgun, McCauley et al. (2000) found signal differences of airgun broadband levels of up to 10 dB at a 1-km range. They concluded that such large differences in levels, measured for the same source at a given range within the same bay, demonstrated the importance of localized properties of seabeds in determining sound propagation.

Other factors that also can significantly affect sound propagation include the orientation of the receivers (the orientation of living animals could similarly affect reception), alignments and depths of array components and of functioning guns within the array, and airgun source depth. The depth at which the firing airgun is placed plays a crucial role in the potential for propagation. Increasing source depth consistently increased the received signal at any specified receiver depth (for example, the depth of the animal) and horizontal range. If the animal is in a shallow-water area and on the bottom, and the airgun is in much deeper water and downslope from the animal, attenuation will greatly affect the sound the animal will receive.

Based on all of the aforementioned, McCauley et al. (2000) concluded that **predicting sound propagation from any specified airgun array needs to be done on a case-by-case basis.**

Bain (2002) found that approximately one-third of sound levels measured during seismic surveys varied by 6 dB from expected values. Shadow zones caused sound levels lower than expected, and land was an effective barrier to direct sound propagation. Cases of levels higher than expected probably were due to upslope enhancement of sound. Long-range propagation through the Strait of Juan de Fuca was better than expected, resulting in airgun noise being clearly audible at ranges of 60-70 km. This was the longest distance at which signal measurement was attempted, and it is possible that the sound was audible at even greater distances. Bain (2002) reports that high frequencies attenuated faster with distance (this would decrease impacts to beluga whales), and low frequencies were filtered out by propagation through shallow water.

Tolstoy et al. (2004) compared measured versus modeled noise level radii associated with different seismic arrays in shallow and very deep water in the Gulf of Mexico and concluded that models may have been underestimating noise level radii in shallow water and overestimating those in very deep waters.

Richardson et al. (1995a:290-291) summarized: "Underwater sound pulses from airgun arrays and similar sources are often audible many tens of kilometers away." Transient noise from such a survey has been recorded on land seismometer arrays 6,100 km away after traveling the deep sound channel (Okal and Talandier, 1986). However, McDonald, Hildebrand, and Webb (1995) suggest that these same sounds may not have been detectable by a whale near the surface in the mid-Pacific because of entrapment in the deep sound channel. During monitoring using passive acoustics in the mid-Atlantic Ocean, Nieukirk et al. (2004) frequently recorded sounds from seismic airguns from locations more than 3,000 km from their array of autonomous hydrophones moored near the mid-Atlantic Ridge. Trends in the patterns of detection were similar in the two years of monitoring with airguns being detected every 10-20 seconds. Nieukirk et al. (2004:1838) reported that "Although airgun sounds tended to dominate recordings during the summer months, loud whale vocalizations could still be detected during intense airgun activity…The high received level of these impulses on multiple hydrophones made it possible to estimate the location of the ships conducting the airgun surveys."

See Appendix II, Section II.E, for a description of the proposed actions.

Marine seismic programs can be either 2D or 3D seismic surveys. A 2D seismic survey typically is more regional in nature and seismic lines tend to be much further apart (rarely closer than 1 km) than in 3D surveys. Seismic programs generally use 2D seismic to explore large areas relatively inexpensively with the intent of identifying areas that warrant further exploration, such as drilling an exploration well or acquiring a 3D seismic survey. Seismic lines often are laid out in a number of different directions. Information that can be extracted from 2D seismic data is more limited than information from 3D seismic data. Marine surveys in the Beaufort Sea OCS waters in the 1970's, 1980's, and most of the 1990's were 2D seismic. Ocean-bottom cable surveys in recent years have been 3D seismic. A 3D seismic survey is conducted on a closer grid and provides more detailed information about the subsurface.

Seismic surveys are of two types, high-resolution seismic surveys and 2D/3D seismic surveys. The next few paragraphs provide a brief discussion of a number of studies on the effects of noise from seismic operations on bowhead whales, and where appropriate, other baleen whales.

IV.C.3.b. Timing of Potential Exposure to Noise and Disturbance from Active Seismic Surveys. In the proposed actions under consideration, we explicitly assume that 2D/3D seismic surveys could occur during the entire open water period in the Chukchi Sea and Beaufort Sea, except as restricted by mitigations. We also assume that seismic operations must comply with the provisions of the permits in Appendix VI or requirements set by NMFS. Thus, we explicitly assume that seismic operations will not occur in either area until the first of July, unless authorized by NMFS, but will continue until ice conditions preclude further operations.

Open-water 2D/3D seismic surveys in the Beaufort Sea Planning Area likely would be feasible only in the months of August, September, and October. Depending on the restrictions usually agreed to in past conflict avoidance agreements, it is likely that 2D/3D seismic surveys will not occur after the bowhead westward migration has occurred, except in areas outside of hunting areas or after hunting for a given Beaufort Sea village has ceased. We assume that steps will be taken to avoid an unmitigable adverse effect on the availability of bowhead whales for take for subsistence, or that steps will be taken to avoid unreasonable conflict with such activities. Timing to avoid effects on subsistence takes may amplify disturbance on the whales, since it may concentrate seismic activity in between hunting activity, both spatially and temporally.

In the Chukchi Sea, depending on ice conditions and conflict avoidance requirements, seismic surveys could not begin until July 1 (unless authorized by NMFS) and end in November. Thus, the total period of seismic surveys is likely to be considerably longer in the Chukchi Sea than in the Beaufort Sea.

IV.C.4. High-Resolution Seismic Surveys. Our scenario assumes that up to three site-clearance surveys could occur in the Beaufort Sea beginning in 2006 and two annually from 2007-2010. We assume that high-resolution surveys would not begin in the Chukchi Sea until after proposed Lease Sale 193 in late 2007. After that time, we assume two surveys annually until 2012.

High-resolution seismic surveys generally are conducted on lease following a lease sale to evaluate potential shallow hazards and identify seafloor features and resources (e.g., shipwrecks, potential archaeological sites). Vessels used for high-resolution seismic are typically smaller (about 37 to 47 m) than those used for 2D/3D seismic surveys.

Some high-resolution seismic surveys, such as those using airguns, emit loud sounds; but the sounds would not be as loud as sounds from 2D/3D seismic surveys. The sound also would not be likely to propagate as great a distance as sounds from 2D/3D seismic surveys.

High-resolution site-clearance seismic surveys for exploration or delineation well sites most likely would be conducted during the ice-free season, the period when bowhead whales might be present in the Beaufort Sea Planning Area. During high-resolution seismic surveys, vessels follow precise, preplotted lines so that the desired coverage of the seafloor is achieved. With seismic gear deployed, the operating vessel speed is typically in the 3.0-3.5 kn range (5.6-6.5 km/h) for high-resolution site surveys.

A "typical" high-resolution survey is described in Appendix II (Section II.E.3.): a ship towing an airgun about 25 m behind the ship and a 600-m streamer cable with a tail buoy. The ship travels at 3-3.5 kn (5.6-6.5 km/h), and the airgun is fired every 7- 8 seconds (or about every 12.5 m). Typical surveys cover one lease block, which is 4.8 km on a side. See Appendix II, Section II.E.4 (last paragraph) for information about MMS archaeological site clearance requirements.

An integrated navigational system keeps track of where the airguns are fired, as well as the position and depth of the streamer cables. Field operations are usually conducted 24 hours a day.

IV.C.4.a. Potential Effects of High-Resolution Seismic on Endangered Whales. Because high-resolution seismic surveys use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys, these activities are less likely to have significant effects on endangered whales. Bowheads appear to continue normal behavior at closer distances to high-resolution seismic surveys than to 2D/3D seismic surveys. In the study by Richardson, Wells, and Wursig (1985), four controlled tests were conducted by firing a single 40 in^3 (0.66-L) airgun at a distance of 2-5 km (1.2-3.1 mi) from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3-5 km (1.86-3.1 mi) away (received noise levels at least 118-133 dB re 1 µPa) rms. Some bowheads oriented away during an experiment at a range of 2-4.5 km (1.2-2.8 mi) and another experiment at a range of 0.2-1.2 km (0.12-0.75 mi) (received noise levels at least 124-131 and 124-134 dB, respectively). Frequencies of turns, predive flexes, and fluke-out dives were similar with and without airgun noise; and surfacing and respiration variables and call rates did not change significantly during the experiments.

Because the site-clearance activities are of shorter duration and have a smaller zone of influence than 2D/3D seismic surveys, we believe it unlikely they would result in a biologically significant effect on bowhead whales. Our primary concern with respect to high resolution surveys is the potential for these activities to add to noise and disturbance from 2D/3D seismic or drilling activities, and to cause local impacts within a specific area if large numbers of bowheads are present. We are specifically concerned about potential impacts that could occur if high resolution seismic survey activity were inshore of 2D/3D seismic activities or drilling operations. A concentration of noise and disturbance-producing factors may keep bowhead whales from high value area.

IV.C.5. 2D/3D Seismic Surveys.

IV.C.5.a. Description and Discussion of the Activity. Offshore geophysical exploration seismic surveys conducted in the summer, and on-ice seismic surveys conducted in the winter, are other sources of noise in the arctic marine environment. Airgun arrays are the most common source of seismic survey noise. A typical full-scale array produces a source level of 248-255 dB re 1 µPa -m, zero to peak (Barger and Hamblen, 1980; Johnston and Cain, 1981). These surveys emit loud sounds, which are pulsed rather than continuous, and can propagate long distances (in some habitats, very long distances) from their source. However, most energy is directed downward, and the short duration of each pulse limits the total energy. Received levels within a few kilometers typically exceed 160 dB re 1 µPa (Richardson et al., 1995a), depending on water depth, bottom type, ice cover, etc. We provide a full description of typical 2D/3D seismic surveying operations in Appendix II.

In their application for an Incidental Harassment Authorization, Shell (2005) describes that during their proposed 2006 Beaufort and Chukchi Seas open-water 3D seismic survey in 2006, the seismic vessel will tow two source arrays, comprising three identical subarrays each, which will be fired alternately as the ship sails downline in the survey area. They specify that the ship will tow up to 6 streamer cables up to 5,400 m long.

Seismic surveys stay active as many days as possible. However, as per an email from P. Fontana (2003) to the MMS Gulf of Mexico Region regarding 2D/3D seismic operations: "On a very good survey we may be in shooting mode up to 40% of the time we are on site. Typically our shooting times average between 25% to 35%." Thus, we anticipate that all seismic vessels in the evaluation areas will not be operating continuously, but rather will have periods when the airguns are silent.

In the Beaufort and Chukchi seas, we anticipate that the seismic vessels will be accompanied by another vessel, which will be used for supplying and other needs, including refueling. In the case of at least one of the operations anticipated to be operating in the Beaufort and Chukchi Seas in 2006, this vessel will be an icebreaker.

While the seismic airgun pulses are directed towards the ocean bottom, sound propagates horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994). In waters 25-50 m deep, sound produced by airguns can be detected 50-75 km away, and these detection ranges can exceed 100 km in deeper water (Richardson et al., 1995a). Sounds produced by seismic pulses can be detected by mysticetes and odontocetes that are from 10-100 km from the source (Greene and Richardson, 1988; Bowles et al., 1994; Richardson et al., 1995a) or potentially further under some conditions.

Since MMS and NMFS last consulted on either of these two planning areas, new data have been published regarding measured versus modeled noise level radii associated with different seismic arrays in shallow and very deep water (Tolstoy et al., 2004) that indicate models may have been underestimating noise levels in shallow water. Because we explicitly assume that seismic surveys could occur anywhere within any portion of the Beaufort Sea or Chukchi Sea evaluation areas, as depicted in Figure 1, and because the characteristics of the surveys themselves are likely to vary from those undertaken previously in either planning area, we assume that the propagation characteristics might also vary from those determined during previous seismic activities in these two planning areas. We summarize the information available about noise levels at distance determined or estimated during previous studies in these planning areas (primarily in the Beaufort Sea) and present and consider also the levels measured by Tolstoy et al. (2004).

We note that in the Biological Evaluation prepared for Beaufort OCS Lease Sale 195 in 2003, we concluded that, "Geophysical surveys conducted in conjunction with proposed Lease Sale 195 are likely to cover much smaller areas to fill in gaps from earlier seismic surveys. Also, some of the seismic work that may be needed may be conducted when whales are not present in the area." This assumption supported our analyses in that document. However, recent interest in 2D/3D seismic exploration by oil and gas companies in the Beaufort and Chukchi Seas indicate that this assumption is no longer true. Based on the best available information (some of which is proprietary), we now expect regular 2D/3D, as well as high-resolution seismic survey activity in Federal waters of the Beaufort Sea over the next 5 years. We expect this level of activity to be greater than that during the period of the previous 5 years (2000-2005). However, as detailed in the scenario section in Appendix II, new seismic survey activity is expected to be mostly 3D seismic. We still expect that some of the seismic survey work will be conducted when whales are not present. However, at present, much of the proposed seismic survey work in both the Beaufort Sea and Chukchi Sea Planning Areas is expected to be open water 2D or 3D seismic surveys using streamers.

IV.C.5.b. Potential Effects of 2D/3D Seismic Surveys on Bowhead Whales. Numerous studies have been conducted on the effects of noise from seismic surveys on bowhead whales. The results from these studies have varied, in some cases considerably. Among some of these studies important variables were different. These included the type of seismic survey (2D versus 3D), the location of the study, and the year in which the study was conducted. Ice (and other weather-related factors) also varies among years as does the use of total available habitat by bowhead whales. Some of the studies employed different methodologies, some of which have been criticized by peer reviewers and others of which are more widely adopted. Because of the importance of the issue of potential noise disturbance of bowhead whales, we provide considerable detail on these studies below. However, we preface this section with an observation: In numerous reports regarding whale response to sound, it has been shown that multiple factors may be important in the whale's response (e.g., McCauley et al., 2000). In some studies, these factors have been shown to include (but may not be limited to): the physical characteristics of the location into which the sound is released and the physical characteristics of the location where the whale is located at the time the sound is released; the whale's sex and reproductive condition (e.g., groups with or without calves); the behavior of the whale (e.g., migrating or feeding); specific characteristics of the sound (e.g., frequency, duration, whether impulsive or not, etc.), and prior exposure to the sound.

Thus, the fact that results from different studies of bowhead response to oil and gas-related sound have varied is not surprising. The studies involving the response of bowheads to 3D marine streamer seismic surveys are most relevant to evaluating the potential effects of the proposed action.

During the 1980's, the behavior of bowhead whales exposed to noise pulses from seismic surveys was observed during the summer in the Canadian Beaufort Sea and during the fall migration across the Alaskan Beaufort Sea. In general, many of the seismic surveys conducted during the 1980's were 2D seismic surveys that covered fairly large areas in deeper waters. Additional studies on seismic surveys were conducted in the central Alaskan Beaufort Sea during the fall migration in 1996-1998. These surveys were 3D ocean bottom cable (OBC) seismic surveys that covered fairly small areas in relatively shallow water fairly close to shore.

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

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

In their May 25, 2001 Biological Opinion for Federal Oil and Gas Leasing and Exploration by the MMS within the Alaskan Beaufort Sea and its effects on the endangered bowhead whale, NMFS (2001:20) noted that early tests of bowhead reactions to active seismic vessels by Ljungblad et al. (1985):

> …were not conducted under controlled conditions (i.e., other noise sources were operating at the time), and approaches at greater ranges were not conducted, so results cannot be used to determine the range at which the whales first begin to respond to seismic activity.

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

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

While conducting a monitoring program around a drilling operation, Koski and Johnson (1987) noted that the call rate of a single observed bowhead whale increased after a seismic operation had ceased. During the 6.8 hours of observation, the whale was within 23-27 km (14.3-16.8 mi) from the drillship. A seismic vessel was reported to be from 120-135 km (74.58-83.9 mi) from the sonobuoy; the two loudest calls received were determined to be approximately 7 km (4.35 mi) and 9 km (5.6 mi) from the sonobuoy, with received levels of 119 and 118 dB, respectively. Approximate signal-to-noise ratios were 24 and 22 dB, respectively. No information is provided regarding the exact distance the whale was from the operating seismic vessel. The increase in call rate was noted within 25 minutes after seismic noise ceased. It also needs to be noted that there were few, if any, calls heard during the 2 hours prior to the start of seismic operations, so it is unclear whether the increase in call rate relates to cessation of seismic noise, the presence of the operating drillship, the combination of both activities, or some other factor that occurred in the late afternoon. During this same study a subgroup of four to seven whales within a larger group (15-20 whales) was noted moving rapidly away from an approaching seismic vessel at a distance of 22-24 km (13.7-14.9 mi). The received level of seismic pulses was 137 dB at 19 km (11.8 mi) from the sonobuoy and 22 km from the whales. The surfacing and diving were unusually brief, and there were unusually few blows per surfacing. No information was available regarding the time required for these whales to return to normal behavior.

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

Based on early data, Richardson and Malme (1993) concluded that collectively, scientific studies have shown that most bowheads usually show strong avoidance response when an operating seismic vessel approaches within 6-8 km (3.8-5.0 mi). Strong avoidance occurs when received levels of seismic noise are 150-180 dB re 1 μPa (Richardson and Malme, 1993). Strong pulses of seismic noise often are detectable 25-50 km (15.5-31 mi) from seismic vessels, but in early studies, bowheads exposed to seismic sounds from vessels more than about 7.5 km (4.7 mi) away rarely showed avoidance. Seismic pulses can be detectable 100 km (62.2 mi) or more away. Bowheads also may show specific behavioral changes, such as reduced surfacing; reduced dive durations; changes in respiration rates, including fewer blows per surfacing, and longer intervals between successive blows; and they may temporarily change their individual swimming paths. The authors noted that surfacing, respiration, and dive cycles may be altered in the same manner as those of whales closer to the vessels. Bowhead surface-respiration-dive characteristics appeared to recover to pre-exposure levels within 30-60 minutes following the cessation of the seismic activity. However, we emphasize that 3D seismic may occur within an evaluation area, or within a more specific areas for the entire open water period. If bowhead whales, especially females with calves, avoided areas where they wanted to rest or feed because seismic surveys were occurring and if seismic surveys overlapped in time and place with large aggregations of these whales, there could be biologically significant effects on bowhead whales in that area.

Inupiat whalers suggested that the fall bowhead migration tended to be farther offshore when there was abundant seismic work off northern Alaska. Aerial surveys have been conducted since 1979 to determine the distribution and abundance of bowhead whales in the Beaufort Sea during their fall migration. These surveys have been used for comparing the axis of the bowhead whale migration between years. Survey data from 1982-1987 were examined to determine whether industrial activity was resulting in displacement of bowhead whales farther offshore (Ljungblad et al., 1988). It was determined that a good indicator of annual shifts in bowhead distribution could be obtained by analyzing the distance of random bowhead sightings from shore (Zeh, as cited in Ljungblad et al., 1988). An analysis of the distance of random bowhead sightings from shore (a total of 60 bowhead sightings) was conducted, but no significant differences were detected in the bowhead migratory route between years. The axis of the bowhead migratory route near Barrow was found to fall between 18 and 30 km (7.76 and 18.6 mi) from shore. Although the analysis involved a relatively small sample size, these observations provide some insight into migration patterns during these years. The NSB, in a letter dated July 25, 1997, questioned the sample size and the precision of the Ljungblad et al. (1988) report to determine whether or not a displacement of fall migrating whales had occurred and how big a displacement would have to be before it could be detected.

Using larger sample sizes (for which confidence intervals were calculated) obtained over a larger study area, the aerial survey project found many between-year (1982-1996) differences in the median water depth at whale sightings that were highly significant (P less than 0.05) (Treacy, 1997). Median depths ranged between 18 m (59 ft) in 1989 and 347 m (1,138 ft) in 1983, with an overall cumulative depth of 37 m (121 ft, confidence interval = 37-38 m). The aerial survey project has reported a potential association between water depth of the bowhead migration and general ice severity, especially in 1983, when severe ice cover may have forced the axis of the migration into waters 347 m (1,138 ft) deep. To address short-term bowhead whale displacement within a given year from site-specific industrial noise, MMS and NMFS require industry to conduct site-specific monitoring programs when industrial activity occurs in the Beaufort Sea Planning Area during fall bowhead migrations.

Since 1996, many of the open water seismic surveys in State of Alaska waters and adjacent nearshore Federal waters of the central Alaskan Beaufort Sea were ocean-bottom cable surveys. These surveys were 3D seismic programs. The area to be surveyed is divided into patches, each patch being approximately 5.9 by 4.0 km in size. Within each patch, several receiving cables are laid parallel to each other on the seafloor. Seismic data are acquired by towing the airguns along a series of source lines oriented perpendicular to the receiving cables. While seismic-data acquisition is ongoing on one patch, vessels are deploying cable on the next patch to be surveyed and/or retrieving cables from a patch where seismic surveys have been completed. Airgun arrays have varied in size each year from 1996-1998 with the smallest, a 560 in^3 array with 8 airguns, and the largest, a 1,500 in^3 array with 16 airguns. A marine mammal and acoustical monitoring program was conducted in conjunction with the seismic program each year in accordance with provisions of the NMFS Incidental Harassment Authorization.

Based on 1996-1998 data, there was little or no evidence that bowhead headings, general activities, or swimming speeds were affected by seismic exploration. Bowheads approaching from the northeast and east showed similar headings at times with and without seismic operations. Miller et al. (1999) stated that the lack of any statistically significant differences in headings should be interpreted cautiously. Changes in headings must have occurred given the avoidance by most bowheads of the area within 20 or even 30 km of active seismic operations. Miller et al. (1999) noted that the distance at which deflection began cannot be determined precisely, but they stated that considering times with operations on offshore patches, deflection may have begun about 35 km to the east. However, some bowheads approached within 19-21 km of the airguns when they were operating on the offshore patches. It appears that in 1998, the offshore deflection might have persisted for at least 40-50 km west of the area of seismic operations. In contrast, during 1996-1997, there were several sightings in areas 25-40 km west of the most recent shotpoint, indicating the deflection in 1996-1997, may not have persisted as far to the west.

LGL Ltd.; Environmental Research Assocs., Inc.; and Greeneridge Sciences Inc. conducted a marine mammal monitoring program for a seismic survey near the Northstar Development Project in 1996 (Miller et al., 1997). The marine mammal monitoring program was continued for subsequent seismic surveys in nearshore waters of the Beaufort Sea in 1997 and 1998 (Miller, Elliot, and Richardson, 1998; Miller et al., 1999). Details of these studies are provided in the Beaufort Sea multiple-sale final EIS.

These studies indicated that the bowhead whale-migration corridor in the central Alaskan Beaufort Sea during 1998 was similar to the corridor in many prior years, although not 1997. In 1997, nearly all bowheads sighted were in relatively nearshore waters. The results of the 1996-1998 studies indicated a tendency for the general bowhead whale-migration corridor to be farther offshore on days with seismic airguns operating compared to days without seismic airguns operating, although the distances of bowheads from shore during airgun operations overlapped with those in the absence of airgun operations. Aerial-survey results indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km.

Sighting rates within a radius of 20 km of seismic operations were significantly lower during seismic operations than when no seismic operations were happening. Within 12-24 hours after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km. There was little or no evidence of differences in headings, general activities, and swimming speeds of bowheads with and without seismic operations. Overall, the 1996-1998 results show that most bowheads avoided the area within about 20-30 km of the operating airguns. Within 12-24 hours after seismic operations ended, the sighting rate within 20 km was similar to the sighting rate beyond 20 km.

The observed 20-30 km area of avoidance is a larger avoidance radius than documented by previous scientific studies in the 1980s and smaller than the 30 mi suggested by subsistence whalers, based on their experience with the types of seismic operations that occurred in the Beaufort Sea before 1996 (Richardson, 2000). The seismic activities in the 1980s were 2D in deeper water. Recent seismic activities were 3D OBC concentrated in shallow water.

Based on recordings of bowhead whale calls made during these same studies, Greene et al. (1999), summarized that results for the 3 years of study indicated that: (1) bowhead whales call frequently during the autumn migration through the study area; (2) calling continued at times when whales were exposed to airgun pulses; and (3) call-detection rates at some locations differed significantly when airguns were detectable versus not detectable. However, there was no significant tendency for the call-detection rate to change in a consistent way at times when airguns started or stopped.

During the 1996-1998 bowhead hunting seasons, seismic operations were moved to locations well west of Cross Island, the area where Nuiqsut-based whalers hunt for bowheads (Miller et al., 1999).

Richardson provided a brief comparison between observations from seismic studies conducted in the 1980s and the 1996 seismic survey at the Arctic Seismic Synthesis Workshop in Barrow (USDOI, MMS, 1997). Observations from earlier seismic studies during the summer and early autumn show that most bowhead whales interrupt their previous activities and swim strongly away when a seismic ship approaches within about 7.5-8 km. At the distances where this strong avoidance occurs, received levels of seismic pulses typically are high, about 150-180 dB re 1 µPa. The surfacing, respiration, and dive cycles of bowheads engaged in strong avoidance also change in a consistent pattern involving unusually short surfacing and diving and unusually few blows per surfacing. These avoidance and behavioral effects among bowheads close to seismic vessels are strong, reasonably consistent, and relatively easy to document. Less consistent and weaker disturbance effects probably extend to longer distances and lower received sound levels at least some of the time. Bowheads often tolerate much seismic noise and, at least in summer, continue to use areas where seismic exploration is common.

However, at least one case of strong avoidance has been reported as far as 24 km from an approaching seismic boat (Koski and Johnson, 1987) and, as noted above, the aerial survey data (Miller et al., 1999) indicated that bowheads tended to avoid the area around the operating source, perhaps to a radius of about 20-30 km.

Richardson noted that many of the observations involved bowheads that were not actively migrating. Actively migrating bowheads may react somewhat differently than bowheads engaged in feeding or socializing. Migrating bowheads, for instance, may react by deflecting their migration corridor away from the seismic vessel. Monitoring of the bowhead migration past a nearshore seismic operation in September 1996 provided evidence consistent with the possibility that the closest whales may have been displaced several miles seaward during periods with seismic activity.

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

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

A recent study in Canada provides recent information on the behavioral response of bowhead whales in feeding areas to seismic surveys (Miller and Davis, 2002). During the late summer and autumn of 2001, Anderson Resources Ltd. conducted an open-water seismic exploration program offshore of the Mackenzie Delta in the Canadian Beaufort Sea. The program consisted of streamer seismic surveys and associated bathymetric surveys conducted off the Mackenzie Delta. The bathymetric surveys were conducted by two medium-sized vessels equipped with side-scan sonar and single-beam echo sounders. The seismic vessel was the *Geco Snapper*. The acoustic sources used in the seismic operations were two 2,250 in^3 arrays of 24 sleeve-type airguns. Each 2,250 in^3 airgun array was comprised of 24 airguns with volumes ranging from 40-150 in^3. The two airgun arrays fired alternately every 8 seconds along the survey lines. The airgun arrays were operated at a depth of 5 m below the water surface. Water depths within the surveyed areas ranged from 6-31 m and averaged 13 m (Miller, 2002). Because marine seismic projects using airgun arrays emit strong sounds into the water and have the potential to affect marine mammals, there was concern about the acoustic disturbance of marine mammals and the potential effects on the accessibility of marine mammals to subsistence hunters. Although there are no prescribed marine mammal and acoustic monitoring requirements for marine seismic programs in the Canadian Beaufort Sea, it was decided that monitoring and mitigation measures in the Canadian Beaufort Sea should be as rigorous as those designed and implemented for marine seismic programs conducted in the Alaskan Beaufort Sea in recent years. The monitoring program consisted of three primary components: acoustic measurements, vessel-based observations, and aerial surveys. The NMFS recommended criterion that exposure of whales to impulse sound not exceed 180 dB re 1 Pa rms (65 *FR* 16374) was adopted as a mitigation standard for this monitoring program. Estimates of sound-propagation loss from the airgun array were used to determine the designated 1,000-m safety radius for whales (the estimated zone within which received levels of seismic noise were 180 dB re 1µPa rms or higher).

Aerial and vessel-based surveys confirmed the presence of substantial numbers of bowheads offshore of the Mackenzie Delta from late August until mid-September. The distribution of bowheads in the study area was typical of patterns observed in other years and suggests that there were good feeding opportunities for bowheads in these waters during that period.

A total of 262 bowheads were observed from the seismic vessel *Geco Snapper* (Moulton, Miller, and Serrano, 2002). Sighting rates during daylight hours were higher when no airguns were operating than during periods with airguns operating. During the period when bowheads were most abundant in the study area (August 23-September 19), the bowhead sighting rate during periods with no seismic (0.85 bowheads/hour) was about twice as high as that recorded during periods with seismic (0.40 bowheads/h) or all seismic operations combined (0.44 bowheads/h). Average sighting distances from the vessel were significantly ($P < 0.001$) lower during no airguns (a mean radial distance of 1,368 m) versus line-seismic periods (a mean radial distance of 1,957 m). The observed difference in sighting rates and the significant difference in sighting distances suggest that bowheads did avoid close approach to the area of seismic operations. However, the still substantial number of sightings during seismic periods and the relatively short (600 m) but significant difference in sighting distances suggests that the avoidance may have been localized and relatively small in nature. At a minimum, the distance by which bowheads avoided seismic operations was on the order of 600 m greater than the average distance by which they avoided general vessel operations. The lower sighting rates recorded during seismic operations suggest that some bowheads avoided the seismic operations by larger distances and, thereby, stayed out of visual range of the marine mammal observers on the *Geco Snapper*.

In this study, a total of 275 bowhead whale sightings were recorded during aerial transects with good lighting conditions (Holst et al., 2002). Bowheads were sighted at similar rates with and without seismic, although the no feeding-seismic sample was too small for meaningful comparisons. Bowheads were seen regularly within 20 km of the operations area at times influenced by airgun pulses. Of 169 transect sightings in good conditions, 30 sightings were seen within 20 km of the airgun operations at distances of 5.3-19.9 km. The aerial surveys were unable to document bowhead avoidance of the seismic operations area. The area of avoidance around the seismic operations area was apparently too small to be evident from the broadscale aerial surveys that were flown, especially considering the small amount of surveying done when seismic was not being conducted. General activities of bowheads during times when seismic operations were conducted were similar to times without seismic.

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

The results from the study in summer 2001 are markedly different from those obtained during similar studies during the autumn migration of bowheads through the Alaskan Beaufort Sea (Miller et al., 2002).

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

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

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

There are also data on the effect of seismic surveys on other species that are useful in interpretation of effects on baleen whales, including bowheads. Below, we review information from McCauley et al. (2000) regarding the responses of humpbacks to seismic surveys in Australia. More recently, at its mini-symposium on acoustics in July 2004, the IWC Scientific Committee Standing Working Group on Environmental Concerns discussed information related to a stranding of humpbacks in Brazilian waters, coincident in time with seismic surveys in the area. During the 2002 breeding season, during the same time that seismic surveys were being conducted on breeding grounds in Brazilian waters, eight strandings of adult humpback whales were reported, a frequency nearly 27% of the total stranding of adults reported in Brazilian waters between 1975 and 2003. There was no clear cause of the stranding. They discussed also information related to a potential displacement by seismic surveys of western Pacific gray whales from a feeding area off of Sakhalin Island (IWC, 2004). Based on their discussions during the mini-symposium both the IWC as a whole and its Scientific Committee agreed that there is compelling evidence of increasing sound levels, including sound from ships and seismic activities.

Weller et al. (2004) tested the hypothesis that the distribution of feeding western gray whales would shift away from seismic surveys by comparing the number of feeding western gray whales and the number of pods sighted during systematic scans conducted before, during, and after 3D seismic surveys. These authors found that both the number of whales and the number of pods sighted were significantly different during 3D seismic surveys than before and after the surveys. Noting that this population depends on the area studies for the majority of its annual food intake and is critically endangered, these authors (Weller et al., 2004:1) concluded that "Disruption of feeding in preferred areas is a biologically significant event that could have major negative effects on individual whales, their reproductive success, and thus the population as a whole."

Several summaries related to the potential effects of seismic surveys have been written (e.g., Richardson et al., 1995; McCauley et al., 2000; Gordon et al., 1998, 2004). Gordon et al. (1998:Section 6.4.3.1) summarized that "Given the current state of knowledge, it is not possible to reach firm conclusions on the potential for seismic pulses to cause…hearing damage in marine mammals." Later in this review, they reach the same conclusion about the state of knowledge about the potential to cause biologically significant masking. "This review has certainly emphasized the paucity of knowledge and the high level of uncertainty surrounding so many aspects of the effects of sound on marine mammals "(Gordon et al., 1998:Section 6.12). While uncertainty is reduced, the statements above are still accurate.

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

IV.C.5.c. Potential Differential Responses of Males and Females. McCauley et al. (2000) recently demonstrated that pods of humpback whales containing cows involved in resting behavior in key habitat were more sensitive to airgun noise than males and than pods of migrating humpbacks. In 16 approach trials carried out in Exmouth Gulf, off Australia, he found that pods of humpbacks with females consistently avoided a single (not an array) operating airgun at an average range of 1.3 km (McCauley et al., 2000). McCauley et al. (2000:692) summarized:

> The generalised response of migrating humpback whales to a 3D seismic vessel was to take some avoidance maneuver at greater than 4 kilometers then to allow the seismic vessel to pass no closer than 3 kilometers. Humpback pods containing cows which were involved in resting behaviour in key habitat types, as opposed to migrating animals, were more sensitive and showed an avoidance response estimated at 7-12 kilometers from a large seismic source.

McCauley et al. (2000) observed a startle response in one instance. Within the key habitat areas where resting females and females and calves occurred, the humpbacks showed high levels of sensitivity to the airgun. The mean airgun level at which avoidance was observed was 140 dB re 1 μPa (rms) the mean standoff range was 143 dB re 1 μPa (rms) and the startle response was observed at 112 dB re 1 μPa (rms) Standoff ranges were 1.22-4.4 km. The levels of noise at which a response was observed are considerably less than those published for gray and for bowhead whales (see above). They were also less than those observed by McCauley et al. (2000) in observations made from the seismic vessel operating outside of the sensitive area where whales were migrating, not engaged in a sensitive activity.

McCauley found that adult male humpbacks were much less sensitive to airgun noise than were females. At times, they approached the seismic vessel. McCauley et al. (2000) speculated that males that did so may have been attracted by the sound because of similarities between airgun sounds and breaching signals. Based on the aforementioned, it is likely that humpback whales feeding in areas within and adjacent to areas within the evaluation area could have their movement and feeding behavior affected by noise associated with seismic exploration. The most likely to be impacted are females and calves. This potential impact would be seasonal, since humpbacks are not common in these areas during the winter.

IV.C.5.d. Summary of Effects of 2D/3D Seismic. In summary of scientific studies and traditional knowledge presented above about the potential effect of 2D/3D seismic surveys on bowheads, bowhead response to 2D/3D seismic surveys varies, sometimes considerably. It is not entirely clear which factor(s) explain the difference in response. However there is a consensus that migratory bowheads may avoid an active seismic source at 20-30 km in some circumstance and deflection may start from even further (35 km). Since data on other whales and other mammals indicates that females with calves may show even stronger avoidance, and since it is often unclear what behavior a whale was engaged in, we assume most individuals may avoid an active vessel at received levels of as low as 116-135 dB re 1 μPa (rms) when migrating, but acknowledge this zone avoidance may be considerably less for feeding whales.

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

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

Data are not sufficient to determine sex, age, or reproductive factors that may be involved in response to vessels. We are not aware of data that would allow us to determine whether females with calves tend to show avoidance and scattering at a greater, lesser, or at the same distances as other segments of the population.

The encounter rate of bowhead whales with vessels associated with exploration would be determined by what areas were being explored. Given the proposed scenario of up to four seismic surveys in each of the two planning areas, there could potentially be up to eight additional support vessels, some of which will be icebreakers, in the vicinity where seismic activity may occur. Data are insufficient for us to accurately predict the average geographic zone of activity by the support vessels and thus, to predict the additional area that could be affected by the vessels.

Bowhead whales could encounter noise and disturbance from multiple seismic vessels and multiple support vessels as they migrate and feed in the Beaufort and Chukchi Seas. The significance of such encounters is expected to depend on the area in which the vessels are transiting, the total number of vessels in the area, the presence of other vessels (see cumulative effects section), and variable already identified regarding the number, behavior, age, sex and reproductive condition of the whales.

Depending on ice conditions, it is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, bowheads probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with exploration are not expected to disrupt the bowhead migration. Small deflections in individual bowhead-swimming paths and a reduction in use of possible bowhead-feeding areas near exploration units may result in adverse effects on the species. During their spring migration (April through June), bowheads likely would encounter few, if any, vessels along their migration route, because ice at this time of year typically would be too thick for seismic-survey ships and supply vessels to operate in. Because MMS is not allowing seismic shooting in the spring lead system until July 1 unless authorized by NMFS, we do not expect seismic survey vessel interaction to be an important source of disturbance during the northward migration.

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead whales, causing injury or death. As noted in the baseline section of this evaluation, available information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not indicate that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality in the Beaufort Sea Planning Area. Risk of strikes would increase as vessel traffic in bowhead habitat increases. We assume travel corridors would be established to minimize the amount of bowhead habitat that would be affected by oil and gas-related vessel traffic. If oil and gas-related vessel traffic increases substantially in areas commonly frequented by bowhead whales during periods when the bowheads are present, vessel strike rates should be carefully monitored.

IV.C.6.a. Effects of Icebreakers. If seismic survey vessels are attended by icebreakers, as we assume, additional disturbance and noise will be introduced by the noise of the icebreaker, which can be considerable. There are no observations of bowhead reactions to icebreakers breaking ice. Response distances would vary, depending on icebreaker activities and sound-propagation conditions. Based on models, bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.24-15.53 mi) from the icebreakers (Miles, Malme, and Richardson, 1987). Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice have not been studied. This study predicts that roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2-12 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. The study also predicts that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson et al. (1995b) found that bowheads migrating in the nearshore lead often tolerated exposure to projected icebreaker sounds at received levels up to 20 dB or more above the natural ambient noise levels at corresponding frequencies. The source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in this study (median difference 34 dB over the frequency range 40-6,300 Hz). Over the two-season period (1991 and 1994) when icebreaker playbacks were attempted, an estimated 93 bowheads (80 groups) were seen near the ice camp when the projectors were transmitting icebreaker sounds into the water, and approximately 158 bowheads (116 groups) were seen near there during quiet periods. Some bowheads diverted from their course when exposed to levels of projected icebreaker sound greater than 20 dB above the natural ambient noise level in the one-third octave band of the strongest icebreaker noise. However, not all bowheads diverted at that sound-to-noise ratio, and a minority of whales apparently diverted at a lower sound-to-noise ratio. The study concluded that exposure to a single playback of variable icebreaker sounds can cause statistically but probably not biologically significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable; however, for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi). Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant if it caused aggregations to leave resting or feeding areas. It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. The predicted typical radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 dB around the typical threshold, with commensurate variability in predicted reaction radius.

While conducting aerial surveys over the Kuvlum drilling location, Brewer et al. (1993) showed that bowhead whales were observed within about 30 km (18.6 mi) north of the drilling location. The closest observed position for a bowhead whale detected during the aerial surveys was approximately 23 km (14.3 mi) from the project icebreakers. The drilling rig was not operating on that day, but all three icebreakers had been actively managing ice periodically during the day. The study did not indicate what the whale’s behavior was, but it did not appear to be avoiding the icebreakers. Three whales were sighted that day, and all three appeared to be moving to the northwest along the normal migration route at speeds of 2.4-3.4 km/h (1.5-2.1 mi/h). Bowhead whale call rates peaked when whales were about 32 km (19.9 mi) from the industrial activity. There was moderate to heavy ice conditions throughout the monitoring area, with heavy, grounded icefloes to the west, north, and east of the drilling site. Brewer et al. (1993) were unable to determine if either ice or industrial activity by themselves caused the whales to migrate to the north of the drilling location, but they concluded that ice alone probably did not determine the observed distribution of whales.

Concerns have been raised regarding the effects of noise from OCS exploration and production operations in the spring lead system and the potential for this noise to delay or block the bowhead spring migration. As stated previously, the general location of the spring lead system in the Beaufort Sea is based on relatively limited survey data and is not well defined. We conclude that an icebreaker in the spring lead system could potentially disturb calving females, females and newborn calves, and northward-migrating bowhead whales. We conclude that effects of an icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant if it disturbed many females and calves from areas where they were resting or feeding. It could cause biologically significant effects if it caused aggregations of feeding whales to disperse and an alternatively good prey source was not nearby.

IV.C.6.b. Effects from Aircraft Traffic. Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines. Underwater sounds from aircraft are transient. According to Richardson et al. (1995a), the angle at which a line from the aircraft to the receiver intersects the water s surface is important. At angles greater than 13 degrees from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period while it passes overhead and is heard underwater.

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

Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowheads (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60-460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of 182 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

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

The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead whales exists in areas where bowheads are aggregated, especially if such aggregations contain large numbers of females and calves. We discuss these areas at the end of our discussion of the potential effects of particular affecters.

Such potential fleeing reactions would likely be considered in incidental take authorizations. Flight practices could be structured by the helicopter operators to avoid such interactions. However, if production facilities are sited in areas currently inhabited by large numbers of whales, and helicopter trip levels are similar to those documented at Northstar, it is likely that this traffic could be an important added source of noise and disturbance to bowhead whales.

IV.C.7. Areas and Situations Where Potential Impacts are Likely to be Greater than Typical. Bowheads are not randomly distributed throughout the two evaluation areas. The extent of use of particular habitats varies among years, sometimes considerably. We cannot predict, in advance of a given year, exactly how bowheads will use the entire area that is available to them. Some aspects of their habitat use are poorly understood. For example, current data are not available on which to typify the current summer use of the northern Chukchi Sea by bowheads and even summer use of the Beaufort Sea is not well understood. For example, in some years, large aggregations of bowheads near Smith Bay have been observed during MMS' Bowhead Whale Aerial Survey Program (BWASP) surveys at the beginning of September. It is unclear if these animals are early migrants that have come from the east, if they summered in the northern portions of the Beaufort Sea and came south, or if they entered from the Chukchi Sea and never migrated east. It is unclear if these whales could be expected to be present in mid- to late-August.

It is clear that if 2D/3D seismic surveys impacted areas of the spring lead and polynya system during the spring migration, impacts could be potentially biologically significant. We note that the general location of the spring lead system in the Chukchi and Beaufort seas is based on relatively limited survey data and is not well defined. Noise-producing activities, such as seismic surveys, in the spring lead system during the spring bowhead migration have a fairly high potential of affecting the whales including females with newborn calves.

It is likely that 2D and 3D streamer surveys could not occur unless large areas of open water existed. Thus, seismic surveys are not expected to be conducted in or near the spring lead system through which bowheads migrate because (1) degraded ice conditions would not allow on-ice surveys, (2) insufficient open water is present for open-water seismic surveys, and (2) we will not permit surveys in the lead system until July 1 unless authorized by NMFS.

Data available from MMS' BWASP surveys over about a 27 year period indicate that, at least during the primary open water period during the autumn (when open water seismic activities are most likely to occur), there are areas where bowheads are much more likely to be encountered and where aggregations, including feeding aggregations and/or aggregations with large numbers of females and calves, are more likely to occur in the Beaufort Sea (Figure 4). Such areas include the areas north of Dease Inlet to Smith Bay, northeast of Smith Bay, and Northeast of Cape Halkett, as well as areas near Brownlow Point.

Such aggregations have been observed in multiple years during BWASP surveys. While Figure 4 (Figure 4) is simply intended to show relative use of various areas over many years and using many years of data, groups of more than 50 or more whales have been seen on many single occasions (see data summarized in Treacy, 2002; Monnett and Treacy, 2005). For example, Treacy (1998) observed large feeding aggregations, including relatively large numbers of calves (for example, groups of 77[6], 62[5], 57[7], and 51[0], where the numbers given in brackets are the numbers of calves) of feeding bowheads in waters off of Dease Inlet/Smith Bay in 1997 and in 1998. However, in some years no large aggregations of bowheads were seen anywhere within the study area. When seen, the aggregations were in open water. As BWASP survey coverage is approximately 10% of the area surveyed, numbers counted are only a fraction of the numbers of whales that may be present.

If 2D/3D seismic surveys occurred in these areas when large aggregations were present, and particularly if multiple 2D/3D seismic surveys occurred concurrently in these areas, large numbers (hundreds) of bowheads could potentially be disturbed by the survey activity or could be excluded by avoidance from habitat for the period the surveys were occurring. As we explain in the description of the proposed action (See Appendix II), the time frame over which 2D/3D seismic surveys are likely to occur in a given area is variable, depending on the size of the area being surveyed as well as the percentage of time when the boat is inactive. However, it would not be atypical for a seismic vessel to be in a given area for 20-30 days. Following the recommendation of the NRC (2005) regarding the expression of the length of period of a potential disturbance or behavioral impacts in migratory species be expressed in the context of how long the total period of potential use of the area is, we note that the period of just a single 3-D seismic survey could be half or more of the bowhead Beaufort Sea open water autumn migration/autumn feeding habitat use period. If another company is interested in the same area (this is especially likely to occur in the Chukchi Sea evaluation area where there are no active leases) seismic survey activities could potentially exclude, through avoidance, bowhead whales from areas for the entire Beaufort Sea open-water autumn migration/autumn feeding period. We do not mean to infer that individual whales do, or do not, use some of these high use areas for this entire autumn open water period. Data are not sufficient to permit us to determine whether or not that is true. However, data do indicate that, in some cases either hundreds of whales could be excluded (through avoidance) from a large area for a relatively long portion of the season, or many more individuals would likely avoid the area as they sequentially came in to use the area.

Considering only seismic activity, and ignoring other potential human uses of an area, we considered a relatively crude scenario where all four potential seismic vessels in a given area were interested in collecting seismic data from the same general area. Because this could occur, although unlikely, we considered the instantaneous area of avoidance under the following assumptions: (1) the seismic vessels are no more distant from each other than the minimum separation of 15 miles that MMS requires; and (2) most bowhead whales will avoid approaching an active seismic vessel from a distance of about 20-30 km (e.g., see study results provided above and summary in Appendix A of LGL Alaska Research Assoc. and LGL Ltd., environmental research associates, 2005), the distance exhibited by migrating bowhead whales in response to OBC seismic surveys in the Alaskan Beaufort Sea at estimated received levels of about 116-135 dB re 1 µPa rms. We caution that this exercise is simply an attempt to gauge an approximate "ballpark" idea of the extent of the area that might be avoided. Since data indicate that bowhead reaction to seismic impacts varies, and could be lower in some cases if bowheads are in an area feeding (e.g., strong avoidance at ~3-7 km) (e.g., see Richardson et al., 1986; 1995a), but could also be higher during migration (e.g., up to 35 km in some cases), especially if much larger air guns were used than those used in surveys in the Beaufort during the late 1990's. Given these assumptions, an instantaneous area being avoided by bowheads in all directions could be at least about 112-132 km x 40-60 km. On Figures 7 and 8, we have attempted to portray such an area (using the 112 x 40 km values in both cases relatively near Barrow and near areas of relatively high whale use, to get a gross idea of the potential for high level impacts). If one mentally moves this rectangle (in reality, this would be not be rectangular, especially on the ends) throughout the two evaluation areas, one can get a crude idea of the potential extent of avoidance in different areas if the assumptions, as discussed above, held. If the area of activity and the rectangle of avoidance were offshore of where the whales wanted to be, the seismic vessels might form a "seismic fence" across which few whales would cross. It is likely most of the whales would not make use of the areas inshore of the "seismic fence," if seismic surveying is being conducted in relatively nearshore blocks.

This admittedly simplistic scenario does not include any avoidance of support vessels, or the attraction of prey that might be in the area. This simplistic ballpark exercise also does not take into account the sizes of the areas being surveyed, turning requirements of the vessels, or the fact that, unless the vessels all moved in tandem, this area would be larger as they moved further apart. The "seismic fence" effect could be mitigated by requiring vessels to be more distant from one another, but only if the distance allowed for noise level reduced corridors through which whales would transit. We note that available data indicate that, given such a scenario, bowheads would potentially come into the edges of the area if the end seismic boats were inactive, but the inactivity of only one of the middle two boats should not result in increased habitat availability.

Such clumping of activities could occur, if different companies were all interested in a similar geological prospect and were spaced as near to one another as MMS requirements would allow. If restrictions were put on the number of operators that could operate simultaneously, within a single season, within a specified geographic area, the total area in the evaluation area excluded by avoidance would rise, but the simultaneous geographic impacts in a given area would be lessened. This potential strategy trade-off could be important in reducing effects in high value areas.

We are aware that the extent of avoidance will vary both due to the actual noise level radii around each seismic vessel, the context in which it is heard, and the motivation of the animal to stay within the area. It also may vary depending on the age, and most likely, the sex and reproductive status of the whale. It may be related to whether subsistence hunting has begun and/or is ongoing.

Because the areas where large aggregations of whales have been observed during the autumn also are areas used, at least in some years, for feeding, it may be that the whales would show avoidance more similar to that observed in studies of whales on their summer feeding grounds. However, as we noted above, it is not clear that reduced avoidance should be interpreted as a reduction in impact. It may be that bowheads are so highly motivated to stay on a feeding ground that they remain at noise levels that could, with long term exposure, cause adverse effects.

We also acknowledge that effects could be greater than anticipated in two situations in the Chukchi Sea. The first situation could arise in the summer if bowheads use the Chukchi Sea in the summer more than is commonly assumed, especially for feeding and if large numbers of females with calves remain in the Chukchi Sea. Since recent data are not available on which to evaluate current habitat use by season or area in the Chukchi Sea, we cannot rule out potential for biologically significant effects in this evaluation area if sufficient mitigation is not imposed to shape the action. The second situation for larger than typical impacts probably exists in the Chukchi Sea in the autumn (e.g., late September on) as whales migrate both towards the Asian coast and toward the Bering Strait. We do not have sufficient data to determine the current migration paths or the numbers of whales that might be deflected from those paths. Data are not available to determine how intensively bowheads feed during the autumn migration in the Chukchi Sea or whether large aggregations exist in certain places due prey resources.

We note that the potential for large numbers of individuals to be excluded by avoidance from a given area, or potentially impacted by higher levels of noise if feeding, could be avoided or substantially reduced by mitigations requiring site-specific monitoring in an area prior to initiation of seismic surveys with specific restrictions on seismic surveys if certain abundance and age/sex classes of bowhead thresholds were exceeded. Large zones of potential avoidance could be reduced through mitigating measures that limited the number of active seismic vessels that could operate within a given area at any given time.

IV.C.8. On-Ice 2D/3D Seismic Surveys. The 2D/3D seismic surveying in shallow water could also be conducted during the winter over the ice and we anticipate that some on-ice surveys could occur. Seismic profiling on shore-fast ice using vibroseis is another source of introduction of noise into the arctic environment. Richardson et al. (1995a) summarized that typical signals associated with this kind of seismic activity sweep from 10-70 Hz but harmonics extend to about 1.5 kHz (Richardson et al., 1995a). In this activity, hydraulically driven pads mounted beneath a line of trucks are used to vibrate, and thereby energize the ice. Noise incidental to the activity is introduced by the vehicles associated with this activity.

These on-ice surveys often extend into the period in April when bowhead whales begin to be observed at Barrow and are present in the Chukchi and Beaufort Sea in the spring lead system. However, during that period in the Beaufort Sea, the whales are far offshore in the spring leads and distant from shallow water areas where such surveys could occur. On-ice surveys are not expected in the Chukchi Sea. These surveys have occurred regularly in nearshore areas of the Alaska Beaufort Sea over the past 30 years. If bowhead whales detect these sounds, there is no indication of any adverse effect on their migration or population recovery. For these reasons, we believe that on-ice surveys are not likely to have detectable adverse effects on bowhead whales. As these surveys are not expected to occur in the Chukchi Sea, we believe that fin and humpback whales will not be exposed to these sounds.

IV.C.9. Summary of Noise Effects Associated with Seismic Surveys. Our primary concern is for potential effects on bowhead whales, especially on females with calves, newborn and other calves, and females in general. Females that are unaccompanied by calves cannot be identified. If seismic surveys resulted in the exclusion of large numbers of these classes of individuals from feeding or resting areas, or if calves were exposed to loud sounds from seismic surveys, we cannot rule out potentially biologically significant effects. However, we believe the potential for such effects can be greatly reduced or avoided through careful application of mitigating measures including aerial monitoring and conservative shutdown criteria when females and calves or large aggregations are present.

The observed response of bowhead whales to seismic noise has varied among studies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age. Feeding bowheads tend to show less avoidance of sound sources than do migrating bowheads. This tolerance should not be interpreted as clear indication that they are not, or are, affected by the noise. Their motivation to remain feeding may outweigh any discomfort or normal response to leave the area. They could be suffering increased stress from staying where there is very loud noise. However, data on other species, and behavioral literature on other mammals, indicates that females with young are likely to show greater avoidance of noise and disturbance sources, than will juvenile or adult males.

Recent monitoring studies (1996-1998) and traditional knowledge indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore shallow waters by a radius of about 20-30 km, with received sound levels of 116-135 dB re 1 μPa (rms). Some bowheads began avoidance at greater distances (35 km). Few bowheads approached the vessel within 20 km. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980's with 2D seismic activities. Avoidance did not persist beyond 12-24 hours after the end of seismic operations. In early studies, bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Available data indicate that behavioral changes are temporary. However, there is concern within the subsistence whaling communities that whales exposed to this source of noise (and other sources) may become more sensitive, at least over the short term, to other noise sources.

If icebreakers attended seismic vessels, as is anticipated, it is anticipated that roughly half of the bowheads would respond at a distance of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB. Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

Bowheads do not typically respond to aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. The behavioral effects from such an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales should resume their normal activities within minutes. Bowheads may exhibit strong temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mi). Fleeing behavior from vessel traffic generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. In some instances, at least some bowheads returned to their original locations. Repeated encounters with aircraft and/or vessels that caused panicked or “fleeing” behavior could result repeated temporary physiological stress reactions, which could have adverse effects on health over time. In many cases, vessel activities are likely to be in shallow, nearshore waters outside the main bowhead-migration route.

Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of biological significance but could become so if whales were repeatedly interrupted or were essentially excluded from a feeding area. The importance of a given high use feeding area (especially those in the western Alaskan Beaufort Sea) in a given year to the total energetics of specific classes of individuals is still highly uncertain. Following the guidance of the NRC (2005) we have looked at these possible disturbances in the context of the total time the whales have to feed on their high latitude grounds and the time they spend in migration. The energetic cost of traveling a few additional kilometers to avoid closely approaching a noise source is very small in comparison with the cost of migration between the central Bering and eastern Beaufort seas. While we previously (USDOI, MMS, 2003a) concluded that these disturbances or avoidance factors were unlikely to be significant, because the anticipated level of industrial activity was not sufficiently intense to cause repeated displacement of specific individuals, the anticipated level of activity in 2006 and after, is greater than in 2003 but less than the activities in the late 1970’s and 1980’s. A disturbance that caused a large number of whales to avoid, or to leave, an important feeding area for weeks or longer is removing access to that resource for a high percentage of the total time available to the whales. A disturbance that caused a large number of whales, particularly females and females and calves to avoid, or to leave, an area typically used for resting (e.g., between hunting areas, or resting during the normal course of migration) for long periods of time (e.g., days in key periods to weeks) could have adverse effects on bowhead whale health. Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant seismic exploration and drilling. Behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic operations (Richardson et al., 1985a), but there still is some apparent localized avoidance (Davies, 1987). There is insufficient evidence to indicate whether or not industrial activity in an area for a number of years would adversely impact bowhead use of that area (Richardson et al., 1985a), but there has been no documented evidence that noise from OCS operations would serve as a barrier to the autumn migration in the Beaufort Sea.

IV.C.10. Effects from Small Oil Spills Associated with Seismic Surveys. Large oil spills are not expected during the course of exploration. We acknowledge that fuel spills associated with the vessels used for seismic exploration could occur, especially during fuel transfer. There could be localized short-term alterations in bowhead habitat and bowhead habitat use as a result of such a spill. Whales exposed to a small fuel spill likely would experience temporary, nonlethal effects. Data available from other mammals indicates that prolonged exposure, or particularly exposure of nursing young to spilled oil, could potentially result in temporary or potentially permanent sublethal effects. For example, ingestion of oil reduces food assimilation and thereby reduces the nutritional value of food. However, it is unlikely such an impact would be detectable. These conclusions are supported by the best available information. There are no data available to MMS that definitely link even a large oil spill with a significant population-level effect on a species of large cetacean. The greatest potential for an adverse effect would be if a large fuel spill (e.g., due to vessel sinking) occurred in the Chukchi Sea and affected the spring lead system. The potential for there to be adverse effects from a fuel oil spill would also likely be greater (than in more typical circumstances) if a large spill of fuel oil (with high concentrations of aromatics) contacted one or more large aggregation of bowheads. The probability of such an accident occurring and affecting this habitat is unlikely.

Copepods may passively accumulate aqueous polyaromatic compounds (PAC) from water and could thereby serve as a conduit for the transfer of PAC to higher trophic level consumers. Bioaccumulation factors were ~2000 for *M. okhotensis* and about ~8000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher (Duesterloh, Short and Barron, 2002). A small fuel spill would not permanently affect zooplankton populations, the bowhead's major food source. The amount of zooplankton lost in a small fuel spill would be small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993).

The potential effects to bowheads of exposure to PACs through their food are unknown. Because of their extreme longevity, bowheads are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events within their lifetime.

In the Biological Opinion for Federal oil and gas leasing and exploration by the MMS within the Alaskan Beaufort Sea, and its effects on the endangered bowhead whale, the NMFS (2001:51) stated that:

> It is difficult to accurately predict the effects of oil on bowhead whales (or any cetacean) because of a lack of data on the metabolism of this species and because of inconclusive results of examinations of baleen whales found dead after major oil releases.

We conclude that there could potentially be displacement of bowhead whales from a local feeding area following a fuel spill and this displacement could last as long as there is a sizable amount of oil and related clean-up vessel activity. Individual bowhead whales could potentially be exposed to spilled fuel oil and this exposure could have short-term effects on health. Outside of a major fuel spill resulting from a vessel sinking, we expect seismic survey spill-related effects to be minor.

IV.C.11. Conclusions about Potential effects of Seismic Surveys on Bowhead Whales. Bowhead whales, especially those that are actively migrating during the fall migration, which are exposed to 2D/3D seismic surveys would most likely exhibit avoidance of such operations and, in so doing, avoid the potential for physical harm from the noise. Most bowhead whales during the fall migration are likely to avoid an area around a seismic vessel operating in nearshore waters by a radius of up to 20-30 km. We acknowledge that we are not certain what the long-term effects may be if multiple seismic surveys and other noise sources occurred for many years within an area that was frequently used by feeding by large numbers of bowhead whales. If seismic surveys were unmitigated, or are insufficiently mitigated, effects that are biologically significant could result if seismic surveys cause avoidance of feeding area, resting areas, or calving areas by large numbers of females with calves or females over a period of many weeks. The impact would likely be related to the importance of the food source to the component of the population that would have utilized it, had not the disturbance caused them to avoid the area. Potential impacts to the population would be related to the type of individuals that were affected (e.g., juvenile males versus females with calves). Activities that cause active avoidance over large distances will have the effect of reducing any rest areas bowheads (e.g., between hunting areas) have during their autumn migration and other use of the Beaufort Sea. The potential adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in an extremely long-lived species such as the bowhead whale are unknown. Available information does not indicate there were any long-term adverse effects on the BCB Seas bowhead from the high level of seismic surveys and exploration drilling during the late 1970's and 1980's in the Beaufort and Chukchi seas. However, sublethal impacts on health (such as reduced hearing or increased stress) could not be detected in this population. The rates of population increase do not indicate any sublethal effects (if they occurred) resulted in an effect on this population's recovery.

Seismic surveys during the open water period have the potential to cause large numbers of bowheads to avoid using areas for resting and feeding for long periods of time (days to weeks) while active surveying is occurring. Avoidance may persist up to 12-24 hours after the end of seismic operations. We believe that potential significant effects can be avoided thorough careful shaping of the action through the implementation of sufficient monitoring coupled with adaptive management to focus mitigating measures where most needed.

We acknowledge considerable uncertainty about potential effects on bowhead whales in the Chukchi Sea, due to a lack of current data about their use of this evaluation area during periods when surveys could be occurring. As thousands of bowheads migrate through portions of the Chukchi during the late autumn, careful monitoring and mitigation will be necessary to avoid impacting large numbers of individuals. Depending on the restrictions usually agreed to in a conflict avoidance agreement, it is likely that 2D/3D seismic surveys will not occur until after the bowhead westward migration has occurred, except in areas outside of hunting areas or after hunting for a given Beaufort Sea village has ceased.

The effects from an encounter with aircraft generally are brief, and the whales should resume their normal activities within minutes. Operations with icebreakers attending can potentially cause a much greater zone of avoidance while they are actively breaking ice (see review of icebreaker information above).

IV.C.12. Potential Effects of Seismic Survey-Related Noise and Disturbance on Fin and Humpback Whales. It is unlikely that there would be any major affect of noise and disturbance associated with oil and gas activities in the Chukchi Sea Planning Area on humpback whales or fin whales. Since we must presume, for the purposes of analyses, that seismic surveys could occur anywhere throughout the Chukchi Sea evaluation area, because we have incomplete knowledge of potential sound propagation in various locations and under specific conditions in the Chukchi Sea, and based upon results from other studies in which seismic sound has been detectable hundreds and even thousands of kilometers from the source, we cannot rule out that humpback or fin whales feeding north of the Chukchi Peninsula could hear noise from seismic surveys associated with exploration, especially sounds from the 2D/3D seismic surveys that were occurring in the Chukchi Sea evaluation area. Impacts of such noise detection, if such detect occurs at all and causes any response, are most likely to short-term and related to minor behavioral changes, and to be of negligible impact to the population. The most likely potential effect, if the humpbacks or fin whales hear some components of the seismic noise, would be some increased attentiveness to the noise, with a potential for slight modification of their attentiveness to other sounds and possibly changes in their vocalizations.

Fin whales and humpback whales might also be exposed to the seismic survey vessels or to the support vessels as they transit to the Chukchi Sea in June and return as ice conditions dictate in the autumn. As noted, survey data indicate that humpback whales leave the most southern part of the Chukchi Sea, the northern part of the Gulf of Anadyr prior to the start of ice formation (Mel'nikov, 2000). As vessels may be heading south to avoid the same ice, these vessels could overlap in time and space with the whales as both head southward. All vessels are required to comply with law that forbids a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yd (91.4 m) of a humpback whale in any waters within 200 nmi of Alaska. Vessels (with some exemptions) transiting near humpbacks are also required to adhere to a "slow, safe speed" requirement to prevent disturbance that could adversely affect humpbacks.

Thus, it is unlikely there would be adverse effects from noise and disturbance associated with oil and gas seismic survey activities in the Chukchi Sea evaluation area on fin or humpback whales because of their distance from such activities. No population impacts are plausible for these two species and effects on individuals are considered unlikely.

IV.D. Potential Effects from Drilling Operations.

Exploration drilling units and other drilling units are sources of noise and disturbance to bowhead whales. Exploration drilling in the Beaufort Sea can be conducted from manmade gravel islands, ice islands, caisson-retained islands, bottom-founded drilling platforms such as the concrete island drilling system or single steel drilling caisson, or from drillships in deeper water supported by icebreakers. The type of drilling platform used depends on water depth, oceanography, ice cover, and other factors. Stationary sources of offshore noise (such as drilling units) appear less disruptive to bowhead whales than moving sound sources (such as vessels). Drilling operations from many of these structures except drillships are likely to be conducted during the winter months. Drilling from ice islands would occur only during the winter when bowheads are not present, and noise from these activities would not affect bowhead whales. Therefore, this type of drilling activity is not discussed here.

We anticipate that gravel islands are not likely to be constructed for exploratory drilling in OCS waters, but that old artificial islands might be used temporarily. In the near future we expect that exploratory drilling in the Beaufort Sea will also be conducted from other platforms and during the open water period depending on water depth, sea ice conditions, availability of drilling units, and the ice-resistance of units. In Appendix II, we state that moveable platforms resting on the seafloor could be used to drill in water depths of 10-20 m, but that drillships or other floating units would be used in deeper waster. Drilling from these units will be in open water. Such drilling would be supported by icebreakers and supply boats.

In the Beaufort Sea, we assume a maximum of two drilling rigs would operate at any one time with a total of six exploration wells and six delineation wells drilled over an eight year period, beginning in 2007. We assume that a total of 102 production and injection wells would be drilled from 2 production platforms between 2012 and 2019.

Exploration drilling in the Chukchi Sea evaluation area could begin after the proposed Chukchi Sea Sale 193 in late 2007. Drilling operations in the Chukchi Sea are likely to employ drillships with ice-breaker support vessels and to operate at a given well site between 30 and 90 days. We anticipate one to two exploration wells per season drilled between June-November. No exploration drilling from Sale 193 would occur in the polynya. If the polynya is offered as part of the proposed sales in the 2007-2012 5-Year Program, no exploration drilling activities would occur before 2011.

Thus, based on the aforementioned scenario, bowhead whales could potentially encounter a total of 3 exploration drilling units within evaluation areas, with icebreaker support possible in the Chukchi Sea and likely in the Beaufort Sea. Beginning in 2012, production and injection wells may also be drilled.

Noise-producing activities, such as drilling operations, in the spring lead and polynya system during the spring bowhead migration have a fairly high potential of affecting the whales. While MMS has decided not to allow seismic survey activity in the spring lead system through late June, or as prescribed by NMFS to protect bowhead whales. No exploration activities would occur in the spring lead system from Sale 193, as excluded in the current 2002-2007 5-Year Program. Exploration drilling from future OCS sales would not occur before 2011. At this time, it is unknown whether future Chukchi Sea Sales will include or exclude the spring lead system. The general location of the spring lead system is based on relatively limited survey data and is not well defined.

Previously, MMS concluded that exploratory drilling operations using floating platforms within the portion of the Beaufort Sea spring lead system during the bowhead migration are unlikely, because the ice at this time of year would be too thick for floating drilling platforms to get to the location and conduct drilling operations, even with icebreaker support. Thus, in the Beaufort Sea multiple-sale EIS, we concluded that spring-migrating bowheads are not likely to be exposed to drilling noise from activities on leases from Sales 186, 195, or 202. We concluded that areas in or near the spring lead system in the Beaufort Sea could be leased during these sales, but any exploratory drilling operations likely would be conducted during the open-water season (August-October) using floating drilling platforms.

Future lease sale decisions will determine whether the polynya area deferred form leasing in the 2002-2007 5-Year Program will be offered for lease in the future. No exploratory drilling in the Chukchi Sea portion of the lead system could begin unless tracts within the polynya area are offered and leased. Open water in this polynya area typically begins in June and continues through November.

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

(0.62-2.5 mi) from a drillship drilling when the signal-to-noise ratio is 30 dB. A smaller proportion would react when the signal-to-noise ratio is about 20 dB (at a greater distance from the source), and a few may react at a signal-to-noise ratio even lower or at a greater distance from the source.

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

Although underwater sounds from drilling on some artificial islands and caissons have been measured, little information is available about reactions of bowheads to drilling from these structures. Underwater noise levels from drilling operations on natural barrier islands or artificial islands are low and are not audible beyond a few kilometers (Richardson et al., 1995a). Noise is transmitted very poorly from the drill-rig machinery through land into the water. Even under open-water conditions, drilling sounds are not detectable very far from the structure. Drilling noise from caisson-retained islands is much stronger. At least during open-water conditions, noise is conducted more directly into the water than from island drill sites. Noise associated with drilling activities at both sites varies considerably with ongoing operations. The highest documented levels were transient pulses from hammering to install conductor pipe. NMFS (2001:27) concluded that:

> ...bowhead whale responses to noise from drilling and exploration activities are expected to depend on the type of activity and its location relative to the whales' normal migration corridors…Thus, a drill ship operating offshore and closer to the center of the migration is expected to have a greater biological impact than a drilling operation from an artificial island situated in very shallow water along the nearshore edge of the migration.

IV.D.1. Potential Effects of Drilling from Artificial Gravel Islands. The following is a brief discussion of several studies on the measurement of underwater noise and the effects of noise from drilling operations on gravel islands on bowhead whales.

IV.D.1.a. Seal Island: Noise measurements were made during the open-water season near Seal Island, a manmade gravel island off Prudhoe Bay in water 12 m deep. Seal Island is the current approximate location for the Northstar Project. Davis, Greene, and McLaren (1985) measured underwater noise from Seal Island during the open-water season while well logging was occurring but not drilling operations. Underwater sound levels recorded from bottom hydrophones 1.65-2.4 km from Seal Island were strongly affected by wind speed and active barge or tug traffic at the island. The strongest tone measured was 486 Hz from turbochargers on the generators used for well-logging operations. This tone was measured by a hydrophone on a boat at distances of up to 5 km from Seal Island. Noise associated with barge or tug movement at the island readily could be detected at 2.4 km from the island, even during high winds. Noise levels in the 20-1,000-Hz band from barge traffic were about 118 dB re 1 µPa at 1.6 km and had decreased to 108-110 dB re 1 µPa at 2.4 km. At that rate of sound attenuation, the noise level from barges was estimated to be about 92 dB at 6 km. Underwater sounds from Seal Island were not detectable 2.3 km away while people were on the island and power generators were operating, but no logging or drilling operations were ongoing.

Aerial surveys for bowhead whales near Seal Island in 1982 (during island construction) and 1984 found that most whales were in water deeper than 18 m, which is consistent with data from previous studies (Davis, Greene, and McLaren, 1985). In 1982, one whale was sighted in 12 m of water about 11 km northwest of Seal Island. In 1984, there were two sightings of single whales in 12-15 m of water. Whales migrating in water deeper than 18 m would have been too far away to detect noise from Seal Island, because industrial noise was not audible in the water more than a few kilometers away. Acoustic data collected in 1982 and 1984 suggest that some bowheads were closer to Seal Island in 1984 than in 1982. Localizations made by the hydrophone array on three occasions indicated the whales were present between

2.5 and 6 km from Seal Island. Bowhead calls recorded on hydrophones were thought to be from whales that were in water at least 18 m deep. The study concluded that there was no evidence to suggest that bowheads avoided Seal Island in 1984 compared to 1982.

IV.D.1.b. Sandpiper Island: Johnson et al. (1986) measured underwater noise from Sandpiper Island, a manmade gravel island in water 15 m deep. Sound was measured using a bottom-hydrophone system at 0.5 km from the island and sonobuoys at greater distances from the island. The median sound levels observed at a fixed location 0.5 km from Sandpiper Island were relatively low. Median noise levels in the 20-1,000-Hz band were 93 and 95 dB re 1 µPa during two periods without drilling and 100 dB re 1 µPa during one period with drilling. In the absence of shipping or other industrial sounds, the expected level of noise in the 20-1,000-Hz band is about 100 dB re 1 µPa for Beaufort Sea State 2 conditions (wind speeds at 7-10 kn and wave heights up to 0.5 m). The most obvious components were tones at 20 and 40 Hz, which were attributed to power generation on the island.

The low-frequency industrial sounds from Sandpiper Island attenuated rapidly with increasing range, at least partially due to the shallow water. The low-frequency sounds were evident when ambient noise levels were low but were largely masked during periods when ambient noise was above average. Sound levels received at a sonobuoy 3.7 km from Sandpiper Island (76 dB re 1 µPa in both the 20- and 40-Hz bands) were 24-30 dB lower than the levels received at the bottom hydrophone 0.5 km from the island. The bottom hydrophone measured drilling sounds of 100 dB re 1 µPa in the 20-Hz-frequency band at 0.5 km from Sandpiper Island. The sounds were severely attenuated at 3.7 km and not detectable at 9.3 km. The effective source level of the 40-Hz tone was estimated at 145 dB re 1 µPa at 1 m.

Impulsive hammering sounds associated with installation of a conductor pipe were as high as 131-135 dB re 1 µPa at 1 km, when pipe depth was about 20 m below the island. In contrast, broadband drilling noise at this distance was about 100-106 dB. During hammering, the transient signals had the strongest components at 30-40 Hz and about 100 Hz. Moore et al. (1984, as cited in Richardson, et al., 1995b) reported that received levels for transient piledriving sounds recorded at 1 km from a manmade island near Prudhoe Bay were 25-35 dB above ambient levels in the 50- to 200-Hz band. They estimated that the sounds might be received underwater as far as 10-15 km from the source, farther than drilling sounds. Aerial surveys for bowhead whales in 1985 indicated that no bowheads were seen closer than 30 km from Sandpiper Island (Johnson et al., 1986). Almost all of the migrating bowheads traveled in water deeper than 18 m, as was found in the surveys for Seal Island. Sandpiper and Northstar islands are both about 6 km south of the 18-m-depth contour. Industrial noise from Sandpiper Island, with or without drilling, was not audible in the water more than a few kilometers away. Because the migration route of almost all bowheads is north of the 18-m contour, few individual whales moved into the zone where industrial noise potentially was detectable.

The authors concluded that the number of whales that passed along the southern edge of the migration route and approached the artificial islands, both Seal and Sandpiper, must have been a very low fraction of the total population given the absence of sightings close to the islands.

IV.D.1.c. Tern Island: Studies at Tern Island were conducted to determine sound levels that could be expected from the proposed Liberty development project. The studies provide information on distances that sound travels as a result of activities on gravel islands.

Greene (1997) measured underwater sounds under the ice at the proposed Liberty Island location from drilling operations on Tern Island in Foggy Island Bay in February 1997. Sounds from the drill rig generally were masked by ambient noise at distances near 2 km. The strongest tones were at frequencies below 170 Hz, but the received levels diminished rapidly with increasing distance and dropped below the ambient noise level at ranges of about 2 km. Drilling sounds were not detected at frequencies above 400 Hz, even at 200 m from the drill rig.

Greene noted that if production proceeded at Liberty, the types and frequency characteristics of some of the resulting sounds would be similar to those from the drilling equipment in this study. Electric power generation, pumps, and auxiliary machinery again would be involved, as would a drill rig during the early stages of production. However, the production island also would include additional processing and pumping facilities. If this equipment requires significantly more electric power, generators may produce sounds that are detectable at greater distances. However, these sounds would diminish rapidly with increasing distances due to high spreading losses (35 dB/tenfold change in range) plus the linear attenuation rates of 2-9 dB per km (0.002-0.009 dB/m). Sound transmission within the lagoon for activities at Liberty would be similar to the sound transmission measured for activities at Tern Island, but the barrier islands to the north and the lagoon's very shallow water near those islands should make underwater sound transmission very poor beyond the islands and into the Beaufort Sea.

Greene (1998) measured ambient noise and acoustic-transmission loss underwater at the proposed Liberty Island site in Foggy Island Bay during the open-water season of 1997 to complement transmission loss and ambient-noise measurements made under the ice at Liberty in February 1997. For wind speeds of zero, 10, 20, and 30 km, typical overall ambient noise levels in the 20-5,000-Hz band were 85, 94, 104, and 114 dB re 1 µPa, respectively. For the data from both recorders taken together, the median 20-5,000-Hz band level for the 44 days was 97 dB re 1 µPa, or 9 dB above the corresponding level for Knudsen's standard for Sea State 0 (Greene, 1998). The levels were consistent with other ambient noise measurements made in similar locations at similar times of the year. The measured ambient levels in winter generally were lower than those measured in summer, which means that industrial sounds would be expected to be detectable at greater distances during the winter. Bowheads are not present in the winter.

Acoustic-transmission loss was measured using a four-element sleeve-gun array and a minisparker as sources. The sleeve-gun array is a relatively low-frequency source (63-800 Hz) compared to the minisparker (315-3,150 Hz). Received sounds were recorded quantitatively at distances up to 8.1 km southeast and 10.1 km north of Liberty. At greater distances (up to 10 km), the sounds from the sleeve-gun array diminished generally according to -25 log(R), while the minisparker sound diminished at approximately -10 log(R), corresponding to cylindrical spreading. This difference is attributed to the sleeve-gun array being a low-frequency source compared to the minisparker. Propagation-loss rates varied with frequency. The minisparker had a higher linear loss rate, which corresponds to higher absorption and scattering losses at higher frequencies.

Richardson et al. (1995a) summarized that noise from drilling activities varies considerably with operations. The highest documented levels were transient pulses from hammering to install conductor pipe. Underwater noise associated with drilling from natural barrier or artificial islands usually is weak and is inaudible beyond a few kilometers. Richardson et al. (1995a) estimated that drilling noise generally would be confined to low frequencies and would be audible at a range of 10 km only during unusually quiet periods, while the audible range under more typical conditions would be approximately 2 km.

IV.D.2. Potential Effects of Drilling Operations from Bottom-Founded Structures. Two types of drilling platforms have been used for offshore drilling in the Alaska Beaufort Sea: the concrete island drilling system, which is a floating concrete rig that is floated into place, ballasted with seawater, and sits on the seafloor; and the single steel drilling caisson, which is a section of a ship with a drill rig mounted on it and also is floated into place, ballasted with seawater, and sits on the seafloor. Drilling from these platforms generally begins after the bowhead whale migration is done and continues through the winter season.

In the absence of drilling operations, radiated levels of underwater sound from the concrete island drilling system were low, at least at frequencies above 30 Hz. The overall received level was 109 dB re 1 µPa at 278 m, excluding any infrasonic components. When the concrete island drilling system was operating in early winter, radiated sound levels above 30 Hz again were relatively low (89 dB at 1.4 km). However, when infrasonic components were included, the received level was 112 dB at 1.4 km. More than 99% of the sound energy received was below 20 Hz. Received levels of sound at 222-259 m ranged from 121-124 dB. The maximum detection distance for infrasonic sounds was not determined. Such tones likely would attenuate rapidly in water shallow enough for a bottom-founded structure. Overall, the estimated source levels were low for the concrete island drilling system, even when the infrasonic tones were included (Richardson et al., 1995a).

Sounds from the steel drilling caisson were measured during drilling operations in water 15 m deep with 100% ice cover. The strongest underwater tone was at 5 Hz (119 dB re µPa) at a distance of 115 m. The 5-Hz tone apparently was not detectable at 715 m, but weak tones were present at 150-600 Hz. The broadband (20-1,000 Hz) received level at 215-315 m was 116-117 dB re µPa, higher than the 109 dB reported for the concrete island drilling system at 278 m.

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

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

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

In Canada, bowhead use of the main area of oil-industry operations within the bowhead range was low after the first few years of intensive offshore oil exploration in 1976 (Richardson, Wells, and Wursig, 1985), suggesting perhaps cumulative effects from repeated disturbance may have caused the whales to leave the area. In the absence of systematic data on bowhead summer distribution until several years after intensive industry operations began, it is arguable whether the changes in distribution in the early 1980's were greater than natural annual variations in distribution, such as responding to changes in the location of food sources. Ward and Pessah (1988) concluded that the available information from 1976-1985 and the historical whaling information do not support the suggestion of a trend for decreasing use of the industrial zone by bowheads as a result of oil and gas exploration activities. They concluded that the exclusion hypothesis is likely invalid.

The distance at which bowheads may react to drillships is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The principal finding of this study was that migrating bowheads appeared to avoid the offshore drilling operation in fall 1986. Thus, some bowheads may avoid noise from drillships at 20 km (12.4 mi) or more. In other studies, Richardson, Wells, and Wursig (1985) observed three bowheads 4 km (2.48 mi) from operating drillships, well within the zones ensonified by drillship noise. The whales were not heading away from the drillship but were socializing, even though exposed to strong drillship noise. Eleven additional whales on three other occasions were observed at distances of 10-20 km (6.2-12.4 mi) from operating drillships. On two of the occasions, drillship noise was not detectable by researchers at distances from 10-12 km (6.2-7.4 mi) and 18-19 km (11.2-11.8 mi), respectively. In none of the occasions were whales heading away from the drillship. Ward and Pessah (1988, as cited in Richardson and Malme, 1993) reported observations of bowheads within 0.2-5 km (0.12-3 mi) from drillships.

The ice-strengthened Kulluk, a specialized floating platform designed for arctic waters, was used for drilling operations at the Kuvlum drilling site in western Camden Bay in 1992 and 1993. Data from the Kulluk indicated broadband source levels (10-10,000 Hz) during drilling and tripping were estimated to be 191 and 179 dB re µPa at 1 m, respectively, based on measurements at a water depth of 20 m in water about 30 m deep (Richardson et al., 1995a).

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

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

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

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

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

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

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

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

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

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

IV.D. 4. Icebreakers. If drillships are attended by icebreakers, as typically is the case during the fall in the U.S. Beaufort Sea, and we expect to be the case in the Chukchi Sea, the drillship noise frequently may be masked by icebreaker noise, which often is louder. Response distances would vary, depending on icebreaker activities and sound-propagation conditions. Based on models, bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.24-15.53 mi) from the icebreakers (Miles, Malme, and Richardson, 1987). Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice have not been studied. This study predicts that roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2-12 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. The study also predicts that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

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

It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration and are subject to a number of qualifications. The predicted "typical" radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least 10 dB around the "typical" threshold, with commensurate variability in predicted reaction radius.
Richardson et al. (1995a) reported that broadband (20-1,000 Hz) received levels at 0.37 km for the icebreaking supply vessel the Canmar Supplier underway in open water was 130 dB and 144 dB when it was breaking ice. The increase in noise during icebreaking is apparently due to propeller cavitation. Richardson et al. (1995a) summarized that icebreaking sound from the Robert Lemeur pushing on ice were detectable >50 km away. We anticipate that an icebreaker would attend a drillship in the Chukchi Sea. Brewer et al. (1993) reported that in the autumn of 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by 25+ km. This ship was icebreaking almost daily. However, Richardson et al. (1995a) noted that in 1987, bowheads also avoided another drillsite with little icebreaking.

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

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

The encounter rate of bowhead whales with vessels associated with exploration would be determined on what areas were being explored. Bowhead whales probably would encounter relatively few vessels associated with exploration activities during their fall migration through the Alaskan Beaufort Sea. Vessel traffic generally would be limited to routes between the exploratory-drilling units and the shore base. Each floating drilling unit probably would have one vessel remaining nearby for emergency use. Depending on ice conditions, floating drilling units may have two or more icebreaking vessels standing by to perform ice-management tasks. It is likely that vessels actively involved in ice management or moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. In either case, bowheads probably would adjust their individual swimming paths to avoid approaching within several kilometers of vessels attending a drilling unit and probably would move away from vessels that approached within a few kilometers. Vessel activities associated with exploration are not expected to disrupt the bowhead migration, and small deflections in individual bowhead-swimming paths and a reduction in use of possible bowhead-feeding areas near exploration units should not result in significant adverse effects on the species. During their spring migration (April through June), bowheads likely would encounter few, if any, vessels along their migration route, because ice at this time of year typically would be too thick for seismic-survey ships, drillships, and supply vessels to operate in.

In 2003, there was concern by Alaskan Native whalers that barge traffic associated with oil and gas activities might have caused bowhead whales to move farther offshore and, thus, to be less accessible to subsistence hunters. Because of the concern over this issue, we provide a summary of the information available to MMS on this issue, with focus on information related to evaluation of potential effects of the whales (for example, their movement patterns). The following is based solely on information provided by ConocoPhillips to MMS (Majors, 2004, pers. commun.; Greene, 2003). Other detailed information is not available to us.

Drilling rigs and equipment associated with the Puviaq exploration well west of Teshekpuk Lake were moved to Camp Lonely for barge out to Deadhorse in the summer of 2003, prior to the autumn whaling season. Camp Lonely is about 85 miles east of Barrow. While barge activities originally were scheduled to be completed prior to September 1, 2003, stormy weather and eroded beach conditions prevented their completion until October 10, 2003. Barrow whalers landed their first whale of the autumn migration on

October 8, 2003. The hunters located whales more than 20 mi offshore of Barrow. Some whalers were concerned that ConocoPhillips' barging activities caused deflection of the whales farther offshore. ConocoPhillips contracted with Greeneridge Sciences to determine noise propagation distances associated with the barging activities. Greene (2003:2) concluded that a broadband source level of 171 dB re 1 µP at 1 m is a reasonable and potentially a conservative (higher than the likely actual source level) estimate to use as a source level for the "relatively small tug and barge used by ConocoPhillips in its demobilization activities." After evaluating alternative models for estimating transmission loss, and considering likely ambient noise levels (based on data collected in 1996 offshore of Northstar), Greene (2003) applied the estimated source level to what he viewed as the most reasonable sound propagation loss model to estimate the received level of sound at four distances (0.1-63 km) from the tug and barge. The estimated hearing distances are based on the assumption that the whales do not hear sounds below the background noise level. Greene acknowledged that this assumption oversimplifies the hearing process but believes it is reasonable, given the approximations made for source level and for propagation loss. Greene (2003) estimated the following received sound levels at specific distances: 131 dB re 1 µPa at 0.1 km; 111 dB re 1 µPa at 1.0 km; 102 dB re 1 µPa at 2.8 km; and 75 dB re 1 µPa at 63 km. Given the assumptions that were required about hearing and the approximations regarding sound transmission loss, Greene (2003:4) stated it would be best to consider the estimates of received sound levels as "guidelines." ConocoPhillips also evaluated traditional knowledge information available from a 1997 workshop held in Barrow (Major, 2004, pers. commun.). Based on this information, they concluded that whales would have returned to their original headings about 45 mi before reaching Barrow if they had encountered noise from the barging operation at Camp Lonely. We cannot critically evaluate this conclusion, because it is unclear exactly which information it is based upon. ConocoPhillips and the NSB both researched the timing of vessel activities in the region. ConocoPhillips reported that this research revealed that another barge, unrelated to oil industry activities, departed Barrow for Deadhorse on October 8, 2003, which was the first day a whale was landed in Barrow (Major, 2004, pers. commun.). They also reported that an elder Barrow whaling captain reported that migration patterns of many species were different in 2003. For example, he reported that bowhead whales were spotted on the west side of Barrow in August, 2003. On the NSB map reporting the locations of landed whales offshore of Barrow, the waters nearshore to about 20 mi offshore were recorded to be muddy. ConocoPhillips concluded that their barging operations were not the cause of deflected whales offshore of Barrow in the fall of 2003 (Major, 2004, pers. commun.). There are no other data available to MMS regarding potential effects of the barge operations. Thus, we cannot critically evaluate the potential influence of the barging operations on whale movements near Barrow in 2003.

Considerable information regarding vessel traffic in 2001 the Beaufort Sea near BPXA's Northstar facility are provided by Williams and Rodrigues (2003). Much of this information was for vessel traffic during the 2002 whaling season was collected by AEWC's whaling communication center. See pages 2-20 to 2-28 of William and Rodrigues (2003) for this detailed information.

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead whales, causing injury or death. As noted in the baseline section of this evaluation, available information indicates that current rates of vessel strikes of bowheads are low. At present, available data do not indicate that strikes of bowheads by oil and gas-related vessels will become an important source of injury or mortality in the Beaufort Sea Planning Area. Risk of strikes would increase as vessel traffic in bowhead habitat increases. We assume travel corridors would be established to minimize the amount of bowhead habitat that would be affected by oil and gas-related vessel traffic. If oil and gas-related vessel traffic increases substantially in areas commonly frequented by bowhead whales during periods when the bowheads are present, vessel strike rates should be carefully monitored.

IV.D.6. Effects from Aircraft Traffic. Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines. Underwater sounds from aircraft are transient. According to Richardson et al. (1995a), the angle at which a line from the aircraft to the receiver intersects the water's surface is important. At angles greater than 13 degrees from the vertical, much of the incident sound is reflected and does not penetrate into the water. Therefore, strong underwater sounds are detectable while the aircraft is within a 26-degree cone above the receiver. An aircraft usually can be heard in the air well before and after the brief period while it passes overhead and is heard underwater.

Data on reactions of bowheads to helicopters are limited. Most bowheads are unlikely to react significantly to occasional single passes by low-flying helicopters ferrying personnel and equipment to offshore operations. Observations of bowhead whales exposed to helicopter overflights indicate that most bowheads exhibited no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). However, bowhead reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995a). This noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Patenaude et al. (1997) found that most reactions by bowheads to a Bell 212 helicopter occurred when the helicopter was at altitudes of 150 m or less and lateral distances of 250 m or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. However, the majority of bowheads showed no obvious reaction to single passes, even at those distances. The helicopter sounds measured underwater at depths of 3 and 18 m showed that sound consisted mainly of main-rotor tones ahead of the aircraft and tail-rotor sounds behind the aircraft; more sound pressure was received at 3 m than at 18 m; and peak sound levels received underwater diminished with increasing aircraft altitude. Sound levels received underwater at 3 m from a Bell 212 flying overhead at 150 m ranged from 117-120 dB re 1 μPa in the 10- to 500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 150 m ranged from 112-116 dB re 1 μPa in the 10- to 500-Hz band.

Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). Aircraft on a direct course usually produce audible noise for only tens of seconds, and the whales are likely to resume their normal activities within minutes (Richardson and Malme, 1993). Patenaude et al. (1997) found that few bowheads (2.2%) during the spring migration were observed to react to Twin Otter overflights at altitudes of 60-460 m. Reaction frequency diminished with increasing lateral distance and with increasing altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of 182 m or less and lateral distances of 250 m or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 460 m and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

IV.D.7. Effects from Construction. Island-construction activities could cause noise and disturbance to bowhead whales. Placement of fill material for island construction generally occurs during the winter, when bowhead whales are not present. Completion of island construction and placement of slope-protection materials may take place during the open-water season, but these activities generally are completed before the bowhead whale fall migration. Placement of sheetpile, if used, would generate noise during the open-water period for one construction season but also should be completed in early to mid-August, before the whales migrate. Noise is not likely to propagate far due to the shallow water and the presence of barrier islands that, in many cases, may lie between the drilling location and the migration corridor used by bowhead whales, depending on the island location. Even during the migration, noise from these activities would be minor and would not affect bowhead whales. If such construction were to occur in an area where large numbers of whales were attempting to feed (such as has been observed in a few years (but not in many other years) in the Dease Inlet/Smith Bay area, the whales might be displaced from a small portion of the feeding range for that year.

Preliminary analysis of noise measurements during the open-water construction season at Northstar Island by Blackwell and Greene (2001) indicated that the presence of self-propelled barges had the largest impact on the level of sound coming from Northstar Island. Self-propelled barges remained at Northstar for days or weeks and always had their engines running, because they maintained their position by “pushing” against the island. Sound measurements on a day when there were no self-propelled barges showed that sounds were inaudible to the field acoustician listening to the hydrophone signal beyond 1.85 km, even on a relatively calm day. By comparison, the sounds produced by self-propelled barges, while limited in their frequency range, were detectable underwater as far as 28 km north of the island. Other vessels, such as the crew boat and tugs, produced qualitatively the same types of sounds, but they were present intermittently, and their effect on the sound environment was lower.

IV.D.8. Potential Impacts of Noise from Production Facilities. As noted in the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), it has been documented that bowhead and other whales avoid various industrial activities if the received sound levels associated with the activity are sufficiently strong (see summaries and references in Richardson et al., 1995a, and NRC, 2003). The monitoring of sound associated with the construction and production activities at the BPXA Northstar facility and the monitoring of marine mammals in nearby areas has recently provided additional information relative to assessing potential impacts of oil and gas production-related noise on bowhead whales. Williams and Rodrigues (2003) reported that BPXA began construction of the Northstar gravel island in early 2000. Northstar is built on an artificial gravel island, and was constructed on the remnants of the submerged artificial gravel island called Seal Island. This facility is about 54 mi (87 km) northeast of Nuiqsut. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea. However, the facility is situated in State of Alaska waters, and thus, is still relatively nearshore relative to leasing blocks offered in the OCS lease sale. Two pipelines connect this island to the existing infrastructure at Prudhoe Bay. Richardson and Williams (2003) reported that transportation to the island from the mainland is primarily via vessels in the summer and helicopters during seasonal transitional periods. Oil production began on 31 October 2001 (Richardson and Williams, 2003).

North Slope residents have expressed concern that the bowhead whale autumn migration corridor might be deflected offshore in the Northstar area due to whales responding to underwater sounds from construction, operation, and vessel and aircraft traffic associated with Northstar. Richardson and Thompson (2004) and other researchers working with LGL and Greeneridge Sciences, Inc. undertook studies during the open-water period to determine both the underwater noise levels at various distances north of Northstar and potential impacts on bowhead whales north of the island, as assessed by locations determined by vocalization locations. The final report confirms the basic findings previously referred to. Additional details from the final report are provided below.

Blackwell and Greene (2004:4-22) summarized that, in the absence of boats, "During both construction….and the drilling and production phase…, island sounds…reached background values at distances of 2-4 km…" in quiet ambient conditions. Blackwell and Greene (2004) concluded that during the open water season, vessels such as self-propelled barges, crew boats, and tugs were the tugs, self-propelled barges) were the primary contributors to the underwater sound field. Broadband sounds from vessels near Northstar were often detected offshore as far as approximately 30 km. "Background levels were not reached in any of the open-water recordings with boats present at Northstar" (Blackwell and Greene, 2004:4-25). At Northstar in 2001, two 61.5 ft. (18.7 m) crew vessels operated between West Dock and Northstar between 23 July 2001 and 7 October 2001 for a total of 824 round trips (Williams and Rodrigues, 2003). Tone above 10 kHz characterized production sound. In air sounds typically reached background levels at 1-4 km, but an 81-Hz tone was detectable 37 km from the island (Blackwell and Greene, 2004).

During three days in September 2001, Greeneridge Sciences collected measurements of underwater and airborne sounds at seven distances north of the island (0.25-37 km). The lowest levels recorded were 87-90 dB re 1 µPa underwater and 37-40 dBA re 20 µPa in air at the most distant locations. Maximum levels were 116 dB re 1 µPa underwater and 56 dBA re 20 µPa in air. Richardson and Williams (2003) and Blackwell (2003) summarized that when both oil production and drilling was occurring, underwater and airborne sound reached background levels at about 3.5 km (2.2 mi.) from Northstar in quiet ambient conditions. The authors report that these values are comparable to those found in previous studies of sounds from gravel islands. Sound levels were higher (up to 128 dB re 1 µPa underwater at 3.7 km) when operating vessels, including crew boats were present. Sound levels were also recorded from cabled hydrophones located about 0.25 nmi (420 m) north of Northstar continuously for 31 days from 31 August to 1 October 2002 (Richardson and Williams, 2003). Broadband (10-1,000 Hz) levels recorded in 2002 by the cabled hydrophones spanned a narrower range than in 2001. In 2001 the 95^{th} percentile was higher (122.8 dB re 1 µPa) than in 2002 (117.2 db re 1 µPa) but the 5^{th} percentile was higher in 2002 (94.8 dB) than in 2001 (87.8 dB). Median values were comparable in both years (2001:102. dB versus 2002:103.0 dB). Many spikes in broadband levels could be attributed to crew boats and barge traffic.

During the normal "open water period" in 2001 (16 June to 31 October), there were approximately 989 roundtrip helicopter flights to Northstar.

Richardson et al. (2004:8-2) summarized that data in 2001 provided evidence of a slight displacement of the "…southern edge of the bowhead whale migration corridor at times with high levels of industrial sound, but no such effect was evident in 2003, and the 2002 results were inconclusive."

It is important to note that this study did not have a "Northstar-absent" control, a point noted by the authors of the report (see Greene et al., 2003:7-5). That is, there are no locations of whales based on vocalizations absent any sound from Northstar to be compared with localizations given Northstar sound. Limitations of the study are well discussed by the authors in the report. However, the available data on bowhead locations, coupled with data on noise propagation, indicate that if noise from Northstar is having an impact on whale movements, the effect, if it exists, is not dramatic.

IV.D.9. Well Abandonment. Other potential sources of noise, disturbance, and possible injury to threatened and endangered species during OCS oil and gas exploration are activities associated with abandonment of exploration and delineation wells. The casings for wells can be cut mechanically or with explosives during the process of well abandonment. The use of explosives could result in injury or even death to threatened and endangered marine mammals that are in the area at the time of the explosions. Underwater blasts can kill or injure marine mammals that are nearby, although the threshold levels for injury or death are not well established (for example, Ketten, Lien and Todd, 1993; Richardson et al., 1995). With respect to well abandonment, the MMS (USDOI, MMS, Pacific OCS Region, 2001) previously summarized that:

> …the use of explosives for delineation well abandonment would involve the detonation of a relatively small, 16- to 20-kilogram charge in the well casing 5 meters below the sea floor. This positioning of the charge would dampen the explosion and restrict shock and acoustic effects primarily to the area of water immediately above the well head. However, a marine mammal close to the detonation site potentially could be injured or killed, or suffer permanent or temporary hearing damage. Some disturbance of marine mammals present in the vicinity of the detonation area could also occur, but these would be expected to be minor and temporary…Overall, impacts from this source are expected to be low.

Bowheads are the only ESA-listed species under the jurisdiction of NMFS that regularly occurs in areas where such well-abandonment activities potentially could take place. Available data indicate that humpback whales and fin whales are unlikely to occur within either proposed planning area or to occur close enough to be adversely affected by well abandonment.

Impacts to bowhead whales from well-abandonment activities could be avoided if these activities were implemented only when bowheads were absent or if sufficient monitoring (e.g., aerial surveys and passive acoustic monitoring) for bowheads occurred prior to the use of any explosives and protocols were implemented to ensure that such explosives were not used if such species were in areas where there was a potential for them to be adversely impacted by the explosives.

IV.D.10. Summary of Potential Effects of Noise and Disturbance Sources.

IV.D.10.a Bowhead Whales. Available information indicates that bowhead whales are responsive, in some cases highly responsive, to anthropogenic noise in their environment. We have reviewed available information above. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source and the reasons for this variability are not fully understood. In other species of mammals, including cetaceans, females with young are more responsive to noise and human disturbance than other segments of the population. Oil and gas exploration, development, and production could result in considerable increase in noise and disturbance in the spring, summer, and autumn range of the BCB Seas bowhead whales.

Depending on their timing, location, and number, these activities potentially could produce sufficient noise and disturbance that bowhead whales might avoid an area of high value to them and suffer consequences of biological significance. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by females and calves.

If seismic operations overlap in time, the zone of seismic exclusion or influence could potentially be quite large, depending on the number, and the relative proximity of the surveys. If seismic surveys were unmitigated, or are insufficiently mitigated to reduce impacts to the whales themselves, effects that are biologically significant could result if seismic surveys cause avoidance of feeding area, resting (including nursing) areas, or calving areas by large numbers of females with calves or females over a period of many weeks, and they are not able to readily use other similar areas without a costly expenditure of energy. The impact to individuals would likely be related to the importance of the food source or resting area to the component of the population that would have utilized it, had not the disturbance caused them to avoid the area. This is likely to remain unknown. Potential impacts to the population would be related to the numbers and types of individuals that were affected (e.g., juvenile males versus females with calves). Activities that cause active avoidance over large distances will have the effect of reducing rest areas bowheads (e.g., between hunting areas) have during their autumn migration and other use of the Beaufort Sea.

The observed response of bowhead whales to seismic noise has varied among studies. The factors associated with variability are not entirely clear. However, data indicate that fall migrating bowheads show greater avoidance of active seismic vessels than do feeding bowheads. Recent monitoring studies (1996-1998) and traditional knowledge indicate that during the fall migration, most bowhead whales avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 km and may begin avoidance at greater distances. Received sound levels at 20 km ranged from 117-135 dB re 1 µPa rms and 107-126 dB re 1µ Pa rms at 30 km. This is a larger avoidance radius than was observed from scientific studies conducted in the 1980's. Avoidance did not persist beyond 12-24 hours after the end of seismic operations. In some early studies, bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Available data indicate that behavioral changes are temporary. The subsistence whaling communities are substantially concerned that whales exposed to this source of noise (and other sources) may become more sensitive, at least over the short term, to other noise sources.

Bowheads respond to drilling noise at different distances depending on the types of platform from which the drilling is occurring. Data indicate that many whales can be expected to avoid an active drillship at 10-20 km or possibly more. The response of bowhead whales to construction in high use areas is unknown and is expected to vary with the site and the type of facility being constructed. Similarly, the long-term response of bowheads to production facilities other than gravel islands located at the southern end of the migration corridor is unknown.

Exploration, development, and production results in an increase in marine vessel activity, and depending on location and season, may include icebreakers, barges, tugs, supply and crew boats, and other vessels. Whales respond strongly to vessels directly approaching them. Avoidance of vessel usually begins when a rapidly approaching vessel is 1-4 km away, with a few whales possibly reacting at distances from 5-7 km. Received noise levels as low as 84 dB re 1 µPa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period.

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

Whales appear to exhibit less avoidance behavior with stationary sources of relatively constant noise than with moving sound sources.

Exploration, development, and production also results in increased aircraft traffic, including possible whale monitoring flights. Most bowheads exhibit no obvious response to helicopter overflights at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise. Bowheads are not affected much by any aircraft overflights at altitudes above 300 m (984 ft). Below this altitude, some changes in whale behavior may occur, depending on the type of plane and the responsiveness of the whales present in the vicinity of the aircraft. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). The effects from such an encounter with either fixed-wing aircraft or helicopters generally are brief, and the whales should resume their normal activities within minutes. If numerous flights for exploration or development and production occur, depending on the location, bowheads may be repeatedly exposed to helicopter noise in areas between shorebases and/or airports and the production facilities. Depending on where shorebases for activities are located, effects could be mitigated by ensuring that flight paths avoided whale aggregations or that flights were high enough to avoid disturbance.

We anticipate that gravel islands are not likely to be constructed for exploratory drilling in OCS waters, but that old artificial islands might be used temporarily. In the near future we expect that exploratory drilling in the Beaufort Sea will also be conducted from other platforms and during the open water period depending on water depth, sea ice conditions, availability of drilling units, and the ice-resistance of units. In Appendix II, we state that moveable platforms resting on the seafloor could be used to drill in water depths of 10-20 m, but that drillships or other floating units would be used in deeper waster. Drilling from these units will be in open water. Such drilling would be supported by icebreakers and supply boats. This is expected to be the norm in the Chukchi Sea.

If gravel islands were used for exploration or production drilling, noise produced from drilling from gravel islands probably would not have large effects on bowhead whales, because gravel islands are constructed in fairly shallow water shoreward of the main migration route, and noise from operations on gravel islands generally is not audible beyond a few kilometers. In the Beaufort Sea, island-construction activities likely would be conducted during the winter and generally are in nearshore shallow waters shoreward of the main bowhead whale migration route. However, as evidenced by Northstar, such construction was supported by numerous trips by barges and other vessels providing materials.

As development moves farther offshore, we anticipate much greater aircraft and vessel support. For example, we estimate (Appendix II) that marine transport requirements during construction in the Far Zone would range between 150-250 vessel trips including numerous barges during the open water period. Bowheads may exhibit temporary avoidance behavior if approached by vessels at a distance of 1-4 km (0.62-2.5 mi). Marine-vessel traffic also may include seagoing barges transporting equipment and supplies from Southcentral Alaska to drilling locations, most likely between mid-August and mid- to late September. If the barge traffic continues into September, some bowheads may be disturbed. Fleeing behavior from vessel traffic generally stopped within minutes after the vessel passed, but scattering may persist for a longer period

Given results from Northstar regarding noise from barges, and the bowheads reaction to moving vessels, the level of barge and vessel activity that would occur if development and production proceeds as envisioned in the scenario, could potentially cause bowhead whales to avoid the area between the production platform and docking facilities during the period of activity. The significance of such a potential effect would depend on where the production facility was located.

Overall, bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, and seismic surveys most likely would experience temporary, nonlethal effects. Bowhead whale response to certain noise sources varies. Some of the variability appears to be context specific (i.e., feeding versus migrating whales) and also may be related to reproductive status and/or sex or age.

As time goes on, many of these activities can and probably will occur in both program areas in the same season and, in some cases, in closely adjacent areas. In 2006, 2D and 3D seismic surveys, icebreaker activity for transit, high resolution surveys, and other support vessel traffic are expected in the Beaufort Sea. Aerial surveys also may be conducted. In 2007, exploration drilling, 2D and 3D seismic surveying, and high-resolution seismic surveys are anticipated in the Beaufort Sea and 2D and 3D seismic are anticipated in the Chukchi Sea. If these activities are clumped in space and coincident in time and place with large numbers of bowhead whales, large numbers of bowheads could be adversely affected.

Data are sufficient to conclude that all response to future noise and disturbance is likely to vary with time of year; sex and reproductive status of individuals exposed; site (because of differences in noise propagation and use by bowheads); activity and the exact characteristics of that activity (e.g., drilling versus seismic, airgun array and configuration, etc.); the animal's motivation to be in an area; and options for alternative routes, places to feed, etc. While habituation is seen in some species, and behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic operations, localized avoidance still occurred. We believe that it is much less likely that bowheads will habituate to at least certain types of noise than some other species because they are hunted annually, and thus, many individuals may have a strong negative association with human noise.

The potential total adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in an extremely long-lived species such as the bowhead whale are unknown. Available information does not indicate any long-term adverse effects on the BCB Seas bowhead from the high level of seismic surveys and exploration drilling during the 1980's in the Beaufort and Chukchi seas. However, sub-lethal impacts on health (such as reduced hearing or increased stress) could not be detected in this population. The rate of this population's increase in abundance does not indicate any sub-lethal effects (if they occurred) resulted in an effect on this population's recovery. There has been no documented evidence that noise from previous OCS operations has served as a barrier to migration.

Because bowheads respond behaviorally to loud noise, they are less likely to suffer hearing loss from increased noise. However, bowheads are more tolerant of noise when feeding and future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise on bowheads, including the potential for increased noise to cause physiological stress responses.

We acknowledge that we are not certain about the nature of long-term effects if multiple exploration seismic surveys and other noise and disturbance sources occurred for many years within an area that was frequently used by feeding or resting by large numbers of bowhead whales. Concentrations of loud noise and disturbance activities during the open water period have the potential to cause large numbers of bowheads to avoid using areas for resting and feeding for long periods of time (days to months) while the noise producing activities continue. We believe that the strongest effects could be avoided through careful shaping of the action through the implementation of sufficient monitoring coupled with adaptive management to focus area, timing and bowhead presence-related mitigating measures where most needed.

IV.D.10.b. Fin and Humpback Whales. Our summary of information about the current and historic distributions of fin whales and humpback whales indicate that these species are not likely to be exposed to potential noise and disturbance associated with many of the actions that could occur within the Chukchi Sea or the Beaufort Sea Planning Areas. We have no information that indicates that fin or humpback whales are known to inhabit the Beaufort Sea or adjacent areas. Thus, noise producing oil and gas activities within the Beaufort Sea are not likely to affect this species. Neither fin whales nor humpback whales are known to typically inhabit the Chukchi Sea Planning Area. However, both species are known to inhabit the southwestern portions of the Chukchi Sea, in waters adjacent to the coast of Chukotka. They also inhabit the Bering Strait and northerly portions of the Bering Sea. They could be disturbed by an increase in oil and gas-related shipping through the Bering Strait that could result from increased activities in the two arctic planning areas. Such effects should be temporary and minor. Based on available information, we conclude it is unlikely that there will be adverse effects on either fin whales or humpback whales from noise causing activities in the Beaufort or Chukchi Sea evaluation areas. We acknowledge that there are no current data available that are sufficient on which to determine current use of the Chukchi Sea Program Area (except that area directly north of Barrow), or adjacent areas.

IV.E. Effects from Discharges.

There could be alterations in bowhead habitat as a result of exploration including localized pollution and habitat destruction. We refer NMFS to the Beaufort Sea multiple-sale EIS for a detailed discussion of drilling muds and other discharges associated with exploration drilling, with probable scenarios regarding the disposal of these substances and for discussion of the potential effects on water quality from their discharge. Any potential adverse effects on endangered whales from discharges are directly related to whether or not any potentially harmful substances are released, if they are released to the marine environment, what their fate in that environment likely is (for example, different hypothetical fates could include rapid dilution or biomagnification through the food chain), and thus, whether they are bioavailable to the species of interest.

Disposal of drilling muds and cuttings would be as specified under conditions prescribed by the EPA's National Pollutant Discharge Elimination System permit. Discharge of drilling muds and cuttings during exploration activities is not expected to cause population-level effects, either directly through contact or indirectly by affecting prey species. Any effects would be localized primarily around the drill rig because of the rapid dilution/deposition of these materials. Exploration drilling muds and cuttings may cover portions of the seafloor and cause localized pollution. However, the effects likely would be negligible, because bowheads feed primarily on pelagic zooplankton and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat.

Bottom-founded drilling units and/or gravel islands may cover areas of benthic habitat that support epibenthic invertebrates used for food by bowhead whales. Muds and cuttings from development drilling from platforms are expected to be treated and disposed of in disposal wells, Muds and cuttings from satellite development wells are expected to be barged either to the host platform for downhole disposal or to shore for disposal.. Produced waters are expected to be reinjected.

Gravel-island-construction activities, including placement of fill material, or installation of sheetpile or gravel bags for slope protection could cause loss of habitat, depending on the location of the gravel island. This construction would cause temporary sediment suspension or turbidity in the water as well as noise and disturbance (see noise and disturbance section).

IV.F. Potential Effects of Large and Very Large Oil Spills on Bowhead, Fin, and Humpback Whales.

IV.F.1. Summary of Potential Oil Spill Effects on Endangered Cetaceans.

IV.F.1.a. Bowhead Whales. We are not, and we cannot be, certain of the level of effects on bowheads should a large or very large oil spill occur. Should development and production occur in the Chukchi Sea OCS, the estimated chance spills >1,000 bbl occurring in the Chukchi Sea OCS is estimated to be about 40%. The estimated chance of one or more 1,000-bbl spills occurring in the Beaufort Sea OCS is about 10-11%. Oil spilled in the Beaufort Sea OCS could contact resources in the Chukchi Sea OCS and vice versa. Thus, bowhead whales could conceivably be exposed to oil and oil spill response from spills in both planning areas. The estimated chance of one or more large spills occurring, based on lease sales in both areas, is 47%.

We conclude that most adult whales exposed to spilled oil likely would experience temporary, or perhaps permanent, nonlethal effects, although prolonged exposure to freshly spilled oil could kill whales. This conclusion is supported by the best available information. There are no data available to MMS that definitely link a large oil spill with a significant population-level effect on a species of large cetacean.

However, while data from previous spills in other locations worldwide are broadly informative, we acknowledge uncertainty about the potential for population level effects or other potential outcomes should a large or very large spill occur in instances where whales are aggregated and/or constrained in their option for alternative routes (for example, in the spring lead and polynya system due to ice conditions) or are aggregated in a feeding area, especially if aggregations contained large numbers of females and calves.

The potential for a population level effect may exist if large numbers of females and calves, especially newborn or very young calves, were to be contacted by large amounts of freshly spilled oil. The uncertainty arises because:

- of the unique ecology of the bowhead whale;
- existing information about the effects of oil on very large cetaceans is inconclusive and, thus, it is not possible to confidently estimate the likelihood that serious injury to individuals of bowhead whales could or would occur with oil exposure;
- there is lack of agreement over the interpretation of post-Exxon Valdez oil-spill cetacean studies;
- there are not data sufficient to determine the vulnerability of newborn or other baleen calves to freshly spilled crude oil;
- it is very difficult, if not impossible, to obtain many of the kinds of data that have been gathered on some other marine mammals to assess acute or chronic adverse sublethal effects from an oil spill (or other affecters) on large cetaceans; and
- there is no other situation comparable to that which could exist if a large or very large oil spill occurred in, or moved into, the spring lead and polynya system, especially if this occurred when there were large numbers of females with newborn calves, occurred when calving was occurring, or occurred when hundreds of individuals were in the leads and polynya on their northward migration.

We feel that it is important to acknowledge this uncertainty about potential effects of a large or very large oil spill on the Western Arctic stock of bowhead whales, because it is listed as endangered and because of its importance to Alaskan Native peoples of the Arctic**.** The NRC (2003a:161), citing Ahmaogak (1985, 1986, 1989) and Albert (1990) states that: "…the potential for an oil spill and its likely effects on bowhead whales are viewed by bowhead-dependent hunters as the greatest threat to the whale population and to their cultural relationship with the animal."

Our overall conclusion about potential oil spill effects broadly agrees with that previously provided by NMFS (2001:51) in its most recent Biological Opinion for Federal oil and gas leasing and exploration by the MMS within the Alaskan Beaufort Sea, and its effects on the endangered bowhead whale. NMFS concluded that:

> It is difficult to accurately predict the effects of oil on bowhead whales (or any cetacean) because of a lack of data on the metabolism of this species and because of inconclusive results of examinations of baleen whales found dead after major oil releases….

Recent research (Lambertsen et al., 2005) on the functional morphology of the mouth of the bowhead whale and consideration of the implications of such functional morphology to evaluating risk to bowheads and other balaenids from ingestion of spilled hydrocarbons indicates that the potential effects from oil fouling of baleen "can be considered poor" and highlights the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

The MMS is currently re-analyzing oil spill risks related to development and production in the Chukchi Sea OCS. Results from these analyses other than the overall oil spill probability are not yet available for incorporation in these effects analyses. When they become available, the MMS will immediately undertake analyses of the potential risks of a large spill in this planning area to affect the bowhead whale. Until such data are available, we cannot fully evaluate the likelihood that bowhead whales outside of the Chukchi Sea OCS (e.g., along the Chukchi Peninsula or near Wrangell Island) could be adversely affected by oil spilled within the Chukchi Sea Planning Area.

IV.F.1.b. Fin Whales and Humpback Whales. As previously summarized, neither fin whales nor humpback whales are expected to appear at any time of the year within either the Chukchi Sea Planning Area or the Beaufort Sea Planning Area. They have been documented to feed in coastal waters of the southwestern Chukchi Sea, adjacent to the Chukchi Peninsula in the summer and autumn. Recent data to confirm their lack of use of areas of the Chukchi Sea evaluation area, except that portion of the area directly north of Barrow, are lacking. They have not been observed in the Beaufort Sea evaluation area during aerial surveys conducted over the past 27 years. Based on data from the late 1980's and early

1990's, individuals from these two species are not likely to be present in the Chukchi Sea if an oil spill occurred in the winter or early spring. They are unlikely to be present within the evaluation area in the summer or autumn. However, depending on oil spill trajectories, they could potentially be exposed to oil spilled in the Chukchi Sea Planning Area that impacted contacted marine waters adjacent to the Chukchi Sea Peninsula Coast or that contacted the Bering Strait.

As noted above, MMS is currently re-analyzing oil spill risks related to development and production in the Chukchi Sea Planning Area. Results from these analyses other than the overall oil spill probability are not yet available for incorporation in these effects analyses. When they become available, the MMS will immediately undertake analyses of the potential risks of a large spill in this planning area to affect these two species of whales. As with the bowhead whale, until this analysis is available, we cannot fully evaluate the likelihood that fin or humpback whales feeding seasonally in waters adjacent to the north side of the Chukchi Peninsula and in the Bering Strait, could be adversely affected by oil spilled within the planning area.

IV.F.2. Potential for the Exposure of the Three Species of Endangered Whales to Oil Spilled in the Chukchi Sea and Beaufort Sea Planning Areas. Bowhead whales are the most likely of ESA-listed baleen whales to be impacted if an oil spill occurred in either the Chukchi Sea or Beaufort Sea Planning Areas because they commonly occur seasonally in areas where such spills could occur. Bowhead whales use of portions of the both the Chukchi Sea and Beaufort Sea evaluation areas for: spring and fall migration; feeding; calving; resting; and limited breeding. Most of the calving for this population probably occurs between the Bering Strait and Point Barrow. Thus, they could be exposed to freshly spilled oil, as well as to oil that is spilled at some distance and that moves into areas inhabited by whales. It is important to know whether or not a species has the potential for exposure to oil that is spilled on the site because freshly spilled oil contains high levels of toxic aromatic compounds that, if inhaled, can cause serious health effects or death. Oil that moves some distance from a site may or may not still (e.g., depending on temperature and whether the oil becomes frozen into ice) have high levels of toxic aromatic compounds.

As previously summarized, fin whales and humpback whales are not expected to appear at any time of the year within either the Chukchi Sea or the Beaufort Sea Planning Area. They have been documented to feed in coastal waters of the southwestern Chukchi Sea, adjacent to the Chukchi Peninsula in the summer and autumn. Recent data to confirm their lack of use of areas of the Chukchi Sea evaluation area, except data from that portion of the area directly north of Barrow, are lacking. They have not been observed in the Beaufort Sea evaluation area during aerial surveys conducted over the past 27 years. Available information does not indicate that individuals from these two species are likely to be present in portions of the Chukchi Sea where they could be adversely affected by oil spilled in the Beaufort Sea at any time of the year. Individuals from these two species are not likely to be present in the Chukchi Sea if an oil spill occurred in the winter or early spring. Based on data from the late 1980's and early 1990's, neither of these two species is expected to occur within the Chukchi Sea evaluation area at any time of the year. However, depending on oil spill trajectories, they could potentially be exposed to oil spilled in the Chukchi Sea evaluation area that impacted contacted marine waters adjacent to the Chukchi Sea Peninsula Coast or that contacted the Bering Strait. As noted above, we cannot evaluate the likelihood of this contact until our Chukchi Sea Planning Area oil spill analyses are available.

IV.F.3. General Background on Potential Effects of Oil on Marine Mammals. Although there is no conclusive evidence that large baleen whales would be killed as a result of contact with spilled oil, the mammalian literature indicates that adult whales could die from prolonged exposure to oil. It is well documented that exposure of at least some mammals to petroleum hydrocarbons through surface contact, ingestion, and especially inhalation can be harmful. Surface contact with petroleum hydrocarbons, particularly the low-molecular-weight fractions, can cause temporary or permanent damage of the mucous membranes and eyes (Davis, Schafer, and Bell, 1960) or epidermis (Hansbrough et al., 1985; St. Aubin, 1988; Walsh et al., 1974). Contact with crude oil can damage eyes (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill treatment centers (Wilson et al.,

1990) after the *Exxon Valdez* oil spill. Ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anaesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988).

Many polycyclic aromatic hydrocarbons are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact the birth weight of young. Fetuses of rats whose mothers were given repeated small doses of Prudhoe Bay crude oil during pregnancy had significantly lower weights and crown-rump lengths than control rats (Khan et al., 1987). All fetuses of rats exposed to polycyclic 7,12-dimethylbenz(a)anthracene during key periods of pregnancy were stunted and oedematous in the deep portions of the dermis and underlying subcutaneous layers (Currie et al., 1970). Aromatic components of crude oil have been associated with a variety of hemorrhagic abnormalities in humans (Haley, 1977). After seals were experimentally dosed with crude oil, increased gastrointestinal motility and vocalization and decreased sleep were observed (Geraci and Smith, 1976; Engelhardt, 1985, 1987). Oil ingestion can decrease food assimilation of prey eaten (for example, St. Aubin, 1988). Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

There are few postspill studies with sufficient details to reach firm conclusions about the effects, especially the long-term effects, of an oil spill on free-ranging populations of marine mammals. However, available evidence suggests that mammalian species vary in their vulnerability to short-term damage from surface contact with oil and ingestion. While differences in acute vulnerability to oil contamination do exist due to ecological (for example, nearshore versus offshore habitat) and physiological reasons (for example, dependence on fur rather than on blubber for thermal protection), species also vary greatly in the amount of information that has been collected about them and about their potential oil vulnerability. These facts are linked, because the most vulnerable species have received the most focused studies. However, it also is the case that it is more difficult to obtain detailed information on the health, development, reproduction and survival of large cetaceans than on some other marine mammals. Data are not available that would permit evaluation of the potential for long-term sublethal effects on large cetaceans.

Marine mammals also can be affected indirectly after a spill due to oil and cleanup disturbance and damage to prey resources.

IV.F.4. Summary of Key Observations of Cetaceans after Large, Very Large, and Catastrophic Oil Spills. If mortality of bowheads were to occur after exposure to fresh crude oil after a large spill, it would be not be consistent with many, perhaps most, published findings of impacts of oil on cetaceans after real oil spills. However, as we pointed out in the recent final EIS for the Cook Inlet Planning Area OCS Oil and Gas Lease Sales (USDOI, MMS, 2003b), information about environmental impacts on whales is rudimentary and full of speculation and uncertainty. While animals such as sea otters, seals, and many birds can be examined closely, impacts on whales from oil spills (and many other perturbations) are difficult to assess because large numbers of most of the species cannot be easily captured, examined, weighed, sampled, or monitored closely for extended periods of time. Thus, impacts such as the sublethal impacts observed on sea otters (for example, reduced body condition, abnormal health, etc.)(see Rotterman and Monnett, 2002, and references cited therein) after the *Exxon Valdez* oil spill are unlikely to be documented in cetaceans because the data needed to determine whether or not such impacts exist cannot be collected. On the other hand, it may be that ecological and physiological characteristics specific to large cetaceans serve to buffer them from many of those same types of impacts. Unless impacts are large and whales die and are necropsied, most effects must be measurable primarily using tools of observation. Unless baseline data are exceptionally good, determination of an effect is only possible if the effect is dramatic. With whales, even when unusual changes in abundance occur following an event such as the *Exxon Valdez* oil spill (as with the disappearance of relatively large numbers of killer whales from the AB pod in Prince William Sound) (see Dahlheim and Matkin, 1994 and the following discussion), interpretation of the data is uncertain or is often controversial due to the lack of supporting data, such as oiled bodies or observations of individuals in distress (and, in that case, the existence of a viable alternate explanation of the probable mortality). Thus, the potential for there to be long-term sublethal (for example, reduced body condition, poorer health, or longer dependency periods), or lethal effects from large oil spill on cetaceans essentially is unknown. There are no data on cetaceans adequate to evaluate the probability of such effects.

Loughlin (1994) observed gray whales swimming in oil from the *Exxon Valdez* oil spill (EVOS) in March 1989, but no gross abnormalities were reported. J. Lentfer (as reported in Harvey and Dahlheim, 1994) reported seeing three gray whales at the southwest entrance to Prince William Sound swimming northwest through a moderate amount of oil. Six other whales were observed near the southwest entrance to Prince William Sound. Based on 10 minutes of observation, J. Lentfer (cited in Harvey and Dahlheim, 1994) reported that the whales continually swam at the surface and appeared lethargic. Fumes from the oil were apparent in the airplane at 100-200 m elevation (J. Lentfer, cited in Harvey and Dahlheim, 1994). After the EVOS, Loughlin (1994) reported that 26 gray whales were found in 1989 on Alaska beaches from Kayak Island to King Salmon. Most of the whales were along the outside of the Kodiak Archipelago near Sitkinak and Tugidak Islands. During 1990, 9 gray whales were stranded at Sitkinak Island and 17 were stranded at Tugidak. Thirty-six gray whale carcasses were counted at these islands in 2 years (Loughlin, 1994). Six gray whales were reported between Kayak Island and Sarichef during 1975-1987. Loughlin (1994) concluded that the reason for the greater number of whales found in 1989 is unexplained but may be attributable to the fact that the search after the *Exxon Valdez* oil spill coincided with the northern migration of gray whales and to the greater activity in remote areas after the spill. Data are insufficient to reach any conclusion about the cause of death of these whales. Other dead cetaceans found in 1989 included one fin whale and one minke whale, both in upper Cook Inlet, one minke whale on Montague Island, and four harbor porpoise (two in the Kodiak areas). Samples from three gray whales, two minke whales, and five harbor porpoise were analyzed for hydrocarbon contaminants. Blubber from one gray whale showed a polycyclic aromatic hydrocarbon level of 467 nanograms per gram (ng/g) wet weight, with a polycyclic aromatic hydrocarbon profile consistent with a petrogenic source (Loughlin, 1994). Polycyclic aromatic hydrocarbon levels in the blubber of one of five harbor porpoises examined were similar (446 ng/g wet weight) but Loughlin did not discuss the polycyclic aromatic hydrocarbon profile of this animal. Loughlin (1994) reported that histological examination of all tissues were unremarkable and provided no information about the cause of death of any of the cetaceans.

Large numbers of gray whale carcasses have been discovered previously in other parts of the range (see examples in Loughlin, 1994). During the oil spill off Santa Barbara in 1969, an estimated 80,000 bbl of oil may have entered the marine environment. Gray whales were beginning their annual migration north during the spill. Whales were observed migrating northward through the slick. Several dead whales were observed and carcasses recovered, including six gray whales, one sperm whale, one pilot whale, five common dolphins, one Pacific white-sided dolphin, and two unidentified dolphins. Brownell (1971, as reported by Geraci, 1990) acknowledged that these whales totaled more than the usual number of gray whales and dolphins stranding annually on California shores, and concluded that increased survey efforts had led to the higher counts. Several of the whales examined were thought to have died from natural causes, and one may have been harpooned. No evidence of oil contamination was found on any of the whales examined. The Batelle Memorial Institute concluded the whales were either able to avoid the oil, or were unaffected when in contact with it.

After the EVOS, Harvey and Dahlheim (1994) observed groups of Dall's porpoises on 21 occasions in oiled areas. One Dall's porpoise had oil on the dorsal half of its body and appeared stressed because of its labored breathing pattern. Harvey and Dahlheim (1994) report that the dorsal surface of the porpoise's body, from the blowhole to the dorsal fin, was covered in oil. Lung problems were common in oiled otters brought into treatment centers after the EVOS and are frequent in mammals following inhalation of petroleum hydrocarbons.

The authors gave no other information on effects. The authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present. However, as noted above in the review of observations following other spills, observations of cetaceans behaving is a lethargic fashion or having labored breathing has been documented in more than one species, including in gray whales after EVOS in which large numbers of individuals were subsequently found dead.

After the EVOS, von Ziegesar, Miller, and Dahlheim (1994) stated that potential (but not documented) impacts to the humpback whale, from the EVOS included displacement from normal feeding areas, reduction in prey, or possible physiological impacts resulting in mortality or reproductive failure. In all 3 years of von Zeigesar's study, humpback whales were observed primarily in Knight Island Passage and areas in the southwestern portions of the sound (see Figures 10-6 and 10-7 in von Zeigesar, Miller, and Dahlheim, 1994). von Zeigesar, Miller, and Dahlheim (1994) reported that no humpbacks were observed feeding in water with floating oil but were seen in areas that comprised the primary path of the spill. However, most of the still floating oil had exited the sound prior to peak humpback abundance. However, considerable oil remained and oil continued to wash off of beaches due to wave action and oil-spill-cleanup activities. Whales also were exposed to increased noise and other disturbance due to oil-spill cleanup. von Zeigesar, Miller, and Dahlheim (1994) report that no humpbacks were observed swimming in oil and no humpback deaths or strandings were reported during 1988-1990 in Prince William Sound. They concluded that the results of their study do not indicate a change in calving rate, seasonal residence time, mortality, or abundance. They concluded also that long-term impacts to the whales or their environment could not have been detected in the short period of their study, and that because of the wide distribution of humpback whales in the North Pacific and unequal surveying effort in their study, the effects, if any, of theEVOS on humpbacks may never be known.

Based on evidence of observation of individuals from the AB pod of killer whales in heavy oil, and large disappearances of whales from the AB pod in the 2 years following that exposure (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994), one could conclude that whales are vulnerable if they are present within a very large spill, probably due to inhalation. Matkin et al (1994) reported that killer whales had the potential to contact or consume oil, because they did not avoid oil or avoid surfacing in slicks. Only in the 2 years following the EVOS did significant numbers (13) of individual whales, primarily reproductive females and juveniles, disappear from AB pod. These authors reported that this mortality was significantly higher than in any other period except when killer whales where being shot by fishers during sablefish fishery interactions. Harvey and Dahlheim (1994) observed 18 killer whales, including 3 calves, and saw the pod surface in a patch of oil. Dahlheim and Matkin (1994) also reported seeing AB pod swim through heavy slicks of oil. Dahlheim and Matkin (1994:170) concluded that "There is a spatial and temporal correlation between the loss of the 14 whales and the EVOS, but there is no clear cause-and-effect relationship." This link is circumstantial, and there is not agreement in the scientific community as to whether or not there likely was an oil-spill impact on killer whales after the EVOS.

We know of no bowhead whale deaths resulting from an oil spill.

Neither mysticete nor odontocete whales seem to consistently avoid oil, although they can detect it (Geraci, 1990). However, in captivity, bottlenose dolphins avoided an oiled area (Geraci, St. Aubin, and Reisman, 1983). Geraci (1990) reported that fin whales, humpbacks, dolphins and other cetaceans have been observed entering oiled areas and behaving normally. After the EVOS, Dall's porpoises were observed 21 times in light sheen, and 7 times in areas with moderate to heavy surface oil (Harvey and Dahlheim, 1994). Geraci (1990) summarized available information about the physiological and toxic impacts of oil on cetaceans (see Table 6-1 in Geraci, 1990). He concluded that although there have been numerous observations of cetaceans in oil after oil spills, there were no certain deleterious impacts.

IV.F.5. Analyses of Potential Effects of an Oil Spill on Bowhead Whales. Following a large or very large oil spill, bowhead or other baleen whales could suffer adverse effects due to:

- inhalation of toxic components of crude oil;
- ingesting oil and/or contaminated prey;
- fouling of their baleen;
- oiling of skin;
- reduced food source; and
- displacement from feeding areas.

IV.F.5.a. Effects of Inhalation of Toxic Components of Crude Oil. The greatest threat to large cetaceans probably is from inhalation of volatile compounds present in fresh crude oil. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of bowheads or other cetaceans could occur if they surfaced in large quantities of fresh oil. Inhalation of volatile hydrocarbon fractions of fresh crude oil can damage the respiratory system (Hansen, 1985; Neff, 1990), cause neurological disorders or liver damage (Geraci and St. Aubin, 1982), have anesthetic effects (Neff, 1990) and, if accompanied by excessive adrenalin release, cause sudden death (Geraci, 1988).

Based on evidence of observation of individuals from the AB pod of killer whales in heavy oil, and large disappearances of whales from the AB pod in the 2 years following that exposure (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994), one could conclude that whales are vulnerable if they are present within a large spill, probably due to inhalation. However, this link is circumstantial, and there is not agreement in the scientific community as to whether or not there likely was an oil-spill impact on killer whales after the EVOS. Similarly, gray whales with apparently abnormal behavior were observed in oil after the EVOS in an area where fumes from the spill were apparently very strong (J. Lentfer, cited in Harvey and Dahlheim, 1994). Subsequently large numbers of gray whale carcasses were discovered. One of three of these whales had elevated levels of polycyclic aromatic hydrocarbons in its blubber. Loughlin (1994) concluded it was unclear what caused the death of the gray whales. During the oil spill off Santa Barbara in 1969, an estimated 80,000 bbl of oil may have entered the marine environment. Gray whales were beginning their annual migration north during the spill. Whales were observed migrating northward through the slick. Several dead whales were observed and carcasses recovered, including six gray whales, one sperm whale, one pilot whale, five common dolphins, one Pacific white-sided dolphin, and two unidentified dolphins. Brownell (1971, as reported by Geraci, 1990) acknowledged that these whales totaled more than the usual number of gray whales and dolphins stranding annually on California shores, and concluded that increased survey efforts had led to the higher counts. Several of the whales examined were thought to have died from natural causes, and one may have been harpooned. No evidence of oil contamination was found on any of the whales examined. The Batelle Memorial Institute concluded the whales were either able to avoid the oil, or were unaffected when in contact with it.

Based on all available information, if individual, small groups or, less likely, large groups of whales were exposed to large amounts of fresh oil, especially through inhalation of highly toxic aromatic fractions, they might be seriously injured or die from such exposure. Although there is very little definitive evidence linking cetacean death or serious injury to oil exposure, disappearances (and probable deaths) of killer whales and the deaths of large number of gray whales both coincided with the EVOS and with observations of members of both species in oil. However, in these two cases, even if one assumed the disappearances of the killer whales and the high number of gray whale carcasses both were the result of the coinciding oil spill, and one assumed impacts on bowhead whales of the same magnitude, it is unlikely that there would be a significant population-level adverse effect in the event of a large oil spill.

As noted above, we know of no bowhead whale deaths resulting from an oil spill. For the reasons discussed in the previous paragraph, it is difficult to predict the impact of a large or very large spill on bowhead whales, fin whales, or humpback whales. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of cetaceans could occur if they surfaced in large quantities of fresh oil. We believe this is most likely if bowhead calves were exposed to fumes from a large spill. Calves take more breaths than do their mothers and spend more time at the surface. Thus, it is likely they would be most likely to succumb to inhalation of toxic aromatic compounds.

The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, reduced immune function, reduced reproduction or longer dependency periods) effects on large cetaceans from a large oil spill is essentially unknown. There are no data on large cetaceans adequate to evaluate the probability of sublethal effects.

Geraci and St. Aubin (1982) calculated the concentrations of hydrocarbons associated with a theoretical spill of a typical light crude oil. They calculated the concentrations of the more volatile fractions of crude oil in air. The results showed that vapor concentrations could reach critical levels for the first few hours after a spill. If a whale or dolphin were unable to leave the immediate area of a spill during that time, it would inhale some vapors, perhaps enough to cause damage. Fraker (1984) stated that a whale surfacing in an oil spill will inhale vapors of the lighter petroleum fractions, and many of these can be harmful in high concentrations. Animals that are away from the immediate area or that are exposed to weathered oils would not be expected to suffer serious consequences from inhalation, regardless of their condition. The most serious situation would occur if oil spilled into a lead that bowheads could not escape. In this case, Bratton et al. (1993) theorized the whales could inhale oil vapor that would irritate their mucous membranes or respiratory tract. They also could absorb volatile hydrocarbons into the bloodstream. Within hours after the spill, toxic vapors from oil in a lead could harm the whales' lungs and even kill them. The number of whales affected would depend on how large the spill was, its behavior after being spilled, and how many whales were present in areas contacted in the first several days following the spill.

IV.F.5.b. Effects of Direct Contact of Skin and other Surfaces with Spilled Oil. Oil first would contact a whale's skin as it surfaces to breathe. The effects of oil contacting skin are largely speculative. We do not know how long spilled oil will adhere to the skin of a free-ranging whale. Oil might wash off the skin and body surface shortly after bowheads vacated oiled areas, if they left shortly after being oiled. However, oil might adhere to the skin and other surface features (such as sensory hairs) longer, if bowheads remained in these areas or after it left the oiled area.

Bowhead whale eyes may be vulnerable to damage from oil on the water due to their unusual anatomical structure. It is documented that crude oil can damage eyes (Davis, Schafer, and Bell, 1960). Corneal ulcers and abrasions, conjunctivitis, and swollen nictitating membranes were observed in captive ringed seals placed in crude oil-covered water (Geraci and Smith, 1976), and in seals in the Antarctic after an oil spill (Lillie, 1954). Corneal ulcers and scarring were observed in otters captured in oiled areas (Monnett and Rotterman, 1989) and in oiled otters brought into oil-spill treatment centers (Wilson et al., 1990) after the EVOS.

In a study on nonbaleen whales and other cetaceans, Harvey and Dahlheim (1994) observed 80 Dall's porpoises, 18 killer whales, and 2 harbor porpoises in oil on the water's surface from the EVOS. They observed groups of Dall's porpoises on 21 occasions in areas with light sheen, several occasions in areas with moderate-to-heavy surface oil, once in no oil, and once when they did not record the amount of oil. Thirteen of the animals were close enough to determine if oil was present on their skin. They confirmed that 12 animals in light sheen or moderate-to-heavy oil did not have oil on their skin. One Dall's porpoise had oil on the dorsal half of its body. It appeared stressed because of its labored breathing pattern. The authors gave no other information on effects. The 18 killer whales and 2 harbor porpoises were in oil but had none on their skin. None of the cetaceans appeared to alter their behaviors when in areas where oil was present. The authors concluded their observations were consistent with other reports of cetaceans behaving normally when oil is present. However, as noted above in the review of observations following other spills, observations of cetaceans behaving is a lethargic fashion or having labored breathing has been documented in more than one species, including one in which large numbers of individuals were subsequently found dead.

Histological data and ultrastructural studies by Geraci and St. Aubin (1990) showed that exposures of skin to crude oil for up to 45 minutes in four species of toothed whales had no effect. They switched to gasoline and applied the sponge up to 75 minutes. This produced transient damage to epidermal cells in whales. Subtle changes were evident only at the cell level. In each case, the skin damage healed within a week. They concluded that a cetacean's skin is an effective barrier to the noxious substances in petroleum. These substances normally damage skin by getting between cells and dissolving protective lipids. In cetacean skin, however, tight intercellular bridges, vital surface cells, and the extraordinary thickness of the epidermis impeded the damage. The authors could not detect a change in lipid concentration between and within cells after exposing skin from a white-sided dolphin to gasoline for 16 hours in vitro.

Geraci and St. Aubin also investigated how oil might affect healing of superficial wounds in a bottlenose dolphin's skin. They found that following a cut, newly exposed epidermal cells degenerate to form a zone of dead tissue that shields the underlying cells from seawater during healing. They massaged the superficial wounds with crude oil or tar for 30 minutes, but the substances did not affect healing. Lead-free gasoline applied in the same manner caused strong inflammation, but it subsided within 24 hours and was indistinguishable from control cuts. The authors concluded that the dead tissue had protected underlying tissues from gasoline in the same way it repels osmotic attack by seawater. The authors further concluded that in real life, contact with oil would be less harmful to cetaceans than they and others had proposed.

While petroleum can damage mammalian skin, Geraci and St. Aubin (1985) reported little effects with exposures of 75 minutes. We noted that after a real spill, oil could be in contact with skin for much longer periods. Lipid composition was not modified, and epidermal cell proliferation was not significantly reduced. However, as pointed out by Harvey and Dahlheim (1994), the significance of these results is uncertain because of small sample sizes and the uncertainty of their applicability to natural situations. It is not clear why some cetaceans that are observed in oil do not become oiled while at least a few apparently do. It is not clear how long crude oil would remain on a free-ranging cetacean's skin once it was oiled. Bratton et al. (1993) synthesized studies on the potential effects of contaminants on bowhead whales. They concluded that no published data proved oil fouling of the skin of any free-living whales, and conclude that bowhead whales contacting fresh or weathered petroleum are unlikely to suffer harm.

Although oil is unlikely to adhere to smooth skin, it may stick to rough areas on the surface (Henk and Mullan, 1997). Haldiman et al. (1985) found the epidermal layer to be as much as seven to eight times thicker than that found on most whales. They also found that little or no crude oil adhered to preserved bowhead skin that was dipped into oil up to three times, as long as a water film stayed on the skin's surface. Oil adhered in small patches to the surface and vibrissae (stiff, hairlike structures), once it made enough contact with the skin. The amount of oil sticking to the surrounding skin and epidermal depression appeared to be in proportion to the number of exposures and the roughness of the skin's surface.

Albert (1981) suggested that oil would adhere to the skin's rough surfaces (eroded areas on the skin's surface, tactile hairs, and depressions around the tactile hairs). He theorized that oil could irritate the skin, especially the eroded areas, and interfere with information the animal receives through the tactile hairs. Because we do not know how these hairs work, we cannot assess how any damage to them might affect bowheads. Albert (1981) noted that eroded skin may provide a point of entry into the bloodstream for pathogenic bacteria, if the skin becomes more damaged. Evidence from Shotts et al. (1990) suggests that the lesions are active sites of necrosis. The authors noted that 38% of the microorganisms in lesions contained enzymes necessary for hemolytic activity of blood cells (breaking down of red blood cells and the release of hemoglobin) compared to 28% of the microorganisms on normal skin. Many of these species of bacteria and yeast were determined to be potential pathogens of mammalian hosts.

The potential effect of crude oil on the function of the cetacean blowhole is unknown. As noted, a Dall's porpoise was observed after the EVOS with crude oil covering its skin and blowhole. This individual was described as having labored breathing. Other porpoise swimming in the same area in oil did not appear to be oiled or to have abnormal behavior (Harvey and Dahlheim, 1994).

IV.F.5.c. Effects of Ingestion of Spilled Oil. It is documented that, with respect to mammals in general, ingestion of petroleum hydrocarbons can lead to subtle and progressive organ damage or to rapid death. Also as noted above, many polycyclic aromatic hydrocarbons are teratogenic and embryotoxic in at least some mammals (Khan et al., 1987). Maternal exposure to crude oil during pregnancy may negatively impact birth weight and health of young in at least some mammals (Khan et al., 1987; Currie et al., 1970). In at least some marine mammals, digestion and behavior is affected with decrease food assimilation of prey eaten (for example, St. Aubin, 1988), increased gastrointestinal motility, increased vocalization, and decreased sleep (Geraci and Smith, 1976; Engelhardt, 1985, 1987) (see discussion above for more detail). Oil ingestion can decrease food assimilation of prey eaten (for example, St. Aubin, 1988).

Bowheads sometimes skim the water surface while feeding, filtering a lot of water for extended periods. If oil were present, they could swallow it. Albert (1981) suggested that whales could take in tarballs or large "blobs" of oil with prey. He also said that swallowed baleen "hairs" mix with the oil and mat together into small balls. These balls could block the stomach at the connecting channel, which is a very narrow tube connecting the stomach's fundic and pyloric chambers (the second and fourth chambers of the stomach) (Tarpley et al., 1987). Hansen (1985; 1992) suggests that cetaceans can metabolize ingested oil, because they have cytochrome p-450 in their livers (Hansen, 1992). The presence of cytochrome p-450 (a protein involved in the enzyme system associated with the metabolism and detoxification of a wide variety of foreign compounds, including components of crude oil) suggests that cetaceans should be able to detoxify oil (Geraci and St. Aubin, 1982, as cited in Hansen, 1992). He also suggests that digestion may break down any oil that adheres to baleen filaments and causes clumping (Hansen, 1985). Observations and stranding records do not reveal whether cetaceans would feed around a fresh oil spill long enough to accumulate a critical dose of oil. There is great uncertainty about the potential effects of ingestion of spilled oil on bowheads, especially on bowhead calves. Decreased food assimilation could be particularly important in very young animals, those that seasonally feed, and those that need to put on high levels of fat to survive their environment.

Bowheads may swallow some oil-contaminated prey, but it likely would be only a small part of their food. It is not known if bowheads would leave a feeding area where prey was abundant following a spill. Some zooplankton eaten by bowheads consume oil particles and bioaccumulation can result (see section on Potential Effects on Food Source below). Tissue studies by Geraci and St. Aubin (1990) revealed low levels of naphthalene in the livers and blubber of baleen whales. This result suggests that prey have low concentrations in their tissues, or that baleen whales may be able to metabolize and excrete certain petroleum hydrocarbons.

IV.F.5.d. Potential Effects of Baleen Fouling. If a bowhead encountered spilled oil, baleen hairs might be fouled, which would reduce a whale's filtration efficiency during feeding. In a recent peer-reviewed paper in the Journal of Mammalogy, Lambertsen et al. (2005:349) concluded that because previous "(E)xperimental assessment of the effects of baleen function...thus far has considered exclusively the role of hydraulic pressure in powering baleen function..." but "...our present results indicate that more subtle hydrodynamic pressure may play a critical role in the function of the baleen in the...balaenids...the current state of knowledge of how oil would affect the function of the mouth of right whales and bowheads can be considered poor, despite considerable past research on the effects of oil on cetaceans."

Lambertsen et al. (2005) contended that oil could be efficiently ingested if globules of oil behave like prey inside the mouth. They point out that if oil is of low viscosity and does not behave like prey, only small amounts would be ingested. Lambertsen et al. (2005:350) characterize these two conditions as being of "questionable validity" and note that if, on the other hand, the resistance of the baleen is significantly increased by oil fouling, as experimental evidence on the baleen of other mysticetes indicates it may be, the most likely adverse effect "...would be a substantial reduction in capture of larger, more actively mobile species, that is euphausiids, with possible reductions in capture of copepods and other prey" (Lambertsen et al., 2005:350). They concluded that their results highlight the uncertainty about how rapidly oil would depurate at the near zero temperatures of arctic waters and whether baleen function would be restored after oiling.

Earlier studies on baleen fouling were summarized by Geraci (1990) who, with colleagues, had also undertaken studies of the effects of oil on baleen function. Geraci (1990:184) noted that while there was "A great deal of interest...in the possibility that residues of oil may adhere to baleen plates so as to block the flow of water and interfere with feeding. The concerns are largely speculative." He also noted that "Such an effect may be imperceptible, though leading to subtle, long-term consequences to the affected animal." Geraci (1990:184) concluded that "A safe assumption is that any substance in seawater which alters the characteristics of the plates, the integrity of the hairs, or the porosity of the sieve may jeopardize the nutritional well-being of the animal."

Braithwaite (1983, as cited in Bratton et al., 1993) used a simple system to show a 5-10% decrease in filtration efficiency of bowhead baleen after fouling, which lasted for up to 30 days. Geraci (1990:186) stated that the "Details of the experimental protocol" used in that study "...are not entirely clear."

Geraci (1990) summarized studies by Geraci and St. Aubin (1982, 1985) where the effects of contamination by different kinds of oil on humpback, sei, fin, and gray whale baleen were tested in saltwater ranging from 0 to 20 ^{o}C. In these studies, resistance to flow of some humpback baleen was increased more than 100%, less than 75% in gray and sei whale baleen, and gray whale samples were "relatively unaffected" (Geraci, 1990:186). Resistance to water flow through baleen was increased the greatest with contamination by Bunker C oil at the coldest temperatures. He summarized that oil of medium weight had little effect on resistance to water flow at any temperature. Fraker (1984) noted that there was a reduction in filtering efficiency in all cases, but only when the baleen was fouled with 10 millimeters of oil was the change statistically different.

In the study in which baleen from fin, sei, humpback, and gray whales was oiled, Geraci and St. Aubin (1985) found that 70% of the oil adhering to baleen plates was lost within 30 minutes (Geraci, 1990) and in 8 of 11 trials, more than 95% of the oil was cleared after 24 hours. The study could not detect any change in resistance to water flowing through baleen after 24 hours. The baleen from these whales is shorter and coarser than that of bowhead whales, whose longer baleen has many hairlike filaments. Geraci (1990:187) concluded that:

> Combined evidence...suggests that a spill of heavy oil, or residual patches of weathered oil, could interfere with the feeding efficiency of the fouled plates for several days at least. Effects would likely be cumulative in an animal feeding in a region so blanketed by weathered oil that the rate of cleansing is outpaced by fouling. That condition could describe the heart of a spill, or a contaminated bay or lead.

Lighter oil should result in less interference with feeding efficiency. Lambertsen et al. (2005:350) concluded that results of their studies indicate that Geraci's analysis of physiologic effects of oiling on mysticete baleen "considered baleen function to be powered solely by hydraulic pressure," a perspective they characterized as a "gross oversimplification of the relevant physiology."

A reduction in food caught in the baleen could have an adverse affect on the body condition and health of affected whales. If such an effect lasted for 30 days, as suggested by the experiments of Braithwaite (1983), this could potentially be an effect that lasted a substantial proportion of the period that bowheads spend on the summer feeding grounds. Repeated baleen fouling over a long time, however, might also reduce food intake and blubber deposition, which could harm the bowheads. As pointed out by Geraci (1990), the greatest potential for adverse effects to bowheads would be if a spill occurred in the spring lead system.

IV.F.5.e. Potential Effects on Food Source. Data from a recent study (Duesterloh, Short, and Barron, 2002) indicated that aqueous polyaromatic compounds (PAC) dissolved from weathered Alaska North Slope crude oil are phototoxic to subarctic marine copepods at PAC concentrations that would likely result from an oil spill and at UV levels that are encountered in nature. *Calanus marshallae* exposed to UV in natural sunlight and low doses (~2µg of total PAC per liter (PAC/L) of the water soluble fraction of weathered North Slope crude oil for 24 hours) showed an 80-100% morbidity and mortality as compared to less than 10% with exposure to the oil-only or sun-light only treatments. At 100% mortality occurred in *Metridia okhotensis* with the oil and UV treatment, while only 5% mortality occurred with the oil treatment alone. Duesterloh, Short, and Barron (2002) reported that phototoxic concentrations to some copepod species were lower by a factor of 23 to >4,000 than the lethal concentrations of total PAC alone (0.05-9.4 mg/L).

This research also indicated that copepods may passively accumulate PACs from water and could thereby serve as a conduit for the transfer of PAC to higher trophic level consumers. Bioaccumulation factors were ~2,000 for *M. okhotensis* and about ~8,000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher bioaccumulation than many other species of copepods because of their characteristically high lipid content. The authors concluded that phototoxic effects on copepods could conceivably cause ecosystem disruptions that have not been accounted for in traditional oil spill damage assessments. Particularly in nearshore habitats where vertical migration of copepods is inhibited due to shallow depths and geographical enclosure, phototoxicity could cause mass mortality in the local plankton population. (Duesterloh, Short, and Barron, 2002:3959).

An oil spill probably would not permanently affect zooplankton populations, the bowhead's major food source, and major effects are most likely to occur nearshore (Richardson et al., 1987, as cited in Bratton et al., 1993). The amount of zooplankton lost, even in a large oil spill, would be very small compared to what is available on the whales' summer-feeding grounds (Bratton et al., 1993).

The potential effects to bowheads of exposure to PACs through their food are unknown. Because of their extreme longevity, bowheads are vulnerable to incremental long-term accumulation of pollutants. With increasing development within their range and long-distance transport of other pollutants, individual bowheads may experience multiple large and small polluting events within their lifetime.

IV.F.5.f. Effects of Displacement from Feeding Areas. We have no observations from western science of the response of bowhead whales following a large oil spill to determine whether they may be temporarily displaced from an area because of an oil spill or cleanup operations. However, Thomas Brower, Sr. (1980) described the effects on bowhead whales of a 25,000-gallon (595-bbl) oil spill at Elson Lagoon (Plover Islands) in 1944. It took approximately 4 years for the oil to disappear. For four years after the oil spill, Brower observed that bowhead whales made a wide detour out to sea when passing near Elson Lagoon/Plover Islands during fall migration. Bowhead whales normally moved close to these islands during the fall migration. These observations indicate that some displacement of whales may occur in the event of a large oil spill, and that the displacement may last for several years. Based on these observations, it also appears that bowhead whales may have some ability to detect an oil spill and avoid surfacing in the oil by detouring around the area of the spill. Potential displacement because of disturbance is discussed in Section III.C.3.

Several other investigators have observed various cetaceans in spilled oil, including fin whales, humpback whales, gray whales, dolphins, and pilot whales. Typically, the whales did not avoid slicks but swam through them, apparently showing no reaction to the oil. During the spill of Bunker C and No. 2 fuel oil from the *Regal Sword*, researchers saw humpback and fin whales, and a whale tentatively identified as a right whale, surfacing and even feeding in or near an oil slick off Cape Cod, Massachusetts (Geraci and St. Aubin, 1990). Whales and a large number of white-sided dolphins swam, played, and fed in and near the slicks. The study reported no difference in behavior between cetaceans within the slick and those beyond it. None of the observations prove whether cetaceans can detect oil and avoid it. None of these observations is sufficient to determine the long-term impacts of such exposure. Some researchers have concluded that baleen whales have such good surface vision that they rely on visual clues for orientation in various activities. In particular, bowhead whales have been seen "playing" with floating logs and sheens of fluorescent dye on the sea surface of the sea (Wursig et al., 1985, as cited in Bratton et al., 1993). These observations suggest that if oil is present on the sea surface and is of such quality or in such quantity that it is readily optically recognizable, bowhead whales may be able to recognize and avoid it (Bratton et al., 1993). However, the observation of their playing with dye may also indicate that they would play with it.

After the EVOS, researchers studied the potential effects of an oil spill on cetaceans. Dahlheim and Loughlin (1990) documented no effects on the humpback whale. von Ziegesar, Miller, and Dahlheim (1994) found no indication of a change in abundance, calving rates, seasonal residency time of female-calf pairs, or mortality in humpback whales as a result of that spill, although they did see temporary displacement from some areas of Prince William Sound. It was difficult to determine whether the spill changed the number of humpback whales occurring in Prince William Sound. This study could not have detected long-term physiological effects to whales or to the humpback's prey.

Cleanup operations following a large or very large spill would be expected to involve multiple marine vessels operating in the spill area for extended periods of time, perhaps over multiple years. Based on information provided in the above section on vessel traffic, bowheads react to the approach of vessels at greater distances than they react to most other industrial activities. According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3-4 mi).

After a large or very large spill, there are typically overflights using helicopters and fixed-winged aircraft to track the spill and to determine distributions of wildlife that may be at risk from the spill. We summarize the response of bowheads to aircraft here. Most bowheads are unlikely to react significantly to occasional single passes by helicopters flying at altitudes above 150 m (500 ft). At altitudes below 150 m (500 ft), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993; Patenaude et al., 1997) and may have shortened surface time (Patenaude et al., 1997). Bowhead reactions to a single helicopter flying overhead probably are temporary (Richardson et al., 1995a). Whales should resume their normal activities within minutes. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft are sometimes conspicuous if the aircraft is below 300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) sometimes caused abrupt turns and hasty dives (Richardson and Malme, 1993). The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

Based on all of the above information, we conclude that there could potentially be displacement of bowhead whales from a feeding area following a large or very large spill and this displacement could last as long as there is a large amount of oil and related clean-up vessels present.

IV.F.6. Areas and Circumstances Where Effects of an Oil Spill are Likely to be Greater than Typical. The number of bowhead or other whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. Bowhead whales may be particularly vulnerable to oil-spill effects due to their use of ice edges and leads where spilled oil may accumulate (Engelhardt, 1987:104). Primarily because of the uniqueness of the bowhead and its apparently obligate use of spring lead and polynyas as its migratory path between wintering and summering grounds, we are uncertain of the potential severity of impact should a large or very large oil spill occur within such a system, especially if spring migration were underway and hundreds of females were calving in or near those leads.

There are two situations in which bowheads are at particular risk in the event of a large oil spill. The first situations would be if a large or very large spill occurred while the whales were migrating north through the Chukchi Sea, or east through the Beaufort Sea, traveling through the spring lead and polynya system, particularly during the period when large numbers of females are calving or accompanied by very young calves. The effects of an oil spill on cetacean newborns or other calves are not known. The potential effects of contact or detection of spilled oil by near term, or post partum females are not known. The migration path through the Chukchi Sea is relatively constrained, the area appears to be the, or a, primary calving ground of the BCB stock, and it must be assumed that essentially the whole stock needs to make this migration in order to get to summering grounds.

The potential for there to be adverse effects from a large oil spill would also likely be greater (than in more typical circumstances) if a very large spill of fresh oil (with high concentrations of aromatics) contacted one or more large aggregation of bowheads especially (but not exclusively) if such an aggregation contained large numbers of females and calves. Such aggregations occasionally have been documented in MMS aerial bowhead whale surveys. For example, Treacy (1998) observed large feeding aggregations, including relatively large numbers of calves (for example, groups of 77[6], 62[5], 57[7], and 51[0], where the numbers given in brackets are the numbers of calves) of feeding bowheads in waters off of Dease Inlet/Smith Bay in 1997 and in 1998. However, in some years no large aggregations of bowheads were seen anywhere within the study area. When seen, the aggregations were in open water. The likelihood of a very large spill occurring and contacting such a group is low but not outside the range of possibilities. The factors associated with the presence of such groups are not yet clear. It is not known if they would leave the area heavily contaminated with crude oil.

IV.F.7. Oil Spill Response Activities. An industry consortium stockpiles response equipment in the Prudhoe area for all three operating seasons in the Arctic: solid ice, open water, and broken ice (USDOI, MMS, 2003a:Section IV.A.6 in the Beaufort Sea multiple sale EIS, USDOI, MMS, 2003a). For the solid-ice season, spill-response demonstrations have shown that there are effective tactics and equipment for oil recovery. For the open-water season, the effectiveness of spill-response equipment is similar to that for other OCS areas. For the broken-ice season, the Beaufort Sea multiple-sale EIS explained that research was ongoing. Recent spill demonstrations and drills have shown that the mechanical effectiveness of response equipment still is reduced greatly by broken ice. Non-mechanical response tactics (e.g. in situ burning) would be applied during these conditions.

IV.F.7.a. Probabilities of Contacting an Oil Spill. Variability in the distribution of bowhead whales in the Beaufort Sea over time and among years, and lack of recent data on bowhead seasonal distribution and abundance in the Chukchi Sea makes attempts to quantitatively model the numbers of whales that might be contacted by oil problematic. Whether, and how many, bowhead whales would come into contact with oil would depend on the location, timing, and magnitude of the spill; the location of whales when the spill occurred and over time following the spill; weather at the time of the spill; the presence and extent of shorefast and broken ice; the effectiveness of cleanup and possibly hazing activities; the motivation of the whales to get to where they were going or to stay where they were; and their options for alternate routes to their destinations (e.g., whether or not they were in leads adjacent to pack ice).

Probably the greatest potential for a large number of whales to contact spilled oil would be if there was an oil spill in the spring lead system, or if an oil spill occurred when whales were aggregated in large feeding groups.

Geraci and St. Aubin (1990) stated that the notable weakness in modeling is that there is no information on the type and duration of oil exposure required to produce an effect. They further stated that for all but the sea otter, the premise that contact is necessarily fatal is indefensible. Models commonly overestimate the impact of a spill. They further stated that few, if any, cetaceans have been claimed by spilled oil. They did not address potential impacts within lead systems or potential effects on calves or females with calves.

IV.F.7.b. Beaufort Sea Oil Spill Probabilities. Our evaluation of oil spill risks in this Biological Evaluation is based on oil spill risk assessment that have previously been provided to NMFS. The first concerns results from our OSRA that were presented in full in the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003) and reiterated in as an appendix to our Biological Evaluation for Beaufort Sea Sale 195. We refer NMFS to Appendix III for our updated information about oil spill risk analysis.

While our resource estimates for Sale 202 vary somewhat from those presumed for 186 and 195, they do not change substantially enough to have a meaningful effect on the OSRA. We do not have resource estimates available for other potential future sales in the planning areas.

This section discusses the probabilities that oil spilled in the Beaufort Sea would contact specific environmental resource areas that are important to bowhead whales (USDOI, MMS, 2003a:Appendix A).

These probabilities are the same as those we provided in the Beaufort Sea multiple-sale (USDOI, MMS, 2003a) EIS. No oil spills are assumed to occur during exploration activities. For the development/production phase, the fate and behavior of a 1,500-bbl spill from a platform and a 4,600-bbl spill from a pipeline are considered. The probabilities of either spill contacting specific environmental resource areas would be the same. The 1,500-bbl spill would cover a smaller area (181 km^2) (Table IV.A-6a) than the 4,600-bbl spill (320 km^2) after 30 days (Table IV.A-6b). Only the 4,600-bbl spill is analyzed in this section. Conditional and combined probabilities also are presented in the following.

A 4,600-bbl spill could contact environmental resource areas where bowhead whales may be present. Approximately 40% of a 4,600-bbl spill during the open-water period would remain after 30 days, covering a discontinuous area of 320 km^2 (Table IV.A-6b). A spill during broken ice in the fall or under the ice in the winter would melt out during the following summer. Approximately 69% of a 4,600-bbl spill during the broken-ice/solid-ice period would remain after 30 days, covering a discontinuous area of 252 km^2 (Table IV.A-6b). The following paragraphs present conditional and combined probabilities estimated by the Oil-Spill-Risk Analysis (OSRA) model (expressed as a percent chance) of a spill contacting bowhead whale habitat within 180 days. Conditional probabilities are based on the assumption that a spill has occurred. Combined probabilities, on the other hand, factor in the chance of the spill occurring.

IV.F.7.b(1). Summer Spill. For conditional probabilities, the OSRA model estimates a less than 0.5-37% chance that an oil spill starting at launch areas (LA) LA1-LA18 will contact environmental resource areas (ERA's) 19-37 within 180 days during the summer, assuming a spill occurs, and a less than 0.5-46% chance, assuming a spill starts at Pipeline Segment (P) P1-P13 (Table A.2-23 in USDOI, MMS, 2003a). The ERA's 19 through 28 are resource areas in the spring lead system in the Beaufort and Chukchi seas; ERA's 29 through 37 are resource areas along the bowhead whale fall-migration route in the Beaufort Sea, as defined by data from the MMS BWASP. The greatest percent chance of contact from a launch area that occurs within the Beaufort Sea Planning Area occurs at ERA 32, which has a 37% chance of contact from a spill occurring at LA10. The chance of contact in this environmental resource area is highest, because the OSRA model's launch area and the environmental resource area are in close proximity to or overlap each other (Maps A-2a and A-2b in USDOI, MMS, 2003a). Similarly, the highest chance of contact in other environmental resource areas occurs when the spill-launch area and the environmental resource area are in close proximity to or overlap each other. The greatest percent chance of contact from a pipeline segment occurs at ERA 32, which has a 46% chance of contact from a spill occurring at P4 (Table A.2-23 in USDOI, MMS, 2003a). The chance of contact in this environmental resource area is highest, because the model's pipeline segment and the resource area are in close proximity to or overlap each other (Maps A-2a and A-2b in USDOI, MMS, 2003a). Similarly, the highest chance of contact in other environmental resource areas occurs when the pipeline segment and the resource area are in close proximity to or overlap each other.

IV.F.7.b(2). Winter Spill. The OSRA model estimates a less than 0.5-27% chance that an oil spill starting at LA1-LA18 will contact ERA's 19-37 within 180 days during the winter, assuming a spill occurs, and a less than 0.5-32% chance, assuming a spill starts at P1-P13 (Table A.2-41 in USDOI, MMS, 2003a). The greatest percent chance of contact from a launch area occurs at ERA's 25 and 28, which have a 27% chance of contact from a spill occurring at LA2 and LA7, respectively. The chance of contact in these environmental resource areas is highest, because the model's launch areas and the resource areas are in close proximity to or overlap each other (Maps A-2a and A-2b in USDOI, MMS, 2003a). Similarly, the highest chance of contact in other environmental resource areas occurs when the launch area and the resource area are in close proximity to or overlap each other. The greatest percent chance of contact from a pipeline segment occurs at ERA 25, which has a 32% chance of contact from a spill occurring at P1 (Table A.2-23 in USDOI, MMS, 2003a). The chance of contact in this environmental resource area is highest, because the model's pipeline segment and the resource area are in close proximity to or overlap each other (Maps A-2a and A-2b). Similarly, the highest chance of contact in other environmental resource areas occurs when the pipeline segment and the resource area are in close proximity to or overlap each other.

For combined probabilities, the OSRA model estimates a less than 0.5-1% chance that one or more oil spills greater than or equal to 1,000 bbl would occur from a production facility or a pipeline (LA1-LA18 or P1-P13, respectively) and contact ERA's 19-37 within 180 days (Table A.2-56 in USDOI, MMS, 2003a). There is a 1% chance that one or more oil spills would occur and contact ERA 28 (Beaufort Spring Lead 10), the resource area with the highest chance of contact.

IV.F.7.c. Chukchi Sea Oil Spill Probabilities. The MMS previously provided oil spill analyses to NMFS in Section IV and Appendix C of the Final EIS for Chukchi Sea Oil and Gas Lease Sale 126 (USDOI, MMS, 1990). However, these analyses are now over 15 years old and new information is available. MMS is currently undertaking analyses to reevaluate oil spill risks for the Chukchi Sea Planning Area and the full results of those analyses are expected to be available in the near future. When the new analyses are available, MMS will provide this information to NMFS with a full evaluation of the potential risk to ESA-listed whales from oil spills potentially resulting from projected oil and gas development and production in the Chukchi Sea Planning Area. Below, we provide very preliminary findings from these analyses regarding spill probabilities. Further detail is provided in Appendix IV. These large spill rates are preliminary results provided to MMS by the Bercha Group Inc. on January 25, 2006. These results will be subjected to further quality assurance/quality control tests prior to the final report. The chance of a spill occurring does not factor in the chance that a development project occurs. Because leasing and exploration could lead to a development project, MMS must evaluate what would happen if a development occurred. Our oil spill risk analysis for a large spill occurring assumes that a project will be developed and 1 Bbbl of oil will be produced.

The large spill rates discussed in this section are all based on spills per billion barrels. We estimate 0.30 pipeline spills and 0.21 platform (and well) spills for a total over the life of Sale 193 production of 0.51 spills. Table 1 shows the estimated total number of oil spills using spill rates at the 95% confidence interval. Total spills over the life of the Sale 193 production range from 0.32-0.77 spills.

Table 1 in Appendix IV shows the estimated chance of one or more large pipeline spills is 26%, and the estimated chance of one or more large platform spills is 19% over the life of Sale 193 production. The total is the sum of the platform, wells, and pipeline spills. Thus, it is estimated that the chance of one or more large spills total is 40%. Table 1 also shows the chance of one or more large spills total using spill rates at the 95% confidence interval. The percent chance of one or more large spills total ranges from 27-54%.

Further evaluation of the probability that any specific area will be contacted by oil spilled in the Chukchi Sea Planning Area will be provided to NMFS during the course of consultation as it becomes available.

IV.F.7.d. Exploration. Large oil spills are not expected from exploration activities. Small spills could occur, with the same typical effects as discussed for large spills, only on a much smaller scale. Unless a large aggregation of females and calves was contacted by the small spill, available evidence indicates that it is unlikely there will be a significant effect on bowhead whales.

We also acknowledge that fuel spills associated with the vessels used for seismic exploration could occur, especially during fuel transfer. Small fuel spills are unlikely to have significant effects on bowheads because it is anticipated that bowheads will generally avoid exploration activities and, hence, not be in the immediate vicinity at the time of a spill.

IV.F.8. Conclusions of Potential Oil-Spill Effects. The effects of a large oil spill and subsequent exposure of the bowhead whale population to fresh crude oil are uncertain, speculative, and controversial. The effects would depend on how many whales contacted oil; the ages and reproductive condition of the whales contacted; the duration of contact, the amount of oil spilled, and the age/degree of weathering of the spilled oil at the time of contact. The number of whales contacting spilled oil would depend on the size, timing, and duration of the spill; how many whales were near the spill; and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. If a very large slick of fresh oil contacted a large aggregation or aggregations of feeding bowheads, especially with a high percent of calves, the effect might be expected to be greater than under more typical circumstances. There is great uncertainty about the effects of fresh crude oil on cetacean calves. Prolonged exposure to freshly spilled oil could kill some adult whales, but, based on available information, the number likely would be small if the spill contacted bowheads in open water. However, Engelhardt (1987) theorized that bowhead whales would be particularly vulnerable to effects from oil spills during their spring migration into arctic waters because of their use of ice edges and leads, where spilled oil tends to accumulate. Several other researchers (Geraci and St. Aubin, 1982; St. Aubin, Stinson, and Geraci, 1984) concluded that exposure to spilled oil is unlikely to have serious direct effects on baleen whales. There is some uncertainty and disagreement within the scientific community on the results of studies on the impacts of theEVOS on large cetaceans (for example, Loughlin, 1994, Dahlheim and Matkin, 1994, Dahlheim and Loughlin, 1990). Bowheads may also have heightened vulnerability to spilled oil because of the functional morphology of their baleen. If baleen in fouled, and if crude oil s ingested, there could be adverse effects on the feeding efficiency and food assimilation of bowhead whales. Such effects are expected to be of most importance to calves, pregnant females, and lactating females. However, loss of feeding efficiency could potentially reduce the chance of survival of any whale and could affect the amount of energy female whales have to invest in reproduction.

Assuming that development and production occurs, large oil spills are less likely to occur in the Beaufort Sea than in the Chukchi Sea. We estimate about a 40% chance of a spill of 1,000 bbl in the Chukchi Sea Planning Area should production occur.

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

Larger groups could be adversely affected if a large spill occurred when large aggregations of bowheads were feeding. Cetaceans that inhabit areas that are in the path of a major oil spill can be impacted in several different ways. First, individuals potentially could be directly affected by contact with the oil or its toxic constituents through inhalation of aromatic fractions of unweathered oil (probably the most serious threat to cetaceans), ingestion (of the oil itself or of contaminated prey), fouling of their baleen, and surface contact. Second, they could be indirectly impacted if the quality or quantity of their prey were reduced. Third, individuals could be directly or indirectly affected due to maternal effects (for example, changes in food assimilation during pregnancy, or reduced maternal health) or in-utero exposure to toxic components of oil. Fourth, they could be affected by disturbance of spill response and cleanup activities. Although there is evidence for all of the aforementioned types of effects in other types of mammals from experiments and/or posts-pill studies, there is very little evidence regarding the probability for any of the aforementioned in cetaceans due to limitations discussed above.

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

It is likely that some whales would experience temporary or perhaps permanent nonlethal effects, including one or more of the following symptoms:

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

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

In conclusion, we reiterate that there is uncertainty about effects on bowheads (or any large cetacean) in the unlikely event of a very large spill. There are, in some years and in some locations, relatively large aggregations of feeding bowhead whales within the proposed lease-sale area. If a large amount of fresh oil contacted a significant portion of such an aggregation, effects potentially could be greater than typically would be assumed and we cannot rule out population-level effects if a large number of females and newborn or very young calves were contacted by a large amount of fresh crude oil. Available information indicates it is unlikely that bowhead whales would be likely to suffer significant population-level adverse affects from a large spill originating in the Beaufort Sea. However, individuals or small groups could be injured or potentially even killed in a large spill. Oil spill response activities (including active attempts to move whales away from oiled areas) could cause short-term changes in local distribution and abundance.

IV.F.9. Potential Effects of a Large Oil Spill on Fin Whales and Humpback Whales. For the reasons discussed in the previous paragraph, it is difficult to predict the impact of a large spill on either humpback whales or especially on fin whales. Based on literature on other mammals indicating severe adverse effects of inhalation of the toxic aromatic components of fresh oil, mortality of cetaceans could occur if they surfaced in large quantities of fresh oil. However, if such mortality occurred, it would be not be consistent with many, perhaps most, published findings of expected impacts of oil on cetaceans. The potential for there to be long-term sublethal (for example, reduced body condition, poorer health, or longer dependency periods), or lethal effects from large oil spill on cetaceans essentially is unknown. There are no data on cetaceans adequate to evaluate the probability of such effects.

Because of their distribution, the primary additional potential adverse effect on fin whales from development would be the effects from a large oil spill that contacted waters adjacent to the Chukchi Peninsula in the southwestern Chukchi Sea. Data do not indicate that fin whales were adversely affected by the EVOS, which was many times larger than the spill range we analyze here, or by the *Glacier Bay* oil spill.

It is even possible that fin whales could be killed if they surfaced in the midst of a large fresh oil slick and inhaled high concentrations of volatile components of crude oil. However, based on available data following both the EVOS and the *Glacier Bay* oil spill, it is unlikely that large numbers of fin whales would be adversely affected. There are no data or other information available that would suggest that there could be a population level effect on fin whales from any activity or event, such as an oil spill, that could result from the activities resulting from Sale 193. Fin whales are widespread and relatively abundant.

During the summer and fall, fin and humpback whales could potentially be negatively impacted by a large spill that contacted the waters adjacent to the north side of the Chukchi Peninsula, especially near Cape Dezhnev in the summer. As discussed in previous paragraphs, literature on the effects of crude oil on mammals indicates that humpback whales could be vulnerable to such a spill. There is no evidence that humpback whales were negatively impacted by the EVOS (von Zeigesar, Miller, and Dahlheim, 1994). However, this spill occurred prior to the period when most of humpbacks that summer in oiled areas of western Prince William Sound would be expected to be present. We will further evaluate the potential of an oil spill to adversely affect these two species after MMS oil spill risk analyses for the Chukchi Sea Planning Area is completed.

IV.G. Environmental Baseline and Cumulative Effects.

IV.G.1 Introduction. For the purposes of interagency consultations under Section 7 of the ESA, the **environmental baseline** is defined as the past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process [50 CFR §402.02].

Cumulative effects are defined in 50 CFR 402.02 (Interagency Cooperation on the ESA of 1973, as amended): "…those effects of future State or private activities not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation."

We note that this definition differs from that of cumulative effects as defined under NEPA. In this biological evaluation, we are attempting to evaluate both the baseline and the cumulative effects for an overall action of uncertain start time (e.g., when the first discovery will be made, etc.) and of long duration (e.g., life of the proposed actions is about 30 years, once begun). Thus, in this section to avoid having to split actions in two and/or have considerable repetition within the document, by discussing some of the sources of potential effects as both part of the environmental baseline (those effects from the particular affecter that have already occurred), and in the cumulative effects section (effects from that source that are reasonably certain to occur in the future).To enhance NMFS' evaluation of the material, we have attempted to clarify those actions that have only operated in the past and are unlikely to happen again (e.g., commercial whaling), those actions that have operated in the past, are continuing to exert effects and are likely to continue to have some effect in the future (e.g., subsistence hunting and oil and gas exploration, and those activities that have not occurred in the past, are not currently occurring, but may occur in the future (e.g., development in the Chukchi Sea Planning Area). Thus, some effects that are discussed as cumulative effects in the Beaufort Sea multiple-sale EIS and in the EA for proposed Lease Sale 195 are discussed in the environmental baseline section in this Biological Evaluation. All actions that require Section 7 consultation under the ESA are included under baseline effects in this evaluation (for example, subsistence hunting, Federal offshore oil and gas lease sales).

IV.G.2. Bowhead Whales. Commercial hunting between 1848 and 1915 caused severe depletion of the bowhead population(s) that inhabits the Bering, Chukchi, and Beaufort Seas. This hunting is no longer occurring and is not expected to occur again. Data indicate that what is currently referred to as the Western Arctic stock (by NMFS) or as the Bering-Chukchi-Beaufort (BCB) Seas stock (by the IWC) of bowheads is increasing in abundance and has increased in abundance substantially since the last ESA consultation between MMS and NMFS involving the Chukchi Sea OCS Planning Area. As noted in the affected environment section, there are scientific analyses indicating that BCB Seas bowheads may have reached, or are approaching, the lower limit of their historic population size. There are related analyses supporting its removal from the list of threatened and endangered species.

We identified the following types of past, present, and reasonably foreseeable actions and factors that potentially could have contributed to the baseline, or could contribute to cumulative effects, on the Western Arctic stock of bowhead whales:

- subsistence hunting
- activities related to offshore oil and gas exploration and development
- commercial fishing and marine vessel traffic
- climate change
- research activities
- pollution and contaminants

There are no data available that indicate that, other than historic commercial whaling, any previous human activity has had a significant population-level adverse impact on the current status of BCB bowheads or their recovery. The uncertainty of the stock structure adds some uncertainty to summaries of the status of bowhead populations that may be impacted by the proposed actions. However, currently available information indicates that at the population level bowheads that use the Beaufort and Chukchi Sea Planning Areas are currently resilient at least to the level of human-caused mortality and disturbance that currently exists within their range, and has existed since the cessation of commercial whaling. Data indicate that at least some bowheads are extremely long-lived (100+ years or more). Thus, many of the individuals in this population may already have been exposed to a high number of disturbance events in their lifetimes. The primary known current human-related cause of mortality is a regulated subsistence hunt by Alaska Natives, which occurs at different times of the year in many of the coastal portions of their range. The existence of this hunt has focused Native, local, state, federal, international, and industry research and monitoring attention on this stock and the development of mitigations intended to ensure its continued availability for subsistence take adequate to meet the needs of bowhead-hunting Native communities. Since the level of take is directly linked to the population abundance and status of this population, protection of the availability of whales for subsistence take is linked to protection needed to ensure the long-term viability of the population. Whether there are long-lasting behavioral effects from this activity are unknown, but overall habitat use appears to be relatively unaffected.

Available information does not indicate that the cumulative effects of all other past or currently occurring noise and disturbance-causing factors combined (e.g., oil and gas activities, shipping, subsistence hunting, and research activities), habitat alteration activities (e.g., gravel island construction, port construction), or local or distant pollution has had any long-lasting physiological, or other adverse effect(s) on the population. This population may be more responsive to human-created noise than many or most other cetacean populations. However, as the factors related to the variability in bowhead responsiveness to anthropogenic noise are unclear, and other populations are not as well-studied, it is also unclear whether there is a human-related cause underlying the high level (at least in some instances) of behavioral responsiveness to human noise of the bowhead. There are not sufficient data about past human activities, including, but not limited to, past offshore oil and gas-related seismic surveys, or ice-management activities, to address whether there are any long-term impacts on their behavior from such activities in either evaluation area.

The potential for cumulative effects to adversely affect bowhead whales is of great concern because of their current endangered status, which resulted from past human activity (overexploitation by commercial whalers), because of their importance as a subsistence species to Alaskan Native residents of coastal villages adjacent to their range, and because of their unusual ecology, which obligates their use of a relatively restrictive area during calving and spring migration.

In addition to the detailed coverage in the Beaufort Sea multiple-sale EIS and the Biological Evaluation prepared for consultation with NMFS on Beaufort Sea Sale 195, several other documents have become available recently that are particularly useful as sources of information about potential cumulative effects on this population. These documents also provide information helpful in evaluating the potential significance of effects on the status and health of this population. These include: the IWC's Scientific Committee's in-depth assessment of BCB Seas stock of bowhead whales (IWC, 2004b); NMFS' *Biological Opinion on Issuance of Annual Quotas Authorizing the Harvest of Bowhead Whales to the Alaska Eskimo Whaling Commission for the Period 2003 through 2007* (NMFS, 2003a); NMFS's *Final Environmental Assessment for Issuing Subsistence Quotas to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2003 through 2007* (NMFS, 2003b); papers evaluating whether this population should be delisted (Shelden et al., 2001, 2003; Taylor, 2003); and the NRC's report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (NRC, 2003a). The IWC reviewed and critically evaluated new information available on the bowhead whale at their 2005 meeting (IWC, 2005a,b). This information and the associated discussions are summarized in the *Report of the Subcommittee on Bowhead, Right and Gray Whales* (IWC, 2005b). The 2003 Alaska Marine Mammal Stock Assessment for this stock remains the most recent finalized stock assessment available but an updated draft 2005 Stock Assessment is available for consideration (Angliss and Outlaw, 2005-draft). We refer NMFS to these documents, to references cited in the multiple-sale EIS and the Biological Evaluation for Sale 195, and to new references cited in the following text for details on potential cumulative effects that might lie outside the scope of the material provided here. Lastly, we note that the IWC will conducting an Implementation Review focusing on the stock structure of the BCB Seas bowhead with the goal of completing this at the 2007 annual meeting (IWC, 2005a).

IV.G.2.a. Geographic and Temporal Scope of the Baseline and Cumulative Analyses. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. As information is available, we have attempted to consider potential effects from the incremental impact of the proposed actions when added to other past, present, and reasonably foreseeable future actions, regardless of what Federal or non-Federal agency or person undertakes such actions.

In the baseline and cumulative effects analyses, we have considered all factors that we believe potentially have, are, or could contribute to the baseline status and to cumulative effects on bowhead whales from the Western Arctic stock (BCB Seas population) anywhere in their range. For this reason, the geographic area considered in our cumulative analyses includes the range of the BCB Seas bowhead whale with emphasis on the Beaufort Sea and the eastern Chukchi Sea as well as portions of the western Chukchi Sea that can be adversely impacted by the proposed actions (Angliss and Outlaw, 2005:Figure 2). Since, at present, it is unclear what areas in the Chukchi Sea outside of the evaluation area could potentially be affected, we have included potential effects on this stock along the bowhead migration route in the Beaufort and Chukchi Seas; in the western Canadian Beaufort Sea, where they aggregate in large numbers and feed in the summer; and in the Chukchi and Bering seas, where they spend long periods of time in the late autumn, winter, and spring.

Our baseline date for analysis was the initiation of commercial whaling of this population in 1848. Our endpoint is the likely period of effect of reasonably foreseeable potential effectors that could be expected to occur over the expected life of the proposed actions, a period of approximately 30-40 years.

IV.G.2.b. Introductory Information Relevant to Evaluation and Interpretation of Potential Cumulative Effects on Bowheads. "Evidence is accumulating" that suggests at least some bowhead "whales live a very, very long time. If estimates are correct, some whales may be over 100 years old" (C. George, as cited in U.S. Dept. of Commerce, 2002). These data add to previous estimates that these whales may live to 50-75 years of age. The NOAA Fisheries (U.S. Dept. of Commerce, 2002) points out that "…some whales alive today may have been alive at the end of the commercial whaling period." Thus, evaluation of potential cumulative effects, both at the individual level and at the level of the population, needs to take a very long view both into the past and into the future.

That said, varying, sometimes considerable, amounts of uncertainty are associated with conclusions about the potential for particular effectors to have impacted bowheads, to be impacting them, and especially to cause impact in the future.

Some of the uncertainty is unavoidable and cannot be remedied. Bowhead whales are very large marine animals. They inhabit parts of the world where weather, day length, and remoteness make research on free-ranging animals difficult, extremely expensive, and sometimes dangerous. Many of the types of data that could reduce the level of uncertainty about potential impacts of some potential effectors, such as very large oil spills, cannot be acquired in any reasonable way. For example, many of the chronic impacts of oil pollution that have been documented in smaller mammals could not be detected in large cetaceans because of the limitations of studying them. They cannot be easily captured, weighed, examined, released, and then captured again. When they die, they typically die at sea, and evidence of the fact and cause of their death is lost. Bowheads cannot be brought into aquariums and subjected to oiling or noise experiments as some smaller marine mammals have been. Thus, for these and other reasons, there is uncertainty about the range of potential physiological, especially long-term sublethal, effects on these (and other large) whales from such factors as oil spills, high-energy noise, or contaminants.

There also is some uncertainty about behavioral impacts of repeated exposure to noise and disturbance in the marine environment, whether that noise is from shipping, oil- and gas-related activities, or hunting. There is uncertainty about the potential effects of climate change because of uncertainty about what physical changes actually will occur, what the biological and human activity-related consequences of such changes will be, and how bowheads will respond to such changes.

Because the potential effects of at least some specific factors are uncertain, an even greater level of uncertainty exists about the cumulative impact of all of the potential factors, especially over the long timeframes that must be considered for this species. In general, the uncertainty about potential cumulative effects is greater the further into the future we try to predict and the more likely a potential affecter may affect bowheads in a manner that is difficult to directly monitor (for example, effects of contaminants).

While such uncertainty exists about the details of some but not all cumulative effects, it also is the case that the Western Arctic stock of bowheads is relatively very well studied and monitored. The overall current status of this population is not uncertain, despite the inherent uncertainty associated with some factors that might have had, or might be having, some adverse (or even positive) effects on it. Because some of the potential cumulative effects on this population are highly regulated (for example, subsistence hunting), we know clearly the level of at least some effects. These two points are important. We are able to view other potential effects against relatively detailed knowledge of population status and in light of rather detailed knowledge about the population level consequences of at least some known cumulative affecters (for example, subsistence hunting, past levels of offshore drilling activity). However, data on other potential effecters (e.g., past seismic surveys during the period of highest seismic survey activity and ice-breaking activities) are not sufficient to allow us to have such a view.

IV.G.2.c. Activities Considered. We have identified the following human actions, other than the proposed action, that either have had, are having, or are likely to have potential effects on BCB Seas bowhead whales:

- historic commercial whaling;
- past, present, and future subsistence hunting;
- previous, present, and future oil- and gas-related activity;
- previous, present and future non-oil and gas industrial development within the range of the bowhead;
- past, current and future research activities;
- recent, current and future marine vessel-traffic and commercial-fishing;
- pollution and contaminants baseline; and
- arctic warming that has already occurred.

As possible, we have tried to increase the transparency of the rationale underlying our conclusions about baseline and cumulative effects and to clarify the uncertainty, where it exists, in evaluation of the potential impact(s) of specific effectors.

IV.G.2.d. Historical Commercial Whaling. It is clear that commercial whaling between 1848 and 1915 was the human activity that had the greatest adverse effect on this population. Commercial whaling severely depleted bowhead whales. Woody and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woody and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Commercial whaling also may have caused the extinction of some subpopulations and some temporary changes in distribution.

Following protection from whaling, this population (but not some other bowhead populations) has shown marked progress toward recovery. As noted in the affected environment section, population estimates for 2001 range between 10,470 (SE = 1,351) with a 95% confidence interval of 8,100–13,500 (George et al., 2004) and 10,545 CV(N) =0,128 (Zeh and Punt, 2004, cited in Angliss and Outlaw, 2005,-draft). Thus estimated population size is within the lower bounds of estimates of the historic population size. Recently, Shelden et al. (2001, 2003) concluded that this population should be removed from the list of species designated as endangered under the ESA.

IV.G.2.e. Past, Present, and Future Subsistence Hunting. Indigenous peoples of the arctic and subarctic of what is now Alaska have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the Alaska Eskimo Whaling Commission (AEWC) through a cooperative agreement between the AEWC and the United States Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) (see Appendix 9.5 of NMFS, 2003b).

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, monitored, managed, and regulated, helps to determine the resilience of the population to other effecters that could potentially cause lethal takes.

In Table II, we reproduce information provided by NMFS (2003b), the IWC (2004b), and from Suydam et al. (2005) regarding the numbers of bowhead whales from the Western Arctic (BCB Seas) stock taken by subsistence hunters from 1978-2004. From 1974-2003, a total of 832 whales were landed by eleven villages (Suydam and George (2004). Hunters in Aklavik in western arctic Canada killed one bowhead in 1991 and another in 1996 (Angliss and Outlaw, 2005).

Currently, Alaskan Native hunters from 10 villages harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. The status of the population is closely monitored, and these activities are closely regulated.

During a special meeting in October 2002, the IWC renewed the catch limits for the BCB Seas bowhead population by consensus, allowing for a combined total of up to 280 bowhead whales to be landed in the years 2003-2007 (IWC, 2002). The number of bowhead whales that can be struck in any given year shall not exceed 67 except that any unused portion of a strike quota from any year, including from the 1998-2002 quota block, shall be carried forward and added to the strike quota of any subsequent year, provided no more than 15 strikes shall be added to the quota for any one year. The IWC further specified that “It is forbidden to strike, take or kill calves or any bowhead whale accompanied by a calf” (IWC, 2002). The NMFS (2003b:4) points out that the “Quota of 56 landed whales per year continues to be shared between Alaskan and Russian Natives, the quota does not meet the documented need for landed whales by Alaska Natives.”

In 2004, NMFS (69 *FR* 7910) announced the aboriginal subsistence whaling quota for bowhead whales, and other limitations deriving from regulations adopted at the 2002 Special Meeting of the IWC (as outlined above). At the end of the 2003 harvest, there were 15 unused strikes available for carry-forward, so the combined strike quota for 2004 was 82 (67 + 15). This arrangement ensured that the total quota of bowhead whales landed and struck in 2005 did not exceed the quotas set by the IWC. Under an arrangement between the United States and the Russian Federation, the Russian natives may use no more than seven strikes, and the Alaska Eskimos may use no more than 75 strikes. NMFS assigned 75 strikes to the Alaska Eskimos and the AEWC allocated these strikes among the 10 villages whose cultural and subsistence needs have been documented in past requests for bowhead quotas from the IWC. The AEWC ensures that its hunters use no more than 75 strikes. This process occurs every year.

Both sexes are hunted but under the IWC rules, there is a prohibition on the take of females accompanied by calves. Calves are occasionally mistakenly taken and lactating females are also harvested, apparently due to difficulties in identifying some female/calf pairs during hunting. Additional details regarding sex, age, and reproductive status of these harvested whales are provided in annual reports from the AEWC and the North Slope Borough (e.g., Suydam et al., 2005) to the IWC. A few whales are also harvested by subsistence hunters in Russia. In recent years, these numbers are as follows: 2004: 1 male (IWC, 2005a); 2003: 3 male whales (IWC, 2004b).

Bowheads are hunted at Gambell and Savoonga on St. Lawrence Island, and along the Chukotkan coast. On the northward spring migration, harvests may occur by the villages of Wales, Little Diomede, Kivalina, Point Hope, Wainwright, and Barrow. During their westward migration in autumn, whales are harvested by Kaktovik, Nuiqsut, and Barrow. At St. Lawrence Island, fall migrants can be hunted as late as December (IWC, 2004b).

The sustained growth of the BCB Seas bowhead population indicates that the level of subsistence take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003a; NMFS, 2003b), it is unlikely this source of mortality will contribute to a significant adverse effect on the recovery and long-term viability of this population.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during the following periods and in the following areas: during their northward spring migration in the Bering Sea, the Chukchi Sea in the spring lead system, and in the Beaufort Sea spring lead system near Barrow; their fall westward migration in subsistence hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; hunting along the Chukotka coast; hunting in wintering areas near St. Lawrence Island. Lowry, Sheffield, and George (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding. When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive used in the hunt, the boat motors, and any sounds made by the injured whale. The NMFS (2003a) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: "…the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians, listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike …" (NMFS, 2003a:35). We are not aware of data indicating how far hunting-related sounds (for example, the sounds of vessels and/or bombs) can propagate in areas where hunting typically occurs, but this is likely to vary with environmental conditions. It is not known if whales issue an "alarm call" or a "distress call" after they, or another whale, are struck prior to reducing call rates.

The NMFS (2003a) reported that:

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

Bockstoce and Burns (1993) reported that during commercial whaling, which **we emphasize** differed greatly from the current subsistence take in terms of its magnitude and intensity, whalemen found that:

> the whales, in the opinion of the whalers, began to adapt to the threat. In particular they vanished for several years in an area where a large number of kills had been made. Furthermore, the bowheads apparently quickly learned to distinguish the sound of a whaleboat approaching them,

> and when a whale was struck, all nearby bowheads would dive and flee. Such responses are similar to those reported by contemporary subsistence hunters…. Similarly, when a boat did approach close to bowheads, the animals were often noticed dodging or slumping in the water to avoid the harpoon.
>
> Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where hunting was occurring on multiple, perhaps dozens or more, occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil and gas-related activities. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. However, we are not aware of information indicating long-term habitat avoidance has occurred with present levels of activity. Additionally, if, as reported above, whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions, over the short-term, to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

Available data are insufficient to determine whether there are longer-term (longer than when the hunting is occurring) changes in habitat use due to hunting. Because evidence indicates that bowhead whales are long-lived, some bowhead whales may have been in the vicinity where subsistence hunting occurred on multiple, perhaps dozens or more, occasions. Thus, many whales may have cumulative exposure to subsistence hunting activities.

Noise and disturbance from subsistence hunting serves as a seasonally and geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil and gas-related activities, add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

Current mitigation of oil and gas activities is aimed primarily at avoiding harm to the whales from the activity, and to ensuring that the activity does not conflict with subsistence hunting of whales. The effect of this mitigation is that during the open water season of relatively higher levels of oil and gas exploration activities, whales may be consecutively disturbed by oil and gas and subsistence activities during the entire open water period.

We are not aware of information indicating long-term habitat avoidance has occurred with levels of activity that are currently occurring or that have occurred in the recent past. **We emphasize** that the subsistence take of bowhead whales appears to be sustainable, and all evidence indicates that the affected population is robust and continues to increase. We note that:

- Unlike most or all of the other potential impactors, the take of bowhead whales for subsistence has been occurring for at least 2,000 years.
- The take is of extremely high cultural significance to the whaling communities.
- The subsistence take is small compared to the estimated size of the population. The NMFS concluded that Alaskan Native hunters from 10 communities take less than 1% of the total population (NMFS, 2003a).
- The take is less than that which would be consistent with the requirements of the IWC "Schedule," a set of principles and guidelines that govern Scientific Committee recommendations on setting catch limits for commercial and aboriginal subsistence whaling. In 2002, the IWC's Scientific Committee agreed "…that it is very likely a catch limit of 102 whales or less annually would be consistent with the requirements of the Schedule" (IWC, 2002:36).

- The AEWC and the NMFS cooperate to conduct research on this population, to monitor the hunt, and to undertake other measures to ensure the long-term health and viability of this population.

The level of subsistence take of bowheads could increase over the life of the proposed actions as the human populations within bowhead hunting communities are increasing (IWC, 2002), and the current quota is well below what the IWC considers consistent with its guidelines (IWC, 2002; IWC, 2003b). The IWC considers population size and related nutritional needs in its quotas for aboriginal harvest.

In summary, it is not unlikely that up to 82 (67 + 15) whales may be struck (with the presumption that they could die, even if not retrieved) in a given year from 2004 through 2007 as long as a total of 280 is not exceeded over the 5-year period. If the population of whales continues to increase in abundance, it is not unlikely that this quota could be increased for the next 5-year period (2008-2012). However, it also is likely that the quota will continue to be a small percentage of the estimated population size and will not have significant adverse impacts on the population. The subsistence take, while additive, actually is small as compared to the capacity of the population to absorb it and to thrive. We are aware of no other known potential human-related effects that approach, or could reasonable be predicted to approach, the level of this known removal. This activity also results in noise and disturbance that may have temporary effects on habitat use. We are not aware of information suggesting there have been any long-term modifications of habitat use due to this form of noise and disturbance. However, we also emphasize that the hunt is highly regulated, has limits on take, and places direct prohibition on the take of females with calves. Other potential effecters have less controllable effects, unless also purposely mitigated and shaped.

The existence of this hunt results in a relatively high level of Native, local, state, national, and international study, monitoring, and management of this population(s) which provides some safeguards for its long-term viability. Mitigations that are focused on protecting the hunt may have the unintended effect of increasing overall impacts on the whales by focusing other (e.g., industrial) activities into periods and places that may act as temporary hunting refuges for the whales unless MMS and NMFS also deliberately design mitigations to offset such an impact.

IV.G.2.f. Climate Change (also referred to as arctic warming, global warming, or climate warming). In our Biological Evaluation (USDOI, MMS, 2004), prepared for consultation under Section 7 of the ESA with NMFS on Beaufort Sea Sale 195, we greatly expanded and summarized information on the potential effects of climate change on bowhead whales. We discuss climate warming further below. We note that environmental effects compatible with climate warming have already occurred in the arctic. There is a growing consensus that more such changes are likely to occur.

In our Biological Evaluation for Beaufort Sea Sale 195 (Appendix C of MMS, 2004), we noted that the Working Group I of the IPCC (IPCC, 2001b) concluded that:

- Since 1861, the global average surface temperature (which is the average of near surface air temperature and sea surface temperature) has increased. Over the 20th century, the increase has been 0.6+0.2 ºC.
- "It is likely that there has been about a 40% decline in Arctic sea-ice thickness during late summer to early autumn in recent decades and a considerably slower decline in winter sea-ice thickness" (IPCC (2001b:4).
- Average global sea level rose between 0.1-0.2 meters during the 20th century.
- In the 20th century, it is very likely that there was a 0.5-1% increase in precipitation per decade over most mid- and high latitudes of the Northern Hemisphere continents.
- It is likely that there has been an increase in cloud cover and an increase in the frequency of heavy precipitation events in the mid to high latitudes.
- Since the mid 1970s, warm episodes of the El Niño-Southern Oscillation (ENSO) phenomenon) have been more intense, persistent and frequent compared to the previous 1,000 years.

The Arctic Climate Impact Assessment (2004) stated "The Arctic is now experiencing and is likely to experience some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to contribute to major physical, ecological, social, and economic changes, many of which have already begun."

We do not attempt to make direct links or to make predictions about whether continued warming will occur, and if it does, what the rate and pattern of change will be. In the following, we provide a short summary from a few highly credible summaries of available information on climate warming and on predictions related to potential climate-warming-related changes that could result in effects on this population of bowhead whales. These sources are the International Panel on Climate Change (IPCC, 2001a,b; SEARCH SSC, 2001; Tynan and DeMaster, 1997; IWC, 1997, 2004).

In 2001, the IPCC published detailed, synthetic and summary reports on the topic of climate change. The IPCC (2001b:2) uses the term "climate change" to refer to "any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the Framework Convention on Climate Change…." In this document, our usage of the term is the same as that defined by the IPCC.

We excerpt some findings from two key documents produced by segments of this committee that may be especially relevant to understanding cumulative impacts on bowhead whales:

The IPCC produced a summary, entitled *Climate Change 2001: Synthesis Report Summary for Policymakers*, "approved in detail at IPCC Plenary XVIII," which "represents the formally agreed statement of the IPCC concerning key findings and uncertainties contained in the Working Group contributions to the third Assessment Report" (IPCC, 2001a). This international group has published (IPCC, 2001b) conclusions with regards to climate change, and we refer readers to this document for detail beyond that which we can cite here. In Table SPM-1 (IPCC, 2001b:5) they list 20th century changes in the atmosphere, climate, and biophysical system of Earth. In this summary and in at least some of the individual working group summaries, the IPCC (2001a,b) used the following terms, where they felt appropriate, to indicate judgmental estimates of confidence: "virtually certain (greater than a 99% chance that a result is true); very likely (90-99% chance); likely (66-90% chance); medium likelihood (33-66% chance); unlikely (10-33% chance); very unlikely (1-10% chance); and exceptionally unlikely (<1% chance). Individual IPCC working groups also published synthetic documents, some of which are cited here and in the EA for Sale 195.

The first issue to address is whether observed changes in climate should be discussed as a potential human impact that can affect bowhead whales, their habitat, and other components of the ecological and human systems that also can be impacted by the proposed action. In other words, does available evidence support the contentions that : (1) global climate is warming, and (2) that human activities have had, and can be expected to continue to have (over the timeframe of the proposed actions, about 30 years), an important role in this warming?

The IPCC (2001a:4-5) concluded that:

- Human activities have increased the atmospheric concentrations of greenhouse gases and aerosols since the preindustrial era.
- An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.
- On a global basis, it is very likely that 1998 was the warmest year and the 1990's was the warmest decade in instrumented history (1861-2000) (IPCC, 2001a,b).
- There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities…. The best agreement between model simulations and observations over the last 140 years has been found when all…anthropogenic and natural forcing factors are combined" (see Figure SPM-2 of IPCC, 2001a).
- The IPCC (2001a:30-31) considers the statement that most of the observed warming over the past 50 years is likely due to increases in greenhouse gas concentrations due to human activities as a "robust finding." They define such findings as those that hold under a variety of approaches, methods, models, and assumptions and one that is expected to be relatively unaffected by

uncertainties." However, they highlight that there is uncertainty that constrains relating regional trends to anthropogenic change.

- Changes in sea level, snow cover, ice extent, and precipitation are consistent with a warming climate near the Earth's surface. Examples include…increases in sea level and ocean-heat content, and decreases in snow cover and sea-ice extent and thickness (IPCC, 2001a:6). The statement that "rise in sea level during the 21st century that will continue for further centuries" is also considered a "robust finding." However, they highlight the uncertainty understanding the probability distribution associated with both temperature and sea-level projections.
- Projections using the SRES emissions scenarios in a range of climate models result in an increase in globally averaged surface temperature of 1.4-5.8 ºC over the period 1990 to 2100. This is about two to ten times larger than the central value of observed warming over the 20th century and the projected rate of warming is very likely to be without precedent during at least the last 10,000 years, based on paleoclimate data. For the periods 1990-2025 and 1990-2050, the projected increases are 0.4-1.1 ºC and 0.8-2.6 ºC, respectively (IPCC, 2001a:8).

The IPCC (2001a) also highlights uncertainty and inconsistencies in local and regional model projections and the ability to predict quantitative changes at these scales due to the capabilities of regional scale models (especially regarding precipitation).

In Table SPM-3, the IPCC (2001a:31-32) listed what they termed robust findings (a finding that holds under a variety of approaches, methods, models, and assumptions and one that is expected to be relatively unaffected by uncertainties) and key uncertainties (those that, if reduced, may lead to new and robust findings. They point out that many of the robust findings have to do with the existence of a climate response to human activity and the direction of the response. Many of the uncertainties are related to quantification of either the timing and/or magnitude of the response.

At the request of the White House, the NRC (NRC, 2001:vii) identified areas in the science of climate change where there are the greatest certainties and uncertainties". In answer to the question of whether climate change is occurring and, if so, how, the NRC (2001:3) wrote that:

> Weather station records and ship-based observations indicate that global mean surface air temperature warmed between about 0.4 and 0.8 C…during the 20th century…the warming trend is spatially widespread and is consistent with an array of other evidence…in this report. The ocean….has warmed by about 0.05 C…averaged over the layer extending from the surface down to 10,000 feet, since the 1950s.

They concluded that:

> The IPCC's conclusion that most of the observed warming of the last 50 years is likely to have been due to the increase in greenhouse gas concentrations accurately reflects the current thinking of the scientific community on this issue. The stated degree of confidence in the IPCC assessment is higher today than it was 10, or even 5 years ago, but uncertainty remains….

The NRC (2001:3) concluded that: "The predicted warming is larger over higher latitudes than over low latitudes, especially during winter and spring, and larger over land than over sea."

Sandven and Johannessen (2004, in Brigham and Ellis, 2004:A-13) reported that data obtained using passive microwave satellite data have shown a decrease of total ice area in the arctic of 3-4% per decade and a more significant reduction of 7-8% reduction per decade in multi-year ice. Significant reductions in the thickness of arctic sea ice (Rothrock, Yu, and Maykut, 1999) and winter multiyear ice (Johannessen et al., 1999) have been reported. In 1998, record sea-ice retreat was observed for the Beaufort and Chukchi seas (Maslanik, 1999). Vincent, Gibson, and Jeffries (2001) reported a decrease in pack ice thickness by 27% from 1867-1999 in the Canadian high Arctic with the collapse of the Ellesmere Ice Shelf (90% reduction). Whether ice cover and ice thickness will continue to decrease in the arctic is uncertain.

Analysis of ice thickness from six submarine cruises from 1991-1997 showed no trend towards a thinning ice cover (Winsor, 2001).

Atmospheric temperature increases due to global warming may be more pronounced in the arctic region than in geographic areas closer to the equator (Peters and Darling, 1985; Peters, 1991). Heavy precipitation events are projected to become more common in the arctic with flooding events likely to increase in frequency, and sea-levels are expected to rise (Walsh, 2003; Gough, 1998).

Climate warming could potentially affect bowheads in ways including:

- increased noise and disturbance related to increased shipping, and possibly related to increased development, within their range;
- increased interactions with commercial fisheries, including increased noise and disturbance, incidental take, and gear entanglement;
- decreases in ice cover with the potential for resultant changes in prey species concentrations and distribution; related changes in bowhead whale distributions; changes in subsistence-hunting practices that could result in smaller, younger whales being taken and, possibly, in fewer whales being taken;
- more frequent climatic anomalies, such as El Niños and La Niñas, with potential resultant changes in prey concentrations; and
- a northern expansion of other whale species, with the possibility of increased overlap in the northern Bering and/or the Chukchi seas.

The IUCN /Species Survival Commission (IUCN/SSC) (IUCN, 2003) concluded that a workshop by the IWC in 1996:

> …placed the issue of climate change, including ozone depletion, firmly on the cetacean conservation agenda…. Effects of climate change are complex and interactive, making them analytically almost intractable. This workshop report acknowledges the difficulties in establishing direct links between climate change and the health of individual cetaceans, or indirect links between climate change and the availability of cetacean prey….

We emphasize that there is uncertainty associated with many of the predictions about potential climate changes, especially at a regional level, and associated environmental changes that could occur. However, if this change occurs, it is likely that shipping would increase throughout the range of the bowhead, especially in the southern portions of the Beaufort Sea. If commercial fisheries were to expand into the Beaufort Sea, as discussed as a possible outcome of climate warming, bowhead whale death and or injury due to interactions with fishing gear, possibly injury and/or death due to incidental take in commercial fisheries, and temporary effects on behavior potentially could occur. There are, however, no data that would permit us to quantitatively predict such types of effects.

With respect to observations and conclusions specifically pertinent to bowhead whales, the SEARCH SSC (2001:2) noted that:

> Available data point to long-term and recently augmented reductions in sea-ice cover (Maslanik et al., 1996; Bjorgo et al., 1997; Cavalieri et al., 1997; Zakharov, 1997; Rothrock et al., 1999)…. Perhaps most alarming, there have…been significant reductions in sea ice extent (Parkinson) et al., 1999) and a 43% reduction in average sea ice thickness (Rothrock et al., 1999) in recent decades.

The SEARCH SSC (2001) also noted that the results of several recent expeditions indicate that the presence of Atlantic-derived water in the arctic has increased. Tynan and DeMaster (1997) pointed out that recent decreases in ice coverage have been more extensive in the Siberian Arctic than in the Beaufort Sea. While Tynan and DeMaster (1997:308) hypothesized that decreases in sea ice extent and warming could have profound effects on some marine mammals and their prey, they summarized that: "Present climate models, however, are insufficient to predict regional ice dynamics, winds and mesoscale features, and mechanisms of nutrient resupply, which must be known to predict productivity and trophic response." However, it is important to note that since their 1997 paper, there has been considerable research on climate changes in the arctic and while the ability to predict change still has considerable uncertainty, the aforementioned "robust findings" have emerged.

Tynan and DeMaster (1997) note an earlier IPCC report that concluded that an increase in human activity is likely to accompany the opening of the Northwest Passage and the Russian Northern Sea Route. They identify a potential for increased environmental pollution, an increased incidence of epizootics, exploration, increased ship traffic, increased fisheries, and increased industrial activities, and the synergistic effects of these factors with ecosystem changes due to climate change as potential concerns for marine mammals populations. Increased freshwater discharge from the Mackenzie River could promote regional ice formation and result in increased riverborne pollutants (Tynan and DeMaster, 1997) into important summering habitat for the bowheads.

Perhaps the greatest potential adverse effect associated with global warming could occur if predictions that the Northwest Passage may become ice free for significant lengths of time prove accurate, opening sea routes across the Beaufort Sea and increasing shipping in all parts of the range of the Western Arctic stock of the bowhead whale. SEARCH SSC (2001:30) concludes that:

> …greater access and longer navigation seasons may be possible in Hudson Bay, the Chukchi and Beaufort seas, and along the Russian Arctic coast if present sea ice trends continue. The significant reduction in the thickness of arctic sea ice…and…winter multiyear ice…suggest the possibility of shipping in the central Arctic Ocean sometime during the 21st century. It is significant to note that at the end of the 20th century nuclear and non-nuclear icebreakers (from Canada, Germany, Russia, Sweden, and the U.S.) have made summer transits to the North Pole and operated throughout the central Arctic Ocean…. Thus it is conceivable that surface ships in the future will not have to confine their operations solely to the arctic marginal seas.

There has been recent environmental change along the Northern Sea Route (across the north of Eurasia) that could alter shipping between northern Europe and Asia. Global interest in this route resulted in a comprehensive study, called the International Northern Sea Route Programme (INSROP) that confirmed that the European Union and Russia are collaborating on programs to better link their areas using arctic shipping, and that technological and environmental challenges are no longer absolute obstacles to commercial shipping. SEARCH SSC (2001:30) states that: "Continued sea ice reductions will no doubt influence the initiation of transportation studies similar too INSROP for the Northwest Passage, the coasts of Greenland, the Alaskan Arctic coast and other regional seas."

Beginning in 1853 and through 2004, there were 99 transits of the Northwest Passage, using 7 different routes (Headland, 2004 in Brigham and Ellis, eds., 2004: A-8). Submarines are thought to use the most northern route which is the deepest. Appendix F in Brigham and Ellis (2004) lists the transits of the Northwest Passage, including information about the route taken by the vessel. Brigham (2004, in Brigham and Ellis, eds., 2004:A-4) summarized that in 1994 two surface ships transited from the Bering Sea to the North Pole during July and August.

Available information indicates that increased shipping in the Alaskan Beaufort Sea and Eastern Chukchi Sea will likely occur first due to increased "in and out" traffic which does not require, and would likely precede, traffic through a reliably open "Northwest Passage." For example, the manager of a Canadian marine service company (B. Gorman, 2004, in Brigham and Ellis, 2004:5) noted that "the marine industry in focused on the Arctic as a destination and not a short-cut...either now or within the next 10 to 20 years."

Increased shipping could have substantial effects on development in the arctic, making new areas economically feasible to develop (SEARCH SSC, 2001). SEARCH SSC (2001:31 states that:

> A substantial change in the open water season for the Beaufort Sea – from 60 to 150 days (Maxwell, 1997) – can potentially reduce the costs associated with offshore oil and gas

> exploration and production…. Shipping access to the large oil and gas reserves in the Barents and Kara seas will be substantially improved if regional warming of the Russian Arctic continues….”

Thus, potential effects of climate warming include increased development in the Beaufort and Chukchi seas. However, it is important to note that all of the aforementioned potential changes in shipping are dependent on continued warming and reductions in sea ice.

The Office of Naval Research (2001) reported that climate warming in the arctic is likely to result in the northward migration of subarctic species of marine mammals and an increase in commercial-fishing activities into the Chukchi and Beaufort seas, where operations have been minimal in the past.

If substantial increases in shipping were to occur that placed more ships in waters inhabited by bowheads, increases in adverse effect to bowheads also might occur due to shipping-related noise and disturbance, vessel strikes, and pollution. Quantification of such potential changes are not possible at this time due to the level of uncertainty about changes that might occur over the course of the proposed project and the shipping industry’s response to greater cross-Beaufort transiting opportunities, when they to occur.

Clapham and Brownell (1999) summarized that “…effects of ship noise on whale behavior and ultimately on reproductive success are largely unknown.”

In the most recent stock assessment (Angliss and Outlaw, 2005) NMFS reiterated their conclusion that data are insufficient to make reliable predictions about the effect of arctic climate change on bowheads.

IV.G.2.g. Conclusions Regarding Climate-Change Effects. We conclude that the potential effects of global warming on this population of bowhead whales are uncertain. There is no current evidence of negative effects on the whales. There is no evidence suggesting that many of the changes that could occur, such as changes in timing of migrations and shifts in distribution, would be associated with overall adverse effects on these whales. In Shelden et al.’s (2003) response to Taylor’s statements regarding the expectation of future downward trends in abundance based on what he termed “available evidence” regarding global warming, they point out that Taylor did not provide citations supporting this claim. Shelden et al. (2003:918-919) state that:

> Although available data do indicate that the Bering Sea environment is changing (e.g., Angel & Smith 2002), we are aware of no evidence that environmental changes will be detrimental to the population in the foreseeable future. In fact, our review…on this issue suggests that climate change may actually result in more favorable conditions for BCB bowheads.

We have, however, identified some potential changes that could result in adverse impacts on bowhead whales, were they to occur. In our 2004 Biological Evaluation for Sale 195 (USDOI, MMS, 2004), we greatly expanded and summarized information on the potential effects of climate change on bowhead whales. In 2005, a symposium “High Latitude Sea Ice Environments: Effects on Cetacean Abundance, Distribution and Ecology” was held as a pre-meeting to the IWC Annual meeting in 2005 (IWC, 2005a). At this symposium, concerns we identified in the 195 Biological Evaluation (USDOI, MMS, 2004) were again identified: increased exposure to killer whale predation; competition with other species; ship traffic; noise; pollution; and fisheries interactions. In addition, they noted that a reduction in sea ice may affect the logistics of the harvest and raised concerns about thermoregulatory issues. The IWC Scientific Committee (IWC, 2005a:23) summarized that: “…the Committee…found it difficult to predict how bowhead whales might be affected by large-scale oceanographic changes in the future.”

Angliss and Lodge (2002:174) stated that:

> Ice-associated animals, such as the bowhead whale, may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and the concomitant change on prey availability. There are insufficient data to make reliable predictions of the effects of Arctic climate change on bowhead whales.

Based on our previous and continued review of available information, we agree with these general conclusions. However, we believe that evidence is accumulating that increased noise and disturbance in bowhead summer, autumn, and potentially spring habitat due to increased shipping and industrial activity that occurs as a result of climate warming has begun to occur and is likely to continue to occur within the time period of activities that result from the proposed actions (e.g., over approximately the next 30-40 years). This noise and disturbance will add to that which has already occurred and is currently occurring due to industrial activity, subsistence harvest, local shipping, research, and limited vessel traffic.

IV.G.2.h. Commercial-Fishing, Marine Vessel-Traffic, and Research Activities. Based on available data, previous incidental take of bowhead whales apparently has occurred only rarely. The bowhead's association with sea ice limits the amount of fisheries activity occurring in bowhead habitat. However, as noted in the section on climate change, the frequency of such interactions in the future would be expected to increase if commercial-fishing activities expand northward, with resultant increases in temporal and, especially, spatial overlap between commercial-fishing operations and bowhead habitat use. There is some uncertainty about whether such expansion will occur. Increases in spatial overlap alone could result in increased interactions between bowheads and derelict fishing gear. In a discussion of population climate warming impacts on bowheads at the meeting of the Subcommittee on Bowheads, Right Whales and Gray Whales at the IWC's annual meeting, P. Wade (referred to in IWC, 2005b:4) reported that that the commercial crab fishery extended further north the previous winter (winter 2004-2005) than in previous years.

Between 1989 and 1994, logbook data on incidental take of bowheads are available, but after that time, the requirement is for fishers to self report. Angliss and Lodge (2002:173) reported that "the records are considered incomplete and estimates of mortality based on them represent minimums." There are no observer program records of bowhead whale mortality incidental to commercial fisheries in Alaska (Angliss and Lodge, 2002). New information on entanglements of bowhead whales indicates that bowheads do have interactions with crab-pot gear. There have been two confirmed occurrences of entanglement in crab-pot gear, one in 1993 and one in 1999 (Angliss and Lodge, 2002). Table 29 in Angliss and Lodge (2002, page 173) details reports of scarring of bowhead whales attributed to entanglement in ropes. Citing a personal communication from Craig George of the NSB, Department of Wildlife Management, Angliss and Lodge (2002) report a preliminary result from reexamination of bowhead harvest records suggest that there may be more than 20 cases indicating entanglements or scarring attributable to ropes in the bowhead harvest records. Angliss and Lodge (2002) reported that the average rate of bowhead entanglement in crab pot gear for 1996-2000 is 0.2. Based on currently available data, the estimated annual mortality rate incidental to commercial fisheries also is 0.2 (see Appendix 2 in Angliss and Lodge, 2002:179).

A young bowhead was reported to have died after being entrapped in fishing net in Japan (Shelden and Rugh, 1995) and another in northwest Greenland in a net used to capture beluga whales. Several cases of rope or net entanglement, at least 12 incidents from 1978-2004, have been reported from whales taken in the subsistence hunt (Angliss and Outlaw, 2005-draft). The number of entanglements or scarring attributed to ropes may include more than 20 cases (C. George, as cited in Angliss and Lodge, 2002). Table 48 in Angliss and Outlaw (2005-draft) details reports of scarring of bowhead whales attributed to entanglement in ropes.

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

Marine vessel traffic, in general, can pose a threat to bowheads because of the risk of ship strikes. As discussed above in Section IV.G.2.f on Climate Change, shipping and vessel traffic is expected to increase in the arctic if warming continues. Additionally, noise associated with ships or other boats potentially could cause bowheads to alter their movement patterns or make other changes in habitat use. Pollution from marine vessel traffic, especially from large vessels such as large cruise ships, also could cause degradation of the marine environment and increase the risk of the whales' exposure to contaminants and disease vectors.

The frequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low but may be increasing. Between 1976 and 1992, only three ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al., 1994). The low number of observations of ship-strike injuries suggests that bowheads either do not often encounter vessels, or they avoid interactions with vessels, or that interactions usually result in the animals' death. The NMFS (2003b, citing a pers. commun. with C. George of the NSB) states that since the 1994 publication by George et al. (1994), ship-strike injuries have been observed on 6 additional whales out of about 180 whales examined between 1995 and 2002.

Available evidence indicates that bowheads either do not often encounter vessels or they avoid interactions with vessels, or that interactions usually result in the animals' death. We believe this general conclusion about ship strikes is likely to be valid. We also agree with the conclusion by the NMFS (2003b) that the rate may have increased slightly in recent years.

Clapham and Brownell (1999) summarized that "…effects of ship noise on whale behavior and ultimately on reproductive success are largely unknown." The NMFS (2003b) concluded that the greatest potential impact to bowhead whales from research in the arctic was from underwater noise generated by icebreakers. They cite the Western Arctic Shelf Basin Interactions (SBI) project, which operated from the U.S. Coast Guard *Healy* and *Polar Star* icebreakers. This was a multiyear, interdisciplinary program aimed at investigating the impacts of climate change on biological, physical, and geochemical processes in the Chukchi and Beaufort Shelf Basin in the Western Arctic Ocean. The SBI's cruise track in 2002 departed from Nome in early May , traveled through the Bering Strait and into the Chukchi Sea north to approximately 75º N. longitude, then west, and then gradually south to a nearshore region on June 5 and about 150º W. latitude. The ship then generally followed the coast to Pt. Lisburne. From that point, it returned directly to Nome on June 15. In 2002, the *Healy* also traveled into the Bering Sea to research the land bridge that once linked Russia and Alaska. According to a U.S. Coast Guard Pacific Area webpage on the project (http://www.uscg.mil/pacarea/healy/deploymets/aws02/science/aws02science.htm), this mission used towed sonar arrays, bottom coring, and CTD profiling.

Richardson et al. (1995a:Table 6.5) reported estimated source levels for similarly sized icebreakers to range from 177-191 db re 1 µPa-m. During icebreaking, extremely variable increases in broad-band (10-10,000 Hz) noise levels of 5-10 dB are caused by propeller cavitation. Based on previous studies of bowhead response to noise, such sound could result in temporary avoidance of animals from the areas where the icebreakers were operating and potentially cause temporary deflection of the migration corridor, depending of the location of the icebreakers.

Richardson et al. (1995a:301) concluded that: "Ships and larger boats routinely use fathometers, and powerful side-looking sonars are common on many military, fishing, and bottom-survey vessels…. Sounds from these sources must often be audible to marine mammals and apparently cause disturbances in some situations."

Active sonars were used in commercial whaling after World War II, and whaling boats sometimes tracked whales underwater using active sonar. Ash (1962, cited in Richardson et al., 1995a) reported that this often caused strong avoidance by baleen whales. Reeves (1992) reported that ultrasonic pulses were used to scare baleen whales to the surface. Maybaum (1990, 1993) reported that humpback whales on the wintering grounds moved away from 3.3 kHz sonar pulses and increased their swimming speed and swim-track linearity in response to 3.1- to 3.6-kHz sonar sweeps. Richardson et al. (1995a) also concluded that Smith (1985) reported that the energy emitted by high-power sonars was sufficient energy to cause concerns about possible nonauditory physical effects and hearing damage in human divers.

The NRC summarized that:

> Recent reports and retrospectively analyzed data show an association between the use of multiple high-energy mid-range sonars and mass strandings of beaked whales (*Ziphius cavirostris*). Recent mass strandings…have occurred in a temporal and spatial association with ongoing military exercises employing multiple high-energy, mid-frequency (1-10 kHz) sonars. (NRC, 2003b:89)

Submarines are highly valued platforms for a variety of oceanic research in part because they are relatively quiet, enabling the use of active and passive acoustic technologies for a variety of studies. Information about the response of bowheads to resting or transiting submarines is not available to MMS. U.S. Navy submarines are likely to continue to be used as platforms in the future.

Some of the research ships that have previously made trips into the range of the bowhead are likely to do so again in the future. All large research ships that are active in the range of the bowheads during periods when they are present have the potential to cause noise and disturbance to the whales, potentially altering their movement patterns or other behavior. However, available evidence does not indicate such disturbance will have a significant effect on this population over the approximate life of the project, even when added to the effects of other effectors.

There has been speculation recently that commercial shipping through the Northwest Passage is likely to substantially increase in the coming decades. For example, an article in 2000 in the *Christian Science Monitor* (Walker, 2000) quotes the director of the Canadian Project at the Center for Strategic and International Studies in Washington, C. Sands, as saying he believes that “there’s a reasonable chance” arctic commercial shipping is going to occur across the Northwest Passage. Burns (2000:4) concludes that “…proposed reduction in sea ice area could also open up the Northwest Passage. This could expose cetaceans to increased ship traffic and mineral exploitation.” Many shipping experts believe that “in-and-out” shipping (e.g., shipping from the Pacific Ocean or Bering Sea through the Chukchi Seas into the Beaufort and then back again) is likely to increase well in advance of regular shipping through the Northwest Passage.

The Western Arctic bowhead has been the focus of research activities that could, in some instances, cause minor temporary disturbance of the whales. During research on the whales themselves, the reactions of the whales generally are closely monitored to minimize potential adverse effects. Additionally, research conducted primarily for reasons other than the study of the bowhead has also occurred within the range of the bowhead. In some cases, such research has the potential to adversely affect the whales through the introduction of additional noise, disturbance, and low levels of pollution into their environment.

Some of the research projects discussed here are continuing in the future, but have already been initiated. Previous research on bowheads has included aerial surveys, ship-based observations, acoustic studies, shore-based censuses, studies involving samples and examination of carcasses of animals killed in the subsistence hunt, and satellite tracking. The NMFS recently initiated photo-identification studies. The MMS will be procuring a large study aimed at better understanding the importance of feeding areas in the western Alaskan Beaufort Sea. In these future activities, as in the past, the primary result of ship-based activities could be temporary disturbance of individual whales from a highly localized area. Whales might slightly and temporarily alter their habitat use to avoid large vessels. Whales also could be temporarily harassed or disturbed by low-flying airplanes during photo-identification work. These effects would be as described for low-flying aircraft in our effects section. All such effects are expected to be of short duration. Aerial surveys generally are flown at a height such that they do not cause harassment.

More generally, Morrison et al. (2001) (citing Brigham, 1998, 2000) point out that from 1977-1998, there have been 27 icebreaker trips to the North Pole (presumably not all in the range of this stock of bowhead) for science and tourism.

Research vessels also sometimes introduce noise intentionally, not just incidentally, into the environment as part of the ship’s operating systems or to enable the collection of specific types of data (e.g., seismic survey data). For example, in 1994, the R/V *Maurice Ewing* conducted a 2D seismic investigation of the continental crust in the Bering and Chukchi seas in Alaska between August 6 and September 1, 1994.

Details of this cruise are available (Galloway and Shipboard Scientific Party, EW94-10, 1994). According to this report, two north-south transects were profiled.

> The eastern transect extended from 58º 50´N, 169º32´W, well within the continental shelf of the Bering Sea, north of the Pribilof Islands, to just south of the shelf edge north of Barrow at 71º49´N, 154º33´W. The western transect extended from the central Chukchi Sea, well within the shelf at 71º23´N, 163º00´W into the Aleutian Basin at 58º00´N, 178º30´W, near Navarinsky Canyon (Galloway and Shipboard Scientific Party, EW94-10, 1994:3).
>
> The hardware for the cruise…consisted of a digital 180-channel streamer…4 km in length, with 25-meter hydrophone spacing…. The source was a[n] 8355 in^3 (137.7 liters), 20-chamber airgun array…. (Galloway and Shipboard Scientific Party, EW94-10, 1994:7).

This source level is greater than those summarized in Table 6.6 of Richardson et al. (1995a), and it is far greater than those recently employed in operating oil- and gas-related seismic surveys in the Beaufort Sea or in most or all experiments to which the reactions of bowheads have been studied. In a more recent permit application for an Incidental Harassment Authorization, Lamont-Doherty (2003), the entity that controls the R/V *Maurice Ewing*, summarized that airgun noise could cause "…tolerance, masking of natural sounds, behavioral disturbance, and perhaps permanent or temporary hearing impairment." In September 2002, two beaked whales were discovered beached on the Gulf of California (Mexico) coast by NMFS biologists vacationing in the region when the *Maurice Ewing* was conducting a seismic survey in the general area (Lamont-Doherty, 2003). However there is no specific evidence of cause and effect.

Bowhead whales from the Western Arctic stock that remained in the Chukchi Sea during the summer of 1994 could have been exposed to noise from this vessel. Because of the source level of this airgun array, it is not unlikely that the distance at which bowheads could be affected by this noise source would be greater than that observed in oil- and gas-related noise research. However, we do not speculate further about whether such exposure occurred or if it did occur, what potential effects it may have had, because observations of marine mammal reactions during this cruise are not available.

In recent years, there also have been scientific field operations in the Arctic Ocean that have used U.S. Navy submarines as platforms. The Scientific Ice Expeditions (SCICEX) program used a Sturgeon-class nuclear-powered attack submarine for unclassified scientific cruises to the Arctic Ocean. A composite of SCICEX tracks in 1993, 1995, 1996, and 1997 can be found at http:/www.ideo.columbia.edu/res/pi/SCICEX and includes travel into bowhead habitat. The program was scheduled to operate at least through 1999. The SCICEX-98 deployment apparently was the fifth of such field operations. The primary objectives of this scientific program, which began on August 1, 1998, were to continue to document physical, chemical, and biological changes in the Arctic Ocean and to characterize the topography and sediment characteristics of the Arctic Ocean floor. The U.S. Navy submarine *Hawkbill* was used in the 1998 field operation. This research cruise entered north of the Bering Strait and traveled along a transect that "roughly paralleled the shelf break north of the Chukchi Sea and terminated just west of Barrow Canyon." A cross-Arctic transect followed and extended to the eastern extreme of the "data release area" (see Figure 1 in the Cruise Report at the following Web-site address).

According to information provided in the Cruise Report (http:www.ideo.columbia.edu/res/pi/SCICEX/Pages/Cruise_Report.html), the SCICEX-98 cruise was a successful first deployment of the Seafloor Characterization and Mapping Mods (SCAMP), which is described in detail in Chayes et al. (1997). However, it is not clear if all elements of SCAMP were used in research activities within the range of the Western Arctic bowhead stock, or if some of the technology used in the 2001 cruise is modified from that described by Chayes et al. (1997). The aforementioned Cruise Report states that geophysical instrumentation used on the cruise included two active sonars. One of these is the Sidescan Swath bathymetric sonar (SSBS), a bilateral swath mapping sonar that operates at 12 kHz at ping intervals out to 20 seconds. Table 1 of Chayes et al. (1997) provides the major "design goal" specifications for the SSBS as follows: Frequency: 12 kHz; pulse length: 8µS to 10 mS; modulation: "CW or" (something is missing in the original source); repetition rate: 2-20 seconds; source level: 233 dB re 1 µPa at 1 m; power: 115 VAC; backscatter swath width: ~160°; bathymetry swath width: ~140°. Additionally, SCAMP employs a subbottom profiling system intended to profile structures down to about

100 m below the seafloor. Based on information in Table 2 of Chayes et al. (1997), the major "design goal" specifications for the SCAMP High Resolution Subbottom Profiler are as follows: Frequency: 2-8 kHz; pulse length: 1-100 mS; modulation: CW or FM; repetition rate: 1-10 seconds; source level: 230 dB re 1 µP at 1 m; penetration: ~100 m. It is not clear if the subbottom profiler detailed in the 1997 paper is that used in 2001. The cruise report for 2001 states that the SCAMP subbottom profiler is an ODEC Bathy-2000P that has been modified for integration with the data system used and for submarine operations. In 2001, the geophysical survey included about 8,900 nmi of trackline over 30 days between August 1 and September 1, 2001, and included habitat documented to be within the range of the bowhead whale during that time.

Other ships have made numerous research trips into the range of the bowhead. For example, in 1995, the NRC reported that the *Alpha Helix* had performed numerous research cruises in the North Pacific, Bering Sea, Chukchi Sea, and Alaskan coastal waters over the past 15 years (NRC, 1995). Operation of this vessel is primarily limited to open water. The R/V *Alpha Helix* has modest ice-strengthening characteristics but no icebreaking capability.

The MMS is continuing to evaluate information about cumulative effects from research activities as it becomes available.

IV.G.2.i. Summary. We conclude that some past and present research-related noise and disturbance could potentially have caused, and can cause, harassment and, possibly, temporary displacement of individual whales. Such noise and disturbance add to cumulative levels of noise in the whales' environment. At present, available information does not indicate that such noise is having behavioral or physiological adverse effects on the bowheads in this stock. However, available information is not sufficient to form any conclusions about such potential effects. We are not aware of any information that suggests long-term displacement from important habitats has occurred, that indicates the population is suffering any significant population-level effect from any single affecter, or that indicates that the cumulative effects, including those from research activities, would have such an effect.

IV.G.2.j. Pollution and Contaminants. Initial studies of bowhead tissues collected from whales landed at Barrow in 1992 (Becker et al., 1995) indicate that bowhead whales have very low levels of mercury, PCB's, and chlorinated hydrocarbons, but they have fairly high concentrations of cadmium in their liver and kidneys. The study concluded that the high concentration of cadmium in the liver and kidney tissues of bowheads warrants further investigation. Becker (2000) noted that concentration levels of chlorinated hydrocarbons in bowhead whale blubber generally are an order of magnitude less than what has been reported for beluga whales in the arctic. This probably reflects the difference in the trophic levels of these two species; the bowhead being a baleen whale feeding on copepods and euphausiids, while the beluga whale being toothed whale feeding at a level higher in the food web. The concentration of total mercury in the liver also is much higher in beluga whales than in bowhead whales.

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

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

Based on the use of autometallography (AMG) to localize inorganic mercury in kidney and liver tissues for five bowhead whales, Woshner et al. (2002:209) reported that "AMG granules were not evident in bowhead tissues, confirming nominal mercury (Hg) concentrations." Detected concentrations ranged from 0.011-0.038 micrograms per gram (µg/g) wet weight for total mercury. Mössner and Ballschmiter (1997) reported that total levels of 310 nanograms per gram (ng/g) polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific/Arctic Ocean, an overall level many times lower than that of other species from the North Pacific or Arctic Ocean (beluga whales [2,226 ng/g]; northern fur seals [4,730 ng/g]) and than that of species from the North Atlantic (pilot whale [6,997 ng/g]; common dolphin [39,131 ng/g]; and harbor seal [70,380 ng/g]). However, while total levels were low, the combined level of 3 isomers of the hexachlorocyclohexanes was higher in the bowhead blubber (160 ng/g) tested than in either the pilot whale (47 ng/g), the common dolphin (130 ng/g), and the harbor seal (140 ng/g). These results confirmed results expected due to the lower trophic level of the bowhead relative to the other marine mammals tested.

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

IV.G.2.k. Offshore Oil- and Gas-Related Activities and other Industrial Activities.

IV.G.2.k(1) Past and Current Activities. We provide description of past and current oil and gas industrial activities in Appendix V and additional information is provided in Wainwright (2002, see below). While we focus our description and consideration of potential effects on offshore activities, we also provide relevant information about onshore activities, because onshore activities can lead to increases in related offshore support (e.g., barge traffic).

Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Beaufort and Chukchi seas as a result of previous lease sales since 1979. Extensive 2D seismic surveying has occurred in both program areas (see Figures V-A, V-B, and V-C and figures in Wainwright, 2002). The MMS-permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960's and early 1970's. Much more seismic activity has occurred in the Beaufort Sea OCS than in the Chukchi Sea OCS. The 2D marine seismic surveys in the Beaufort Sea began with two exploration geophysical permits issued in 1968 and 4 in 1969. Both over-ice (29 permits) and marine 2D (43 permits) seismic surveys were conducted in the 1970's. With one exception, all 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980's were 2D. In the Beaufort Sea, 23 MMS G&G permits were issued in 1982 (11 marine and 12 over-ice 2D surveys) and 24 MMS G&G permits were issued in 1983 (1, 3D over-ice survey; 14, 2-D over-ice surveys; and, 9, 2D marine surveys). The first 3-D on-ice survey occurred in the Beaufort Sea OCS in 1983. In the 1990's, both 2D (2 on-ice and 21 marine) and 3D (11 over-ice and 7 marine OBC) seismic surveys were conducted in the Beaufort Sea. The first marine 3D seismic survey in the Beaufort Sea OCS occurred in 1996. To date, all 3D marine seismic surveys in the Beaufort Sea OCS have been OBC operations. The most exploration geophysical permits issued in any one year in the Chukchi Sea was 7 (6 marine and 1 over ice) in 1986.

Thirty exploratory wells have been drilled in the Federal Beaufort Sea (see Table V-11 in Appendix V) over a 20+ year period between 1981 and 2002. This drilling occurred from a variety of drilling platforms (e.g., gravel islands, SSDC, drillships, etc.) and, during different seasons of the year, including the open water period. The last exploration well drilled in the Beaufort Sea OCS was drilled in the winter of 2002 at the McCovey prospect.

Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. There are no existing OCS offshore leases in the Chukchi Sea and, except for the Barrow gas fields (local use only), no substantive existing development. Five exploratory wells have been drilled, all using drillships, in the Chukchi Sea OCS. These wells were drilled between 1989 and 1991, inclusive. The last Chukchi Sea well was drilled in 1991 at the Diamond Prospect. No seismic survey activity has occurred in the Chukchi Sea since 1991 and there has been no 3D seismic survey activity in the Chukchi Planning Area.

Many of offshore activities also required ice management (icebreaking), helicopter traffic, fixed wing monitoring, other support vessels, and, in some cases stand-by barges.

Available information does not indicate that oil- and gas-related activity (or any recent activity) has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of the BCB Seas bowhead population. Data indicate that the BCB Seas bowhead whale population has continued to increase over the timeframe that oil and gas activities has occurred. There is no evidence of long-term displacement from habitat. However, there are no long-term oil and gas developments in the offshore within bowhead high use areas. Northstar is at the southern end of the migratory corridor and Endicott is within the barrier islands. Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. As noted in the section on effects, recent monitoring studies indicated that most fall migrating whales avoid an area with a radius about 20-30 km around a seismic vessel operating in nearshore waters. We are not aware of data that indicate that such avoidance is long-lasting after cessation of the activity.

Available data are, however, inadequate to fully address issues about effects of past oil and gas activity in the Beaufort Sea on bowhead behavior. The MMS study 2002-071 titled *GIS Geospatial Data Base of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea* provided a compilation of available data on the location, timing, and nature of oil- and gas-related activities from 1979-1999. It was intended to provide a "…database to address concerns expressed by subsistence hunters and others living within …villages of the Beaufort Sea about the possible effects that oil and gas activity, particularly seismic activity, drilling, and oil and gas support vessel activities may have on the behavior of...especially the bowhead whale." However, "(S)uch an analysis requires an adequate level of detail…", "…there are significant gaps in the data for the period 1979-1989" (Wainwright, 2002:viii) and "(V)ery limited information was obtained on ice management" (Wainwright, 2002:52). For all but 2 years, 1985-1986, during the period 1979-1989, inclusive, Wainwright (2002:Table 2, p. 8) assessed the availability of information about 2D/3D seismic surveys conducted under OCS permit as a 0 out of a possible 3. This score of 0 indicates: "Significant data sets are missing. These data are not suited for statistical analysis." During this same period, they also provide a rank of 0 out of 3 to categorize the completeness and adequacy of information on seismic surveys under state MLUP permit. For the entire period of study (1979-1998), they rate the completeness and adequacy of information on seismic and acoustic surveys in State waters without permits, ice management, and other vessel activity all as 0 (see Wainwright, 2002:Table 2, p. 8). Thus, while data on the bowhead status are adequate to determine that the BCB Seas bowhead whale population apparently continued to recover during the periods when past and current levels of oil and gas activities were occurring, we cannot adequately assess potential effects on patterns or durations of bowhead habitat use. Wainwright (2002:13) summarized that "…it was not possible to compile adequate data on seismic activity prior to 1990." Because of the inadequacy of the data on activities, and because of the limitations inherent in studying large baleen whales, we also cannot assess whether there were any adverse health effects to individuals during the period of relatively intensive seismic survey activity in the 1980's.

Data for the 1990s are better, and the levels of activity are more comparable to those anticipated in the near future. There were no geohazard (high-resolution seismic surveys) surveys during the fall migration period in the 1990s (Wainwright, 2002). Table 4 of Wainwright (2002:45) gives information about the kinds and levels of seismic and acoustic activity in the 1990s. On Figure 11 of Wainwright (2002:41) summarizes that except in 1990 and 1998, seismic surveying activity was completed by September 30th and most of the activity was between September 1-15. During 3 of the years, there was no seismic surveying activity during the fall migration period. Figures 2a through 10c of Wainwright (2002) depict all known seismic, acoustic, and drilling activity during the period of September 1-October 20 from 1990-1998.

Data on past drilling in both federal and state waters is relatively complete, especially since 1990 and is summarized in Tables V-11 and B1 here and in Wainwright (2002). Data on other activities, such as hunting activity, barge traffic, and shipping noise are incomplete. Thus, while it is clear there have been multiple noise and disturbance sources in the Beaufort Sea over the past 30 years, because of the incompleteness of data, even for the 1990s, for many types of activities, we cannot evaluate the totality of past effects on bowhead whales resulting from multiple noise and disturbance sources (e.g., 2D seismic in state and federal waters, drilling, ice-management, high-resolution acoustic surveys, vessel traffic, construction, geotechnical bore-hole drilling, aircraft surveys, and hunting). Because data are also incomplete for the Chukchi Sea, we reach the same general conclusions.

To facilitate NMFS's evaluation of past activities, we are sending a copy of the report by Wainwright (2002) to your Anchorage field office with this Biological Evaluation.

IV.G.2.k(2) Future Activities. Potential cumulative effects to bowhead whales from oil and gas activities could include behavioral responses to seismic surveys; aircraft and vessel traffic; exploratory drilling; construction activities, including dredging/trenching and pipelaying; and development drilling, production operations, and oil-spill-cleanup operations that take place at varying distances from the whales. It also could include effects from small and large oil spills (if a large oil spill were to occur). In general, bowheads may try to avoid vessels or seismic surveys if closely approached, but they do not respond very much to aircraft flying overhead at 1,000 ft or more. Bowheads try to avoid close approaches by motorized vessels. The response of individual bowheads to sound, such as drillship sounds, is variable (for example, Richardson et al., 1985; Richardson and Malme, 1993). However, some bowheads are likely to change their migration speed and swimming direction to avoid getting close to them. Whales appear less concerned with stationary sources of relatively constant noise than with moving sources. Bowheads do not seem to travel more than a few kilometers in response to a single disturbance, and behavioral changes are temporary, lasting from minutes (for vessels and aircraft) up to 12-24 hours for avoidance (for seismic activity). In some other species, responsiveness is linked to both context and to the sex and/or reproductive status of the animal. For example, in studies in Australia, humpback whale females with calves show greater avoidance of operating seismic boats than do males. Detailed discussions of how these various activities may affect bowheads can be found in the effects section above.

In Appendices II and V, we provide considerable detail on current and reasonably foreseeable oil- and gas-related projects that may affect bowhead whales. We have evaluated the potential effects of future OCS oil and gas activities in our effects of the proposed actions section. Some effects on bowhead whales may occur because of activities from previous and proposed lease sales of State areas offshore or proposed development in state waters. Generally, bowhead whales remain far enough offshore to be mainly in Federal waters, but they move into State waters in some areas, such as the Beaufort Sea southeast and north of Kaktovik and near Point Barrow.

The Liberty Project is a reasonably foreseeable future development project that is now likely to be located onshore and to access OCS leases via extended reach drilling. The Hammerhead prospect was leased in Sale 195. It lies within the bowhead whale's normal fall-migration route. Bowhead whales could be adversely affected by noise and disturbance from vessel traffic, construction, drilling, barge and other boat traffic, icebreaker activity, aircraft flights, related seismic surveys, etc., if development proceeds at Hammerhead field or other reasonably foreseeable future development projects (such as Kuvlum if leased in Sale 202, Sandpiper, or Flaxman Island prospects). In general, development projects that are similar in construction and placement to Endicott are not likely to have strong effects on bowhead whales. Endicott is built on a barrier islands in relatively shallow water. Support traffic travels over the causeway. Although Northstar is not inside the barrier islands, it is at the southern end of the bowhead's typical fall-migration route. We provide discussion of studies of Northstar noise and effects on whales in the effects section above. Operations for both Endicott and Northstar projects are conducted from gravel structures. Much of the production noise from oil and gas operations on gravel islands is substantially attenuated within 4 km and often not detectable at 9.3 km. The Sandpiper and Flaxman Island prospects, also reasonably foreseeable future development projects, are shoreward of the main bowhead whale normal fall-migration route. Endicott, Northstar, and Flaxman Island are all or mostly on State lands. While Flaxman Island is a barrier island, it is closer to the bowhead whale's main fall-migration route and very near a bowhead high use area (see Figure III).

Development of these prospects likely would share infrastructure with the any existing eastern development (for example, Badami or Pt. Thompson if eventually developed). Each development likely would have its own production facility and wells and a pipeline connecting onshore. However, vessel traffic associated with all of these developments is likely to substantially increase marine noise and disturbance in areas used for migrating and feeding by bowhead whales. Installing production platforms and constructing pipelines could disturb bowhead whales on their fall migration, if pipeline construction in deeper water took place during the latter part of the open-water season. If helicopters from Deadhorse pass low overhead, they could cause bowheads to dive. A high level of vessel traffic would cause disturbance and likely avoidance by migrating whales and could potentially increase their physiological stress. Whales would take evasive action to try to avoid close approach by vessels. We summarize reactions to boats and helicopters in the potential effects of the proposed action section.

However, vessel traffic and other oil and gas support sounds can be detected at considerable distance from the islands, depending on ambient sound conditions (e.g., see Blackwell, 2004). If activity at Flaxman Island resulted in avoidance by aggregations of bowheads, there could be adverse effects due to loss of feeding or resting habitat. Sandpiper is near Northstar, and the effects on bowheads from development at that location likely would be similar to those expected from Northstar (reviewed in the effects section) and potentially additive to those effects.

We are hampered in fully understanding potential effects from a future Northstar-like facility in the same area because of the lack of pre-Northstar data. Bowhead whales might be displaced somewhat further offshore during their migration. The overall energetic costs of such minor displacement are likely to also be minor. Available information indicates that potential effects on migration should not be dramatic. The area is not an area where large aggregations of whales have been seen in multiple years. Bowheads might be displaced slightly farther offshore. There may be behavioral effects on the whales in the region including reduced residency time in the area.

Other Federal and State sales in the Beaufort Sea that are scheduled through 2007 (see Table V-3) could lead to more noise and disturbance from exploratory activities. This would include activities within the marine environment associated with the BLM lease sales in the NPR-A.

The Ooogurk, Tuvaaq, and Nikaitchuq proposed developments near the Kuparuk Rivers have potential to contribute to noise and disturbance of bowhead whales, including aggregations of females with calves, especially due to vessel traffic to and from Barrow associated with such developments. The Liberty Project is located inside of the barrier islands, well shoreward of the bowhead's fall-migration route (USDOI, MMS, 2002). Operations for the Liberty Project, if developed, also likely would be conducted from gravel structures, limiting how far noise would travel.

Future State and Federal lease sales that could lead to oil and gas activity that has the potential to adversely affect bowhead whales is listed in Table V-3). We have considered the potential effects from the federal OCS lease sales in the effects section. The BLM reported that marine docking facilities for NPR-A potentially could be located in Peard Bay, Barrow, or Dease Inlet, although initial development projects could be staged out of Prudhoe Bay and materials transported by vehicle in winter or barge in summer (USDOI, BLM and MMS, 2003). This could increase vessel traffic through the Dease Inlet/Smith Bay areas. Areas north of Smith Bay and Dease Inlet are used in some years (e.g., 1997, and see Figure 2) for weeks by large numbers of bowheads, including relatively high percentages of females with calves. Vessel traffic coming from either the west or the east into this area has the potential to disturb whales. The response of female and calf groups to such vessel traffic is unknown. The BLM noted that the vessel trip frequency would depend on the number of concurrent projects and the stage of development (USDOI, BLM, and MMS, 2003). Because numbers of vessel roundtrips from equipment source area to NPR-A staging area (13/summer) are forecast for a project during the construction period, and supply vessels are likely to follow established routes, the actual area disturbed could potentially be limited. The area and, potentially the numbers of individuals affected, would increase if concurrent projects at different locations were to be developed. Vessel traffic occurs during the open-water season and, although numbers of bowheads that could be exposed to such traffic could be substantial in some years but probably not others, the geographic scale of the effect compared to the area used by bowheads even off of Smith Bay and Dease Inlet is likely to be small and concentrated in the nearshore shipping corridor. However, if such activity is coincident with seismic surveys occurring in state and federal waters of the Smith Bay/Dease Inlet area, with exploration drilling, and/or with any construction, the cumulative impacts of these activities could cause bowhead use of the area north of Smith Bay/Dease Inlet to decline. It is not clear how whales that were feeding in the area would respond to noise and disturbance in the area or whether migrating whales would stop to feed if there was a high level of activity within either the inlet or the bay. If whales, particularly females with calves, that would have used the area for feeding or resting, avoid the area because of the noise, and if a comparable feeding areas is not accessible to them without a significant expenditure of energy, then a potentially biologically significant effect could occur. As pointed out at the NOAA International Symposium on Shipping Noise and Marine Mammals, and summarized by Southall (2004:15), changes in behavior such as altering motor behavior and vocalizations, have "…both direct energetic costs and potential effects on foraging, navigation, and reproductive activities." This is clearly true if large numbers of individuals, especially females and calves, avoid or are dispersed from, seasonally available feeding areas or important rest areas.

The construction of an onshore natural gas pipeline across Alaska and future tankering of crude oil from Valdez are projects that would not be likely to have important cumulative effects on bowhead whales. However, if a gas-pipeline route were to offshore it potentially could introduce construction noise and disturbance that adversely impacts bowhead whales. We assume any such pipeline would be relatively nearshore and that gas flow noise would not be discernable by bowheads in deeper water offshore.

Overall, bowhead whales exposed to noise-producing activities associated with offshore oil and gas exploration, development, and production activities would be most likely to experience temporary, nonlethal behavioral effects such as avoidance behavior. Effects could potentially be longer term, if sufficient oil and gas activity were to occur in a localized area. For example, there is some indication that long-term displacement has occurred in some cetaceans, albeit rarely, due to noise and/or disturbance associated with increased vessel traffic effects and noise associated with other (not oil- and gas-associated) sources. For example, shipping and dredging associated with an evaporative saltworks project in Guerrero Negro Lagoon in Baja California (NRC, 2003b) caused gray whales to abandon the lagoon through most of the 1960's. When boat traffic declined, the lagoon was reoccupied first by single whales, and later by cow-calf pairs (Bryant, Lafferty, and Lafferty, 1984). Morton and Symonds (2002) reported that killer whale use of Broughton Archipelago in British Columbia declined significantly when high-amplitude acoustic harassment devices were installed at salmon farms in an attempt to deter seal predation. Almost no whales were observed in the archipelago between 1993 and 1999, when the acoustic harassment devices were in use. Killer whales reoccupied the archipelago within 6 months of the removal of the devices in 1999 (Morton and Symonds, 2002; NRC, 2003b).

The IWCSC (IWC, 2005a:45) received an update on, and discussed, noise pollution (including seismic surveys), the limitations of mitigation measures, and the use of alternative technology at their 2004 annual meeting. The scientific committee stated that: "Detail on the type, number and configuration of airguns is needed to evaluate source capabilities and the potential impact on cetaceans."

The IWCSC will hold a pre-meeting to assess the potential for seismic surveys to impact cetaceans at their 2006 annual meeting (IWC, 2005a).

There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in bowheads. However, over the timeframe of the proposed actions (about 30 years), available information indicates that there is some potential for a level of noise and/or related disturbance to be reached that would potentially have such an effect in local areas. Existing regulatory authority under both the MMPA and the ESA is sufficient to keep such a situation from occurring and to mitigate many of the potential impacts from noise and other disturbance.

Native hunters believe that there is potential for increased noise (for example, from shipping and/or oil and gas development) to drive whales farther from shore, decreasing their availability to subsistence hunters, and potentially reducing mortality from this source. If such an effect occurred, it could produce a countervailing effect to adverse effects on the whale population. As noted in the section on subsistence hunting, cumulative noise and disturbance associated with oil and gas activities, shipping, and subsistence hunting could potentially have an additive or even synergistic effect on bowhead whale habitat use. However, at present, we are aware of no other information that suggests such an effect would be likely to occur or that such effects have occurred.

Effects of a large oil spill in federal or state waters would most likely result in nonlethal temporary or permanent effects. However, we reiterate that due to the limitations of available information and due to the limitations inherent in the study of baleen whales, there is uncertainty about the range of potential effects of a very large spill on bowhead whales, especially if a large aggregation of females with calves were to be contacted by a large or very large spill of fresh oil. The NMFS has concluded that, given the abundance of plankton resources in the Beaufort Sea (Bratton et al., 1993), it is unlikely that the availability of food resources for bowheads would be affected. As summarized in the effects section, individuals exposed to spilled oil may inhale hydrocarbon vapors, experience some damage to skin or sensory organs, ingest spilled oil or oil-contaminated prey, feed less efficiently because of baleen fouling, and lose some prey killed by the spill. Prolonged exposure to freshly spilled oil, or possibly exposure to high concentrations of freshly spilled oil, could kill or injure whales. Because of existing information available for other mammals regarding the toxic effects of fresh crude oil, and because of inconclusive results of studies on cetaceans after the EVOS, we are uncertain about the potential for mortality of more than a few individuals. Such potential probably is greatest if a large aggregation of feeding or milling whales, especially an aggregation containing relatively high numbers of calves, was contacted by a very large slick of fresh oil. Such aggregations occasionally have been observed in open-water conditions north of Smith Bay and Dease Inlet, near Cape Halkett and other areas (see Figure 2).

Available information suggests that the potential for oil-industry activities outside of the Beaufort Sea and Chukchi Sea to contribute to cumulative effects on this stock of bowhead whales is still limited. This remains the case. Industry has not expressed interest in the Norton Basin or Hope Basin Planning Areas. None of the Bering Sea area is currently open for leasing. The MMS is considering whether to include leasing in the North Aleutian Basin Planning Area in the 2007-2012 5-Year Program. This area is currently under Presidential withdrawal from leasing. It is unknown whether an oil spill in this area could adversely affect bowhead whales.

In the Beaufort Sea multiple-sale EIS, we stated that in the Canadian Beaufort Sea, the main area of industry interest has been around the Mackenzie River Delta and offshore of the Tuktoyaktuk Peninsula. This remains the case. Oil was discovered in these areas, although industry showed little interest in the area during the 1990s. Interest in the area increased recently, and an open-water seismic-exploration program was conducted off the Mackenzie River Delta during late summer and autumn of 2001. This was the first major offshore seismic surveying program in that area since the early 1990s. We are not aware of plans for any additional seismic surveys. Some drilling operations may be conducted in the Canadian Beaufort Sea over the next few years. Bowhead whales migrate to and feed offshore of the Mackenzie River Delta region of the Canadian Beaufort Sea. Offshore development and production in this area likely would have greater potential to have adverse impacts on feeding bowhead whales than development elsewhere in the Beaufort Sea.

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

However, data are inadequate to fully evaluate potential impacts on whales during this period, including the duration of habitat use effects or numbers and types of individuals that did not use high-use areas because of the activities. Oil and gas exploration activities, especially during the 1990's and early 2000's have been shaped by various mitigating measures and related requirements for monitoring. Such mitigating measures, with monitoring requirements, were designed to, and probably did, reduce the impact on the whales and on potential impacts on whale availability to subsistence hunters. We assume future activities in Federal OCS waters will have similar levels of protective measures. However, we cannot be certain of what mitigating measures will be imposed in state waters or what the impacts of land-related support activities will be. We also note that the effectiveness of mitigations is not entirely clear, nor is it clear when, or if, the level of activity might become large enough to cause effects that are biologically significant to large numbers of individuals. Looking at each action separately indicates that there should not be a strong adverse effect on this population. Future activity in the OCS has the potential to contribute a substantial increase in noise and disturbance that will occur from oil and gas activities in state waters and on land as well as increase spill risk to this currently healthy population. It is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales. As we consult with NMFS over the next few months, we will continue to explore ways to determine the potential for cumulative impacts on these whales.

IV.H. Fin Whales.

IV.H.1. Past Commercial Hunting. Most stocks of fin whales were depleted by commercial whaling (Reeves, Silber, and Payne, 1998) beginning in the second half of the mid-1800's (Schmitt, de Jong, and Winter, 1980; Reeves and Barto, 1985). In the 1900's, hunting for fin whales continued in all oceans for about 75 years (Reeves et al., 1998) (see information on whaling level in the previous section on current and historic abundance). It is likely that reports of Soviet takes of fin whales in the North Pacific are unreliable (Reeves, Silber, and Payne, 1998), because evidence indicates the Soviets over-reported fin whale catches by about 1,200, presumably to hide takes of species such as right whales and other protected species (Doroshenko, 2000). In 1965, Nemoto and Kasuya (1965) reported that fin and sei whales were the primary species taken in the Gulf of Alaska during Japanese commercial whaling in recent catches. Figure 1 of that report documents that in 1963, more than 150 fin whales were taken just south of the Kenai Peninsula. Other areas of high take in 1963 were southeast Alaska especially and areas offshore between Prince William Sound and Glacier Bay. Multiple smaller groups of fin whales were taken offshore of areas south of Kodiak Island and the Alaska Peninsula to Unimak Pass, and large numbers were taken throughout the northern Gulf in an area bounded on the south at approximately 53° N. latitude. Legal commercial hunting ended in the North Pacific in 1976.

IV.H.2. Other Past, Present, and Foreseeable Human Impacts. Documented human-caused mortality of fin whales in the North Pacific since the cessation of whaling is low. There is no evidence of subsistence take of fin whales in the Northeast Pacific (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002). The NMFS (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002) summarized that "There are no known habitat issues that are of particular concern for this stock" (Angliss, DeMaster, and Lopez, 2001; Angliss and Lodge, 2002). Perry, DeMaster, and Silber (1999a:51) list the following factors possibly influencing the status of fin whales in the North Pacific:

1. Offshore oil and gas development as a "Present or threatened destruction or modification of habitat"
2. and vessel collisions as an "Other natural or man-made factor."

The possible influences of disease or predation and of overutilization are listed as "Unknown."

Documented fishery interaction rates are low in the North Pacific. However, the only information available for many fisheries in the Gulf of Alaska comes from self reporting by individual fishers. Such data likely are biased downwards. Based on the death in 1999 of a fin whale incidental to the Bering Sea/Aleutian Island groundfish fishery, National Marine Fisheries Service estimates three mortalities in 1999 and an average yearly take of 0.6 [coefficent of variation (CV) = 1]) between 1995 and 1999 (Angliss and Lodge, 2002). Based on the fact that there have not been known takes since that time, Angliss and Outlaw (2005:rev. 1/12/06) concluded that the total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0. In the North Atlantic, nine entanglements were recorded in the NMFS Northeast Regional entanglement database between 1975 and 1992 (Blaylock et al., 1995) and three other instances indicating entanglement were recorded between 1992 and 1996 (Waring, et al., 1998). In the North Atlantic, there is concern about the potential impact of overexploitation of certain fish stocks on fin whales (Perry, DeMaster, and Silber, 1999a). Reported instances of fin whale deaths due to vessel strikes are low. One fin whale death due to vessel strike was reported in the North Pacific in 1991 (Perry, DeMaster, and Silber, 1999a), and a fin whale was struck by a vessel in Uyak Bay in 2000. In the North Atlantic, there is documented effect on behavior from whale watching and other recreational boat encounters and from commercial-vessel traffic (for example, Stone et al., 1992) and also evidence of habituation to increased boat traffic (Watkins, 1986).

The MMS (2006) currently is evaluating whether to offer areas for oil and gas leasing in the North Aleutian Basin and other planning areas within the range of the fin whale. The Bering Sea, including portions of the North Aleutian Basin Planning Area, is an area of high use by fin whales for feeding during many months of the year (see affected environment section). If oil and gas leasing and related activities occur, then fin whales could be exposed to the potential impacters referred to in the effects section of the bowhead whale.

The Potential Biological Removal for this stock is low: 11.4 (5,703 x 0.02 x 0.1 (Angliss and Outlaw, 2005:rev. 1/12/06)). Thus, potential cumulative effects warrant concern and monitoring.

IV.I. Humpback Whales.

Commercial whale hunting resulted in the depletion and endangerment of humpback whales. Prior to commercial hunting, humpback whales in the North Pacific may have numbered approximately 15,000 individuals (Rice 1978). More than 28,000 animals from the North Pacific were removed from the North Pacific during the 20th century (Rice 1978). The U.S.S.R. killed 6,793 humpback whales between 1961-1971, primarily in the Gulf of Alaska and Bering Sea (Doroshenko, 2000). Unregulated hunting legally ended in the North Pacific in 1966.

The NMFS (1991a) reports that entrapment and entanglement in active fishing gear (O'Hara, Atkins, Ludicello, 1986) as the most frequently identified source of human-caused injury or mortality to humpback whales. Entrapment and entanglement have been documented in Alaska (for example, von Zeigesar, 1984 cited in von Ziegesar, Miller, and Dahlheim, 1994). From 1984-1989, 21 humpbacks are known to have become entangled in gear in Alaska. Gear types included gill nets, seine nets, long lines or buoy lines, and unidentified gear.

Vessel collision also is of concern for humpbacks. The NMFS (1991a) reported that at least five photographed humpbacks in southeastern Alaska had gashes and dents probably caused by vessel strikes.

The NMFS (1991a) also lists noise and disturbance from whale-watching boats; industrial activities; and ships, boats, and aircraft as causes of concern for humpback whales. The impact of pollution on humpbacks is not known. Habitat degradation also could occur due to coastal development. In Hawaii humpback habitat, harbor and boat-ramp construction, vessel moorings, water sports, increased boat traffic, dumping of raw sewage by boats, runoff and overflow of sewage from land sites, and agriculture and associated runoff are all potential causes of current habitat degradation.

Based on the general category of factors specified as requiring consideration under the ESA, Perry, DeMaster, and Silber (1999b) listed the following factors as possibly impacting the recovery of humpbacks in the North Pacific:

1. vessel traffic and oil and gas exploration as types of "Present or threatened destruction or modification of habitat"(Central Stock);
2. whale watching, scientific research, photography, and associated vessel traffic as types of "Overutilization…" (Central Stock); and
3. entanglement in fishing gear as "Other natural or man-made factors" (Central Stock).

They list the threat of disease or predation as unknown.

During 1990-2000, six commercial fisheries within the range of the both the western and central North Pacific stocks were monitored: Bering Sea/Aleutian Island and Gulf of Alaska groundfish trawl, longline, and pot fisheries. One humpback was killed in the Bering Sea/Aleutian Island groundfish trawl fishery in 1998 and one in 1999. There are no records of humpbacks killed or injured in the fisheries in which fishers self report (Angliss and Lodge, 2002), but the reliability of such data is unknown. One entanglement is recorded in 1997 for a humpback in the Bering Strait (Angliss and Lodge, 2002). However, between 1996 and 2000, five entanglements of humpbacks from the Central North Pacific Stock were reported in Hawaiian waters. Table 27b of Angliss and Lodge (2003:157) gives a total of 34 humpbacks from the Central North Pacific Stock classified as being involved in a human-related stranding or entanglement between 1997 and 2001. The Alaska Scientific Review Group (2001) stated that 32 humpbacks were entangled in southeast Alaska in the past 5 years. Vessel strikes cause significant mortality in humpbacks in the California/Oregon/Washington stock (an average of 0.6 killed per year) (Barlow et al., 1997) and in the western Atlantic (Perry, DeMaster, and Silber, 1999b). Perry, DeMaster, and Silber (1999b) reported that continued development of coasts and oil exploitation and drilling may lead to humpbacks avoidance of areas. In a Newfoundland inlet, two humpbacks with severe mechanical damage to their ears were found dead near a site of continued subbottom blasting (Ketten, Lien, and Todd, 1993; Lien et al., 1993; Ketten, 1995). Perry, DeMaster, and Silber (1999b) summarized that humpbacks respond the most to moving sound sources (for example, fishing vessels, low-flying aircraft). Long-term displacement of humpbacks from Glacier Bay and parts of Hawaii may have occurred due to vessel-noise disturbance (see references in Perry, DeMaster, and Silber, 1999b) (see further discussion in Section IV.B.1.f). Due to concerns about the impacts of helicopters in Hawaiian waters, helicopters are prohibited from approaching within a slant range of 1,000 feet or 305 meters from humpbacks (NMFS, 1987). Noise on their wintering grounds from the ATOC and the Navy's Low-Frequency Active Sonar program also are sources of concern for the central North Pacific stock (Angliss and Lodge, 2002). No subsistence take of humpbacks is reported from Alaska or Russia (Angliss and Lodge, 2002).

Perry, DeMaster and Silber (1999b:35) concluded that, based on available information, "commercial fishing activities may pose a significant threat to the status…" of the stock of humpbacks inhabiting the western North Atlantic. Todd et al. (1996) have suggested that exposure to deleterious levels of sound may be related to rates of entrapment in fishing gear. Rates of entrapment between 1980 and 1992 were shown to vary between a low of 26 per year to a high of 200 (see Todd et al., 1996:Table 1 and references cited therein).

The MMS (2006) currently is evaluating whether to offer areas for oil and gas leasing in the North Aleutian Basin and other planning areas within the range of the humpback whale. The Bering Sea, including portions of the North Aleutian Basin Planning Area, is an area of high use by humpback whales for feeding during many moths of the year (see affected environment section). If oil and gas leasing and related activities occur, then humpback whales could be exposed to the potential impactors referred to in the effects section of the bowhead whale. Studies have documented that humpback whales, especially females with calves, respond to seismic survey noise (see Noise and Disturbance Effects section above). Todd et al. (1996) concluded that exposure of the humpbacks to deleterious levels of sound may have influenced entrapment rates.

The Potential Biological Removal (PBR) for the Western North Pacific stock of humpback whale is estimated as 1.3 animals (367 x 0.035 x 0.1) and that for the Central North Pacific stock as 12.9 (3,698 x 0.035 x 0.1) (Angliss and Outlaw, 2005:rev. 1/12/06). For the Western Pacific stock, NMFS (Angliss and Outlaw, 2005:rev. 1/12/06) noted that the estimated human-related mortality rate is based solely on mortalities that occurred incidental to commercial fisheries and is higher than the PBR level for this stock; therefore, the estimated fishery mortality and serious injury rate exceeds 10% of the PBR (0.1). The rate cannot be considered insignificant and approaching zero." NMFS (Angliss and Outlaw, 2005:rev. 1/12/06) also noted that "Noise pollution from the U. S. Navy's Low Frequency Active Sonar program and other anthropogenic sources (i.e., shipping) is a potential concern..."

Potential cumulative effects on both the North Pacific stock and on the Western North Pacific stock warrant concern and monitoring.

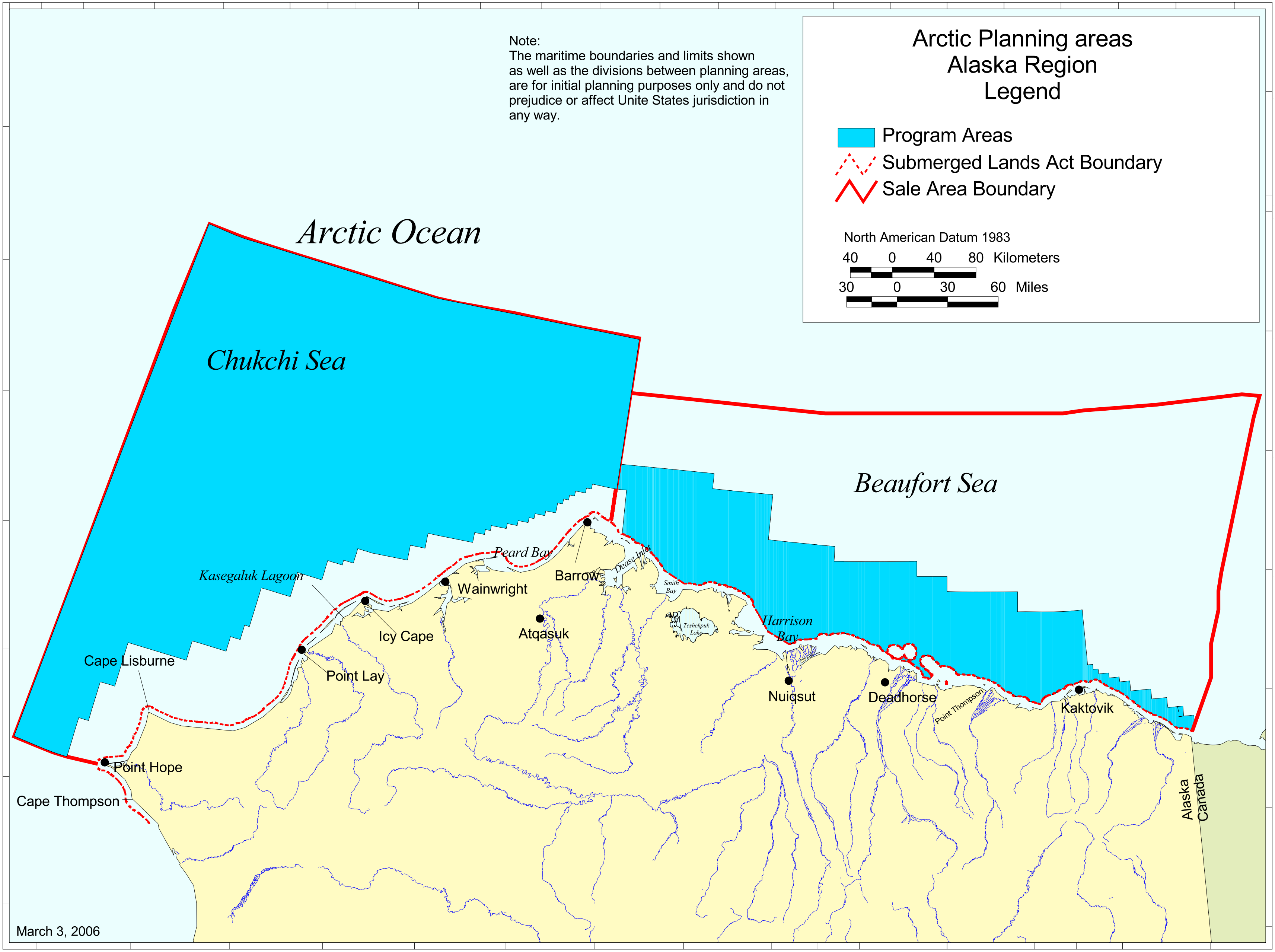

Note:
The maritime boundaries and limits shown as well as the divisions between planning areas, are for initial planning purposes only and do not prejudice or affect Unite States jurisdiction in any way.
Arctic Planning areas
Alaska Region
Legend
Program Areas
Submerged Lands Act Boundary
Sale Area Boundary
North American Datum 1983
40 0 40 80 Kilometers
30 0 30 60 Miles
Arctic Ocean
Chukchi Sea
Beaufort Sea
Peard Bay
Kasegaluk Lagoon
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison Bay
Barrow
Wainwright
Atqasuk
Icy Cape
Point Lay
Cape Lisburne
Point Hope
Cape Thompson
Nuiqsut
Deadhorse
Point Thompson
Kaktovik
Alaska
Canada
March 3, 2006

Figure 1

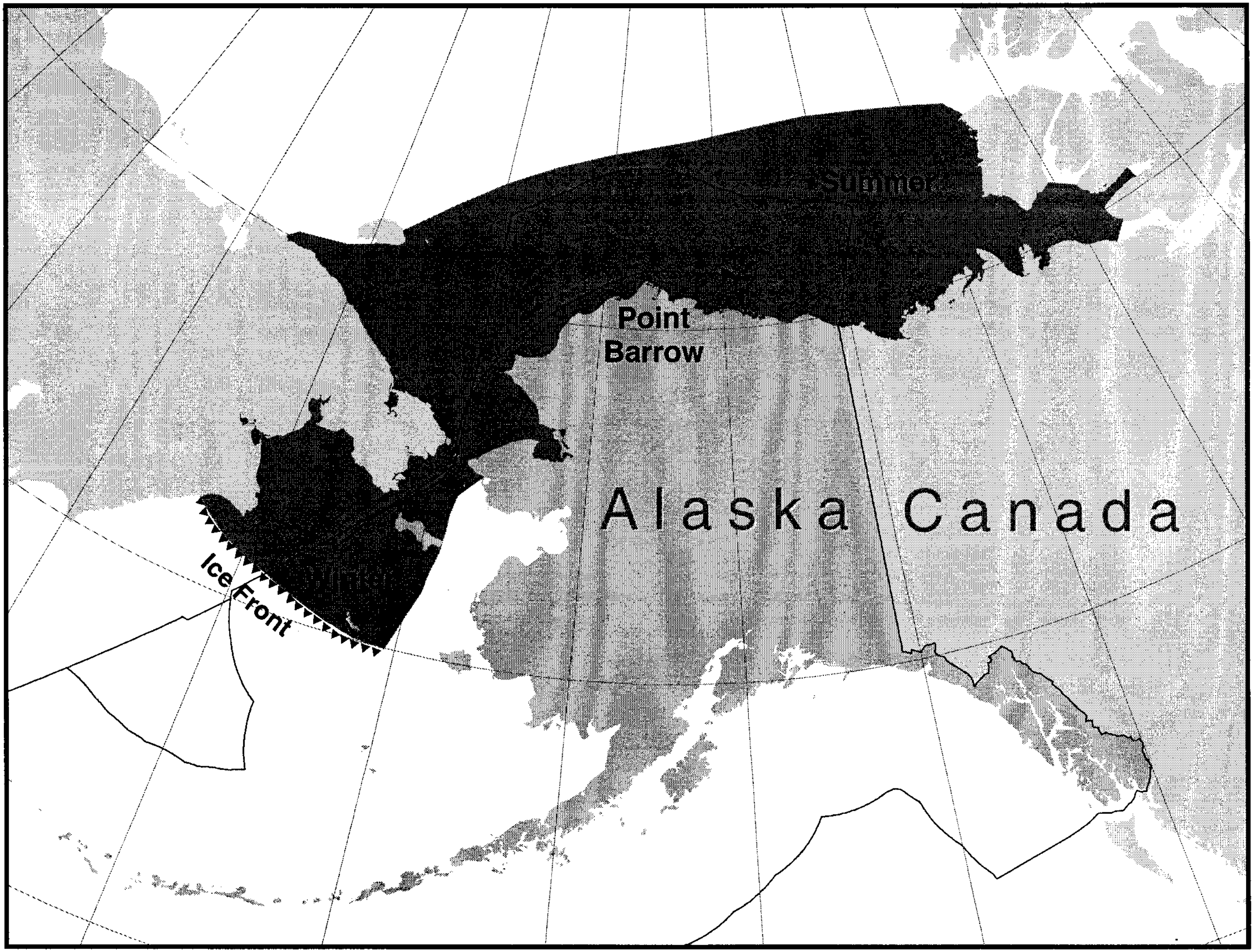
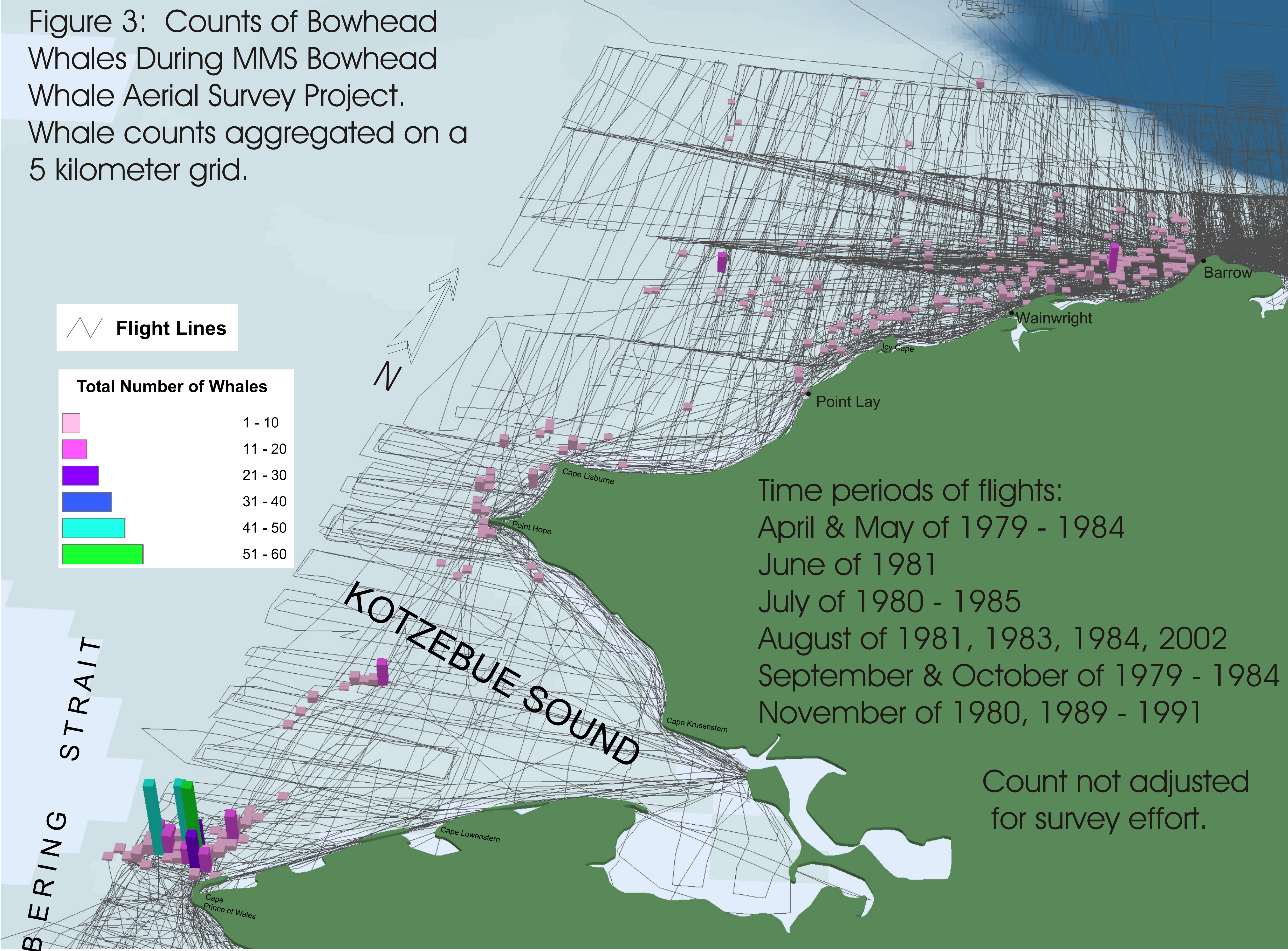


Figure 2. Approximate distribution of the Western Arctic stock bowhead whales (shaded dark area). Winter, summer, and spring/fall distributions are depicted (see text). Reproduced from Figure 43 of Angliss and Outlaw, 2005-rev. 12/23/05.

Figure 3: Counts of Bowhead Whales During MMS Bowhead Whale Aerial Survey Project. Whale counts aggregated on a 5 kilometer grid.



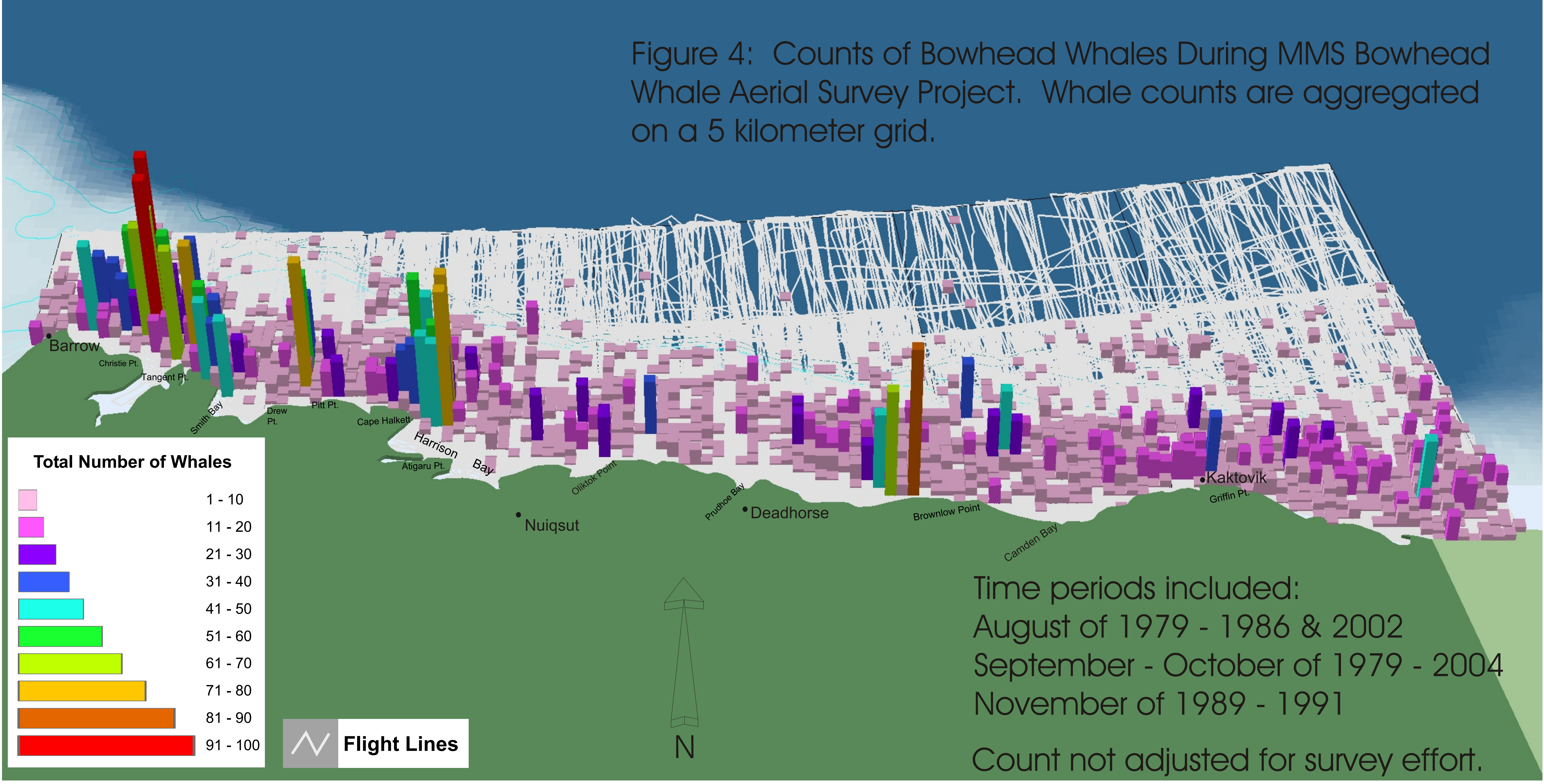


Figure 4: Counts of Bowhead Whales During MMS Bowhead Whale Aerial Survey Project. Whale counts are aggregated on a 5 kilometer grid.

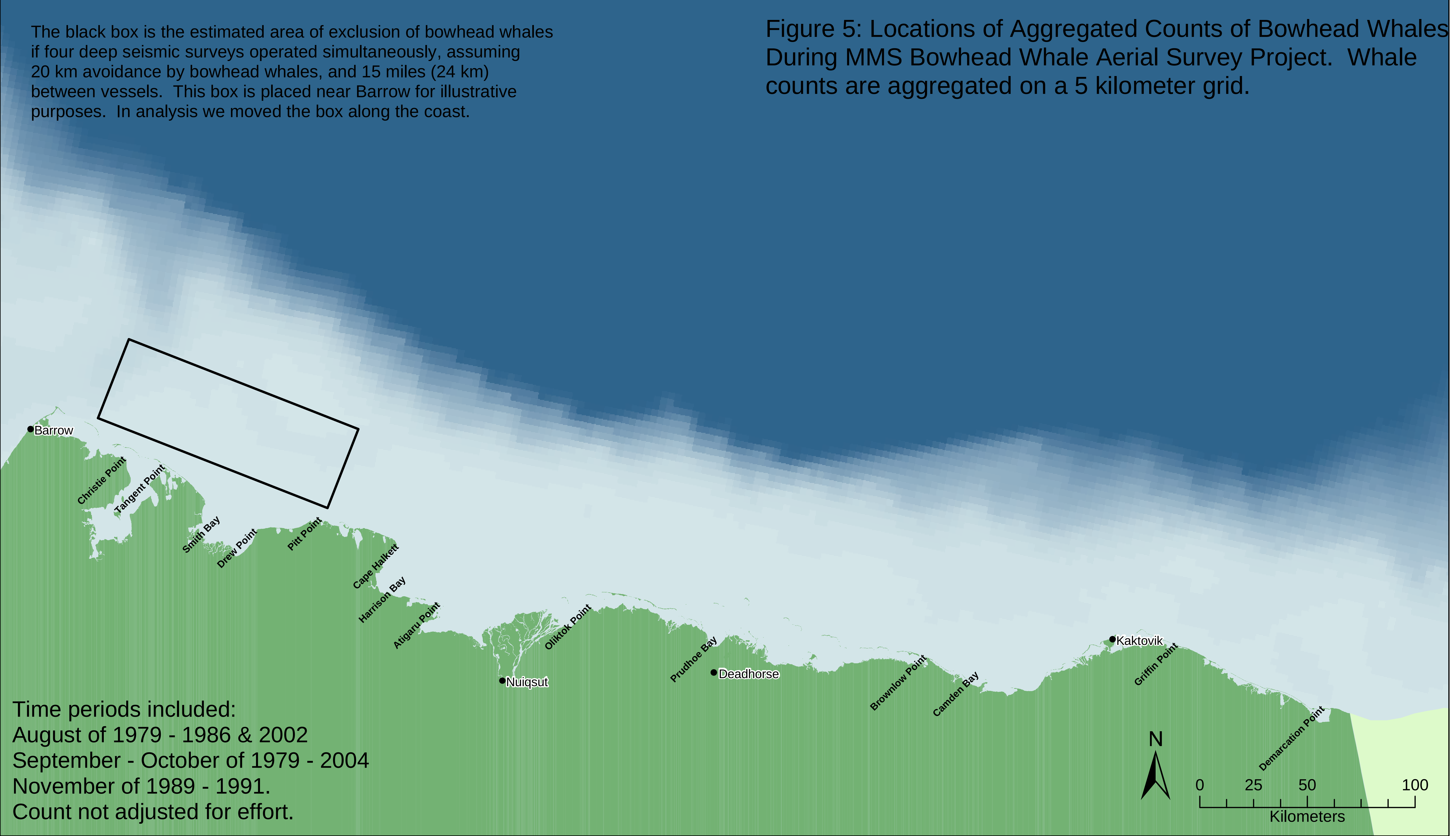


Figure 5: Locations of Aggregated Counts of Bowhead Whales During MMS Bowhead Whale Aerial Survey Project. Whale counts are aggregated on a 5 kilometer grid.

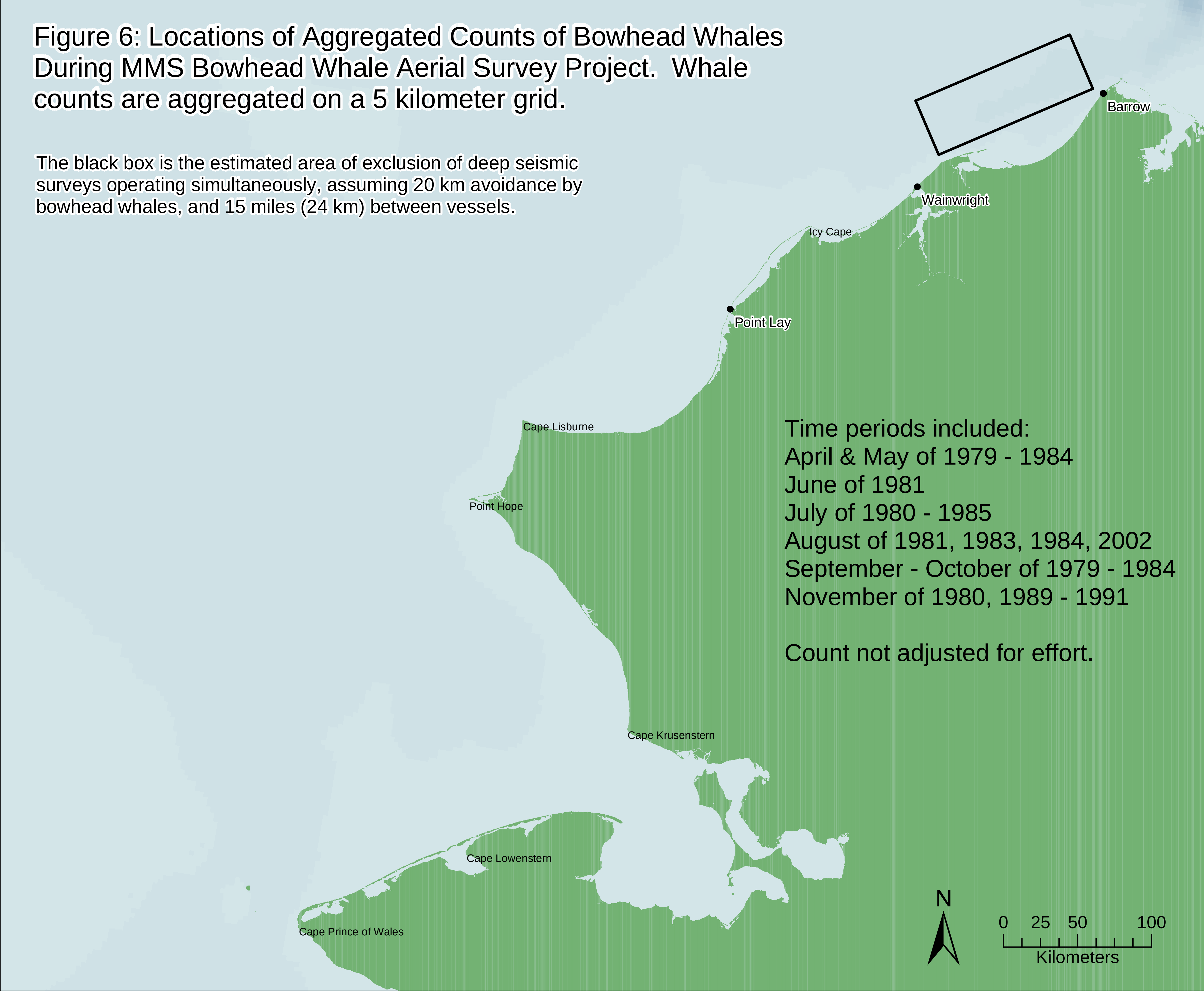


Figure 6: Locations of Aggregated Counts of Bowhead Whales During MMS Bowhead Whale Aerial Survey Project. Whale counts are aggregated on a 5 kilometer grid.

The black box is the estimated area of exclusion of deep seismic surveys operating simultaneously, assuming 20 km avoidance by bowhead whales, and 15 miles (24 km) between vessels.

Time periods included:
April & May of 1979 - 1984
June of 1981
July of 1980 - 1985
August of 1981, 1983, 1984, 2002
September - October of 1979 - 1984
November of 1980, 1989 - 1991

Count not adjusted for effort.

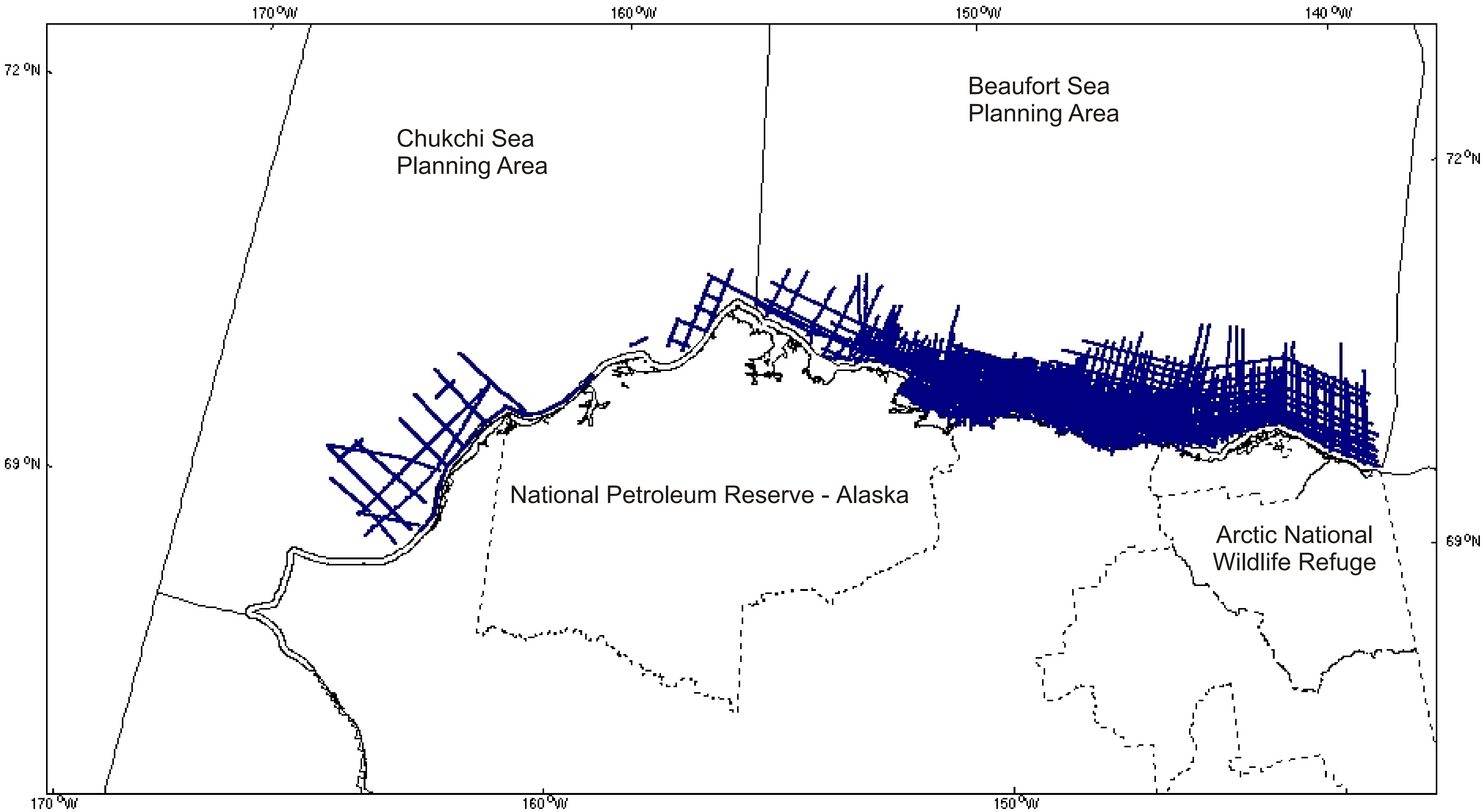


Figure V-A Arctic Outer Continental Shelf 2D Seismic Data Collected from 1970 through 1979

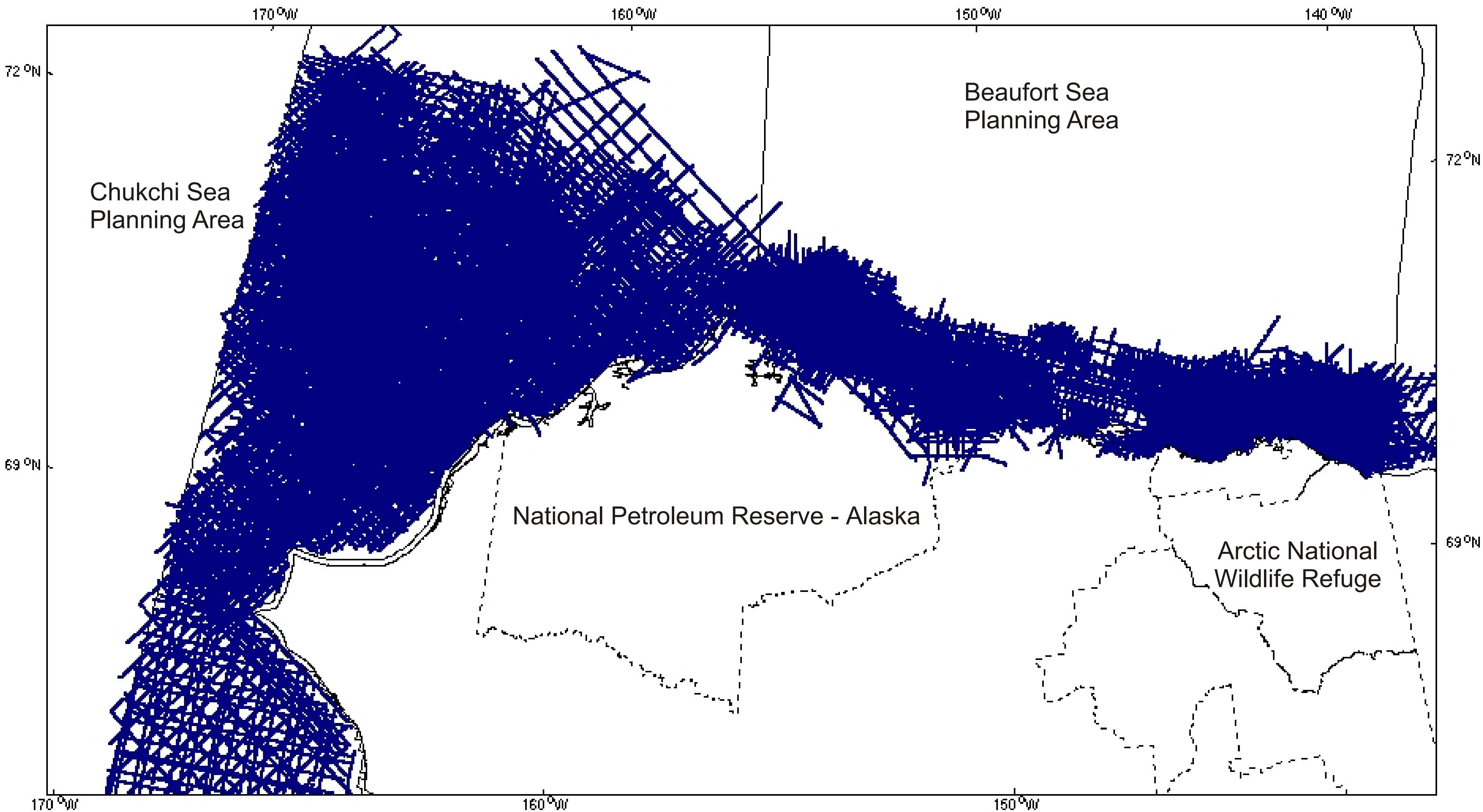


Figure V-B. Arctic Outer Continental Shelf 2D Seismic Data Collected from 1980 through 1989

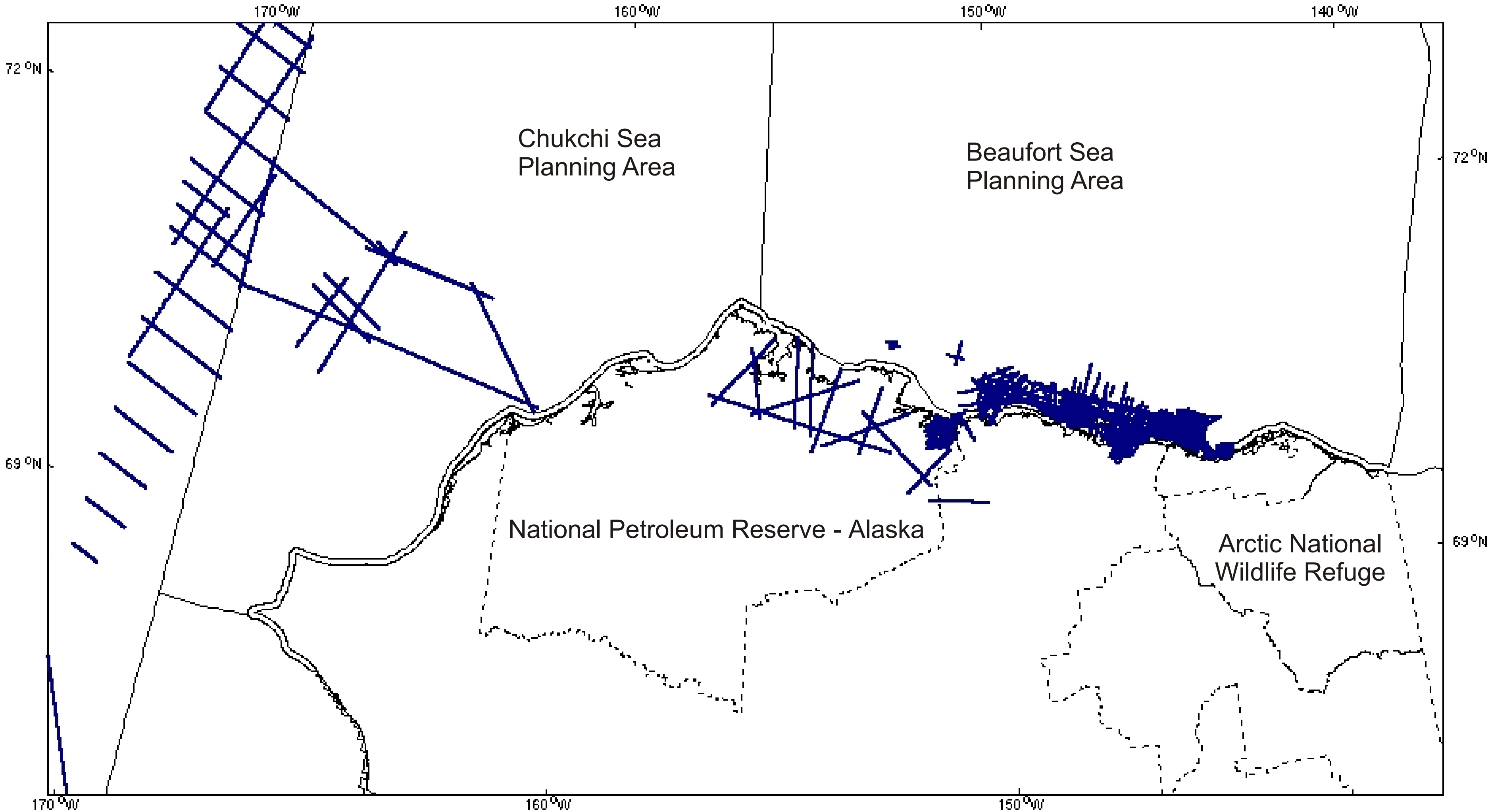


Figure V-C. Arctic Outer Continental Shelf 2D Seismic Data Collected from 1990 through 2004

Table II-1
Proposed Scenario of Oil and Gas Activities in the Beaufort and Chukchi Sea Planning Areas from Actions between 2007 and 2012

Number of Sales	Years of Activity (leasing to full abandonment	Oil (Bbbl)	Gas (Tcf)	Platforms	Exploration and Delineation Wells	Development and Production Wells	Miles of New Offshore Pipelines	Vessel Trips/Week/platform	Helicopter Trips/Day/Platform	New Pipeline Landfalls	New Shore Bases	New Waste Facilities	New Processing Facilities	Docks/Causeways	Exploration Wells	Muds, Cuttings, Produced Water	Development Wells Muds, Cutting, Produced Water
TBD	35 years	0.5-2.0	None	3-10	Up to 30	100-400	Up to 200	1-3*	1-3	1-3	1-2	0.1	0.1	1	425 tons dry mud with 80% recycled	525 tons dry rock cuttings, totaling 610 tons discharged at each well site	All muds, cuttings and produced water treated and disposed of in wells

Notes:

In the Arctic, service vessel trips will only occur during water and broken ice conditions.

Assumptions

1. Oil from the Arctic areas would be transported by new subsea and overland pipelines to the Trans-Alaska Pipeline systems (TAPS). The taps would carry the oil south to the marine terminal in Valdez where it would be loaded on tankers and shipped primarily to West Coast ports.
2. The lifting of the export ban on Alaskan crude oil has led to some shipments to East Asia, but the majority of oil transported from the North Slope will be sent to the U.S. West Coast.
3. In the Arctic, oil development occurs first because TAPS is an established oil transportation system. Associated natural gas recovered with oil production will be reinjected to maximize oil recovery or used for fuel by facilities. The reinjected gas could eventually be recovered when a new gas export system is constructed from the North Slope (2015 at the earliest).
4. Oil from the Cook Inlet Planning Area would be transported from offshore production platforms to shore using new subsea pipelines. Onshore common-carrier pipeline systems would deliver oil and gas to existing local refineries and the transmission pipeline grid. The oil and gas products would be marketed and consumed in Alaska.
5. Natural gas production from the North Aleutian Basin area will be converted to Liquefied Natural Gas 9LNG) and then transported to the US West Coast. A new LNG facility will be constructed on the Alaska Peninsula. Crude oil and natural gas liquids will be separated and then transported by marine vessels to either the Cook Inlet or the Valdez terminal.
6. Coastal barge traffic will occur to support and supply services bases.
7. The range in oil production estimates for the Arctic subregion includes resources from the Beaufort (0.5-1.0 BBO) and the Chukchi (1.0). The minimum is for the low-end Beaufort case (0.5 BBO) and the maximum is for both areas producing (2.0 BBO).
8. Resource estimates for the cumulative cases include: remaining production from offshore fields (State and Federal), plus new production from resources under lease as of 2007, plus resources assumed to be produced as a result of sales held under the 2007-2012 Program. For all areas other than the Beaufort, the cumulative estimates are equal to the proposal estimates because there are no producing reserves or significant resources under Federal leases.
9. The cumulative case for the Arctic subregion does not include production from onshore areas (State or Federal) on the North Slope.
10. New shorebase facilities will be constructed to support development and then expanded to include waste and processing infrastructure for production operation. These facilities will be co-located with pipeline landfalls and other transportation facilities (dock and airstrips)

Table II-2. Exploration and Development Scenario, Chukchi OCS

Scenario Element	Range	Comments
Oil production (Bbbl)	1	First development project only
Natural gas production	0	Delayed for North Slope gas line; reinjected
Exploration wells	3-6	2-5 wells are dry holes or sub-commercial shows
Delineation wells	4-8	Confirm and define the commercial discovery
Production platforms	1	Central platform with processing facility; supports 4-20 subsea satellite templates
Production wells	80-120	Total includes 20-80 subsea production wells
Service wells	20-40	All service wells are on platform
In-field flowlines (mi)	10-50	Gathering system from subsea wells
Offshore sales pipeline (mi)	30-150	Possible distance to landfall
Onshore sales pipeline (mi)	Up to 300	Connecting to existing/future North Slope pipelines
Peak production (kBpd)	200-250	Oil production only. Associated gas is reinjected
New landfall	1	Point Belcher near Wainwright
New support shorebase	1	Point Belcher near Wainwright
New processing facility	1	Co-located with shorebase
New waste facility	1	Co-located with shorebase
Drilling fluid discharge by exploration wells (tons)	665-1,330	475 tons/well with 80% recycled for exploration and delineation wells (95 tons discharged for 7-14 wells)
Rock cutting discharge by exploration wells (tons)	4,200-8,400	600 tons/well (7-14 wells total)
Discharges during development drilling	0	80% of drilling fluids are recycled; remaining waste fluids and rock cuttings for on-platform wells will be disposed of in service wells. Drilling wastes from subsea wells will be barged for disposal at an onshore disposal facility or downhole disposal at the platform.
Years of activity	30-40	Period from lease sale to end of oil production

Table II-3
Representative Development Schedule for Sale 202

Year	Exploration Wells	Delineation Wells	Exploration Drilling Rigs	Production Platforms	Production Wells	Injection Wells	Production Drilling Rigs	Offshore Pipelines (miles)	New Shorebases	Field #1 Oil Production (MMbbl)	Cumulative Oil Production (MMbbl)
2003	—	—	—	—	—	—	—	—	—	—	—
2004	—	—	—	—	—	—	—	—	—	—	—
2005	—	—	—	—	—	—	—	—	—	—	—
2006	—	—	—	—	—	—	—	—	—	—	—
2007	—	—	—	—	—	—	—	—	—	—	—
2008	—	—	—	—	—	—	—	—	—	—	—
2009	—	—	—	—	—	—	—	—	—	—	—
2010	1	—	1	—	—	—	—	—	—	—	—
2011	—	—	—	—	—	—	—	—	—	—	—
2012	1	—	1	—	—	—	—	—	—	—	—
2013	1	1	1	—	—	—	—	—	—	—	—
2014		2	1	—	—	—	—	—	—	—	—
2015	1	2	1	—	—	—	—	—	1	—	—
2016	—	—	—	—	—	—	—	—	—	—	—
2017	1	—	1	—	—	—	—	—	—	—	—
2018	1	—	1	1	4	4	1	35	—	—	—
2019	—	—	—	1	14	8	2	—	—	30.8	30.8
2020	—	—	—	—	20	8	2	—	—	38.6	69.4
2021	—	—	—	—	20	9	2	—	—	38.6	108.0
2022	—	—	—	—	10	5	1	—	—	38.6	146.6
2023	—	—	—	—	—	—	—	—	—	38.6	185.2
2024	—	—	—	—	—	—	—	—	—	38.6	223.8
2025	—	—	—	—	—	—	—	—	—	34.0	257.8
2026	—	—	—	—	—	—	—	—	—	29.9	287.7
2027	—	—	—	—	—	—	—	—	—	26.3	314.0
2028	—	—	—	—	—	—	—	—	—	23.2	337.2
2029	—	—	—	—	—	—	—	—	—	20.4	357.6
2030	—	—	—	—	—	—	—	—	—	17.9	375.5
2031	—	—	—	—	—	—	—	—	—	15.8	391.3
2032	—	—	—	—	—	—	—	—	—	13.9	405.2
2033	—	—	—	—	—	—	—	—	—	12.2	417.4
2034	—	—	—	—	—	—	—	—	—	10.8	428.2
2035	—	—	—	—	—	—	—	—	—	9.5	437.7
2036	—	—	—	—	—	—	—	—	—	8.3	446.0
2037	—	—	—	—	—	—	—	—	—	7.3	453.3
2038	—	—	—	—	—	—	—	—	—	6.7	460.0
2039	—	—	—	—	—	—	—	—	—	—	—
—	**6**	**5**	**—**	**2**	**68**	**34**	**—**	**35**	**1**	**460.0**	**—**

Table II-4. Possible Timetable Chukchi Sea Development

Year	Seismic Surveys	Exploration Wells	Delineation Wells	Exploration Drilling Rigs	Production Platforms	On-Platform Wells	Subsea Wells	Service Wells	Production Drilling Rigs	In-Field Flowlines (miles)	Offshore Pipelines (miles)	New Shorebases	(MMbbl)
2005													
2006	4												
2007	4												
2008	4												
2009	3	1		1									
2010	3	1		1									
2011	2		2	1									
2012	1		2	1									
2013	1		2	1									
2014	1	1		1									
2015	1	1		1								1	
2016	1												
2017											30		
2018											30		
2019							8		2	5	30		
2020					1	6	8	3	3	5			54.0
2021						18	8	5	4	5			70.0
2022						18	8	5	4	5			82.0
2023						18	8	5	4	5			82.0
2024						10	8	6	3	5			82.0
2025						10		4					82.0
2026													72.2
2027													63.5
2028													55.9
2029													49.2
2030													43.3
2031													38.1
2032													33.5
2033													29.5

Table II-4. Possible Timetable Chukchi Sea Development (continued)

Year	Seismic Surveys	Exploration Wells	Delineation Wells	Exploration Drilling Rigs	Production Platforms	On-Platform Wells	Subsea Wells	Service Wells	Production Drilling Rigs	In-Field Flowlines (miles)	Offshore Pipelines (miles)	New Shorebases	Annual Oil Production (MMbbl)
2034													26.0
2035													22.8
2036													20.1
2037													17.7
2038													15.6
2039													13.7
2040													12.1
2041													10.6
2042													9.3
2043													8.2
2044													7.2
2045													
2046													
2047													
	25	4	6	7	1	80	48	28	20	30	90		1000
notes:	(1 mo/yr)			(4 mo/yr)		(30 inj wells)			(rig/years)				

Table V-1
Alaska North Slope Oil and Gas Discoveries as of December 2005

	Name	Location of Field or Pool	Production Oil, Gas	Location of Production Facility	Discovery	Production Began	Category	Ranking Criteria
Past Development And Production								
1	South Barrow	Onshore	Gas	Onshore	1949	1950	Field	—
2	Prudhoe Bay	Onshore	Oil	Onshore	1967	1977	Field	—
3	Lisburne	Onshore	Oil	Onshore	1967	1981	Field	—
4	Kuparuk	Onshore	Oil	Onshore	1969	1981	Field	—
5	East Barrow	Onshore	Gas	Onshore	1974	1981	Field	—
6	Milne Point	Onshore	Oil	Onshore	1969	1985	Field	—
7	Endicott	Offshore	Oil	Offshore	1978	1986	Field	—
8	Sag Delta	Offshore	Oil	Onshore	1976	1989	Field	—
9	Sag Delta North	Offshore	Oil	Offshore	1982	1989	Satellite[1]	—
10	Schrader Bluff	Onshore	Oil	Onshore	1969	1991	Satellite[2]	**When**
11	Walakpa	Onshore	Gas	Onshore	1980	1992	Field	**Production**
12	Point McIntyre	Offshore	Oil	Onshore	1988	1993	Field	**Began**
13	North Prudhoe Bay	Onshore	Oil	Onshore	1970	1993	Field	—
14	Niakuk	Offshore	Oil	Onshore	1985	1994	Field	—
15	Sag River	Onshore	Oil	Onshore	1969	1994	Satellite[3]	—
16	West Beach	Onshore	Oil	Onshore	1976	1994	Field	—
17	Cascade	Onshore	Oil	Onshore	1993	1996	Field	—
18	West Sak	Onshore	Oil	Onshore	1969	1997	Satellite[2]	—
19	Badami	Offshore	Oil	Onshore	1990	1998	Field	—
20	Eider	Offshore	Oil	Offshore	1998	1998	Satellite[1]	—
21	Tarn	Onshore	Oil	Onshore	1991	1998	Field	—
22	Tabasco	Onshore	Oil	Onshore	1992	1998	Satellite[2]	—
23	Midnight Sun	Onshore	Oil	Onshore	1998	1999	Satellite[4]	—
24	Alpine	Onshore	Oil	Onshore	1994	2000	Field	—
25	Northstar	Offshore	Oil	Offshore	1984	2001	Field	—
26	Aurora	Onshore	Oil	Onshore	1999	2001	Satellite[4]	—
27	NW Eileen/Borealis	Onshore	Oil	Onshore	1999	2001	Field	—
28	Polaris	Onshore	Oil	Onshore	1999	2001	Satellite	—
29	Meltwater	Onshore	Oil	Onshore	2000	2001	Pool	—
30	Nanuk	Onshore	Oil	Onshore	—	2001	Pool	—
31	Palm	Onshore	Oil	Onshore	2001	2002	Pool	—
32	CD South	Onshore	Oil	Onshore	1996	2003	Pool	
33	Orion	Onshore	Oil	Onshore	2000	2003	Satellite	
Present Development								
								When
34	CD North (Fjord)	Onshore	Oil	Onshore	1992	(2006)	Pool	**Production**
								Is Estimated
Reasonably Foreseeable Future Development And Production								
35	Oooguruk	Offshore	Oil	Offshore	2003	—	Prospect	—
36	Tuvaaq	Offshore	Oil	Offshore	2005	—	Show	—
37	Spark/Rendezvous	Onshore	Gas & Oil	Onshore	2000	—	Prospect	—
38	Liberty	Offshore	Oil	Offshore	1983	—	Pool	—
39	Kalubik	Offshore	Oil	Onshore	1992	—	Prospect	—
40	Pete's Wicked	Onshore	Oil	Onshore	1997	—	Prospect	—
41	Sikulik	Onshore	Gas	Onshore	1988	—	Pool	—
42	Thetis Island	Offshore	Oil	Offshore	1993	—	Prospect	**When We Estimate**
43	Gwydyr Bay	Offshore	Oil	Onshore	1969	—	Pool	**Chance and**
44	Point Thomson	Onshore	Gas & Oil	Onshore	1977	—	Pools	**Timing of**
45	Mikkelson	Onshore	Oil	Onshore	1978	—	Prospect	**Development**
46	Sourdough	Onshore	Oil	Onshore	1994	—	Pool	**(highest/first to**
47	Yukon Gold	Onshore	Oil	Onshore	1994	—	Prospect	**lowest/last)**
48	Flaxman Island	Offshore	Oil	Offshore	1975	—	Prospect	—
49	Sandpiper	Offshore	Gas & Oil	Offshore	1986	—	Pool	—
50	Stinson	Offshore	Oil	Offshore	1990	—	Prospect	—
51	Hammerhead	Offshore	Oil	Offshore	1985	—	Pool	—
52	Kuvlum	Offshore	Oil	Offshore	1987	—	Prospect	—
53	Nikaitchua	Offshore	Oil	Offshore	2004	—	Prospect	

Table V-1
Alaska North Slope Oil and Gas Discoveries as of December 2005 (continued)

	Name	Location of Field or Pool	Production Oil, Gas	Location of Production Facility	Discovery	Production Began	Category	Ranking Criteria
Speculative Future Development								
54	Hemi Springs	Onshore	Oil	Onshore	1984	—	Prospect	—
55	Ugnu	Onshore	Oil	Onshore	1984	—	Pool	—
56	Umiat	Onshore	Oil	Onshore	1946	—	Pool	—
57	Fish Creek	Onshore	Oil	Onshore	1949	—	Prospect	—
58	Simpson	Onshore	Oil	Onshore	1950	—	Pool	—
59	East Kurupa	Onshore	Gas	Onshore	1976	—	Show	**Insufficient**
60	Meade	Onshore	Gas	Onshore	1950	—	Show	**Information to**
61	Wolf Creek	Onshore	Gas	Onshore	1951	—	Show	**Estimate Chance**
62	Gubik	Onshore	Gas	Onshore	1951	—	Pool	**of Development**
63	Square Lake	Onshore	Gas	Onshore	1952	—	Show	—
64	East Umiat	Onshore	Gas	Onshore	1964	—	Prospect	—
65	Kavik	Onshore	Gas	Onshore	1969	—	Show	—
66	Kemik	Onshore	Gas	Onshore	1972	—	Show	—
67	Altamura	Onshore	Gas/Oil	Onshore	2002	—	Show	—
68	Lookout	Onshore	Oil	Onshore	2002	—	Prospect	—

Notes:
Field information is taken from State of Alaska, Dept. of Natural Resources Annual Report December, 2004 and Petroleum News
Footnotes for Satellites identify the associated production unit:
[1]Duck Island Unit;
[2]Kuparuk River Unit;
[3]Milne Point Unit;
[4]Prudhoe Bay Unit.
Parentheses indicate when production startup is expected.
Definitions: Field—infrastructure (pads/wells/facilities) installed to produce one or more pools.
Satellite—a pool developed from an existing pad.
Pool—petroleum accumulation with defined limits.
Prospect—a discovery tested by several wells.
Show—a one-well discovery with poorly defined limits and production capacity.

Table V-2
Trans-Alaska Pipeline System and Proposed Future Natural Gas Projects

Name	Estimated Pipeline Length (miles)	Project Description and Route
		Active Project
Trans-Alaska Pipeline (TAPS)	800	The TAPS is the key transportation link for all North Slope oil fields. It has been in operation since 1977 and to date, has carried nearly 13 billion barrels of oil. Approximately 16.3 square miles are contained in the pipeline corridor that runs between Prudhoe Bay and Valdez. The Dalton Highway (or Haul Road) was constructed parallel to the pipeline between Prudhoe Bay and Fairbanks. The pipeline design capacity is 2 million barrels per day, and it reached near peak capacity in 1988. The TAPS 2005 year to date average barrels of oil pumped through pump station 1 was just under 900,000 barrels. The lower operational limit generally is thought to be between 200,000 and 400,000 barrels per day. If oil production from northern Alaska cannot be sustained above this minimum rate, the TAPS will become non-operational, and all oil production is likely to be shut in. Alyeska Pipeline Service Company is planning pipeline reconfiguration efforts between 2005 and 2011 to extend the economic life of the TAPS and North Slope oil fields.
		Future Natural Gas Projects
All-Alaska Gas Pipeline	800	The "All Alaska Gas Pipeline" is similar to the old "Trans-Alaska Gas System" project. The route would originate in the Prudhoe Bay Unit and run parallel to the Trans-Alaska oil pipeline to Valdez, then jog to the east to Anderson Bay to an LNG plant. There are "variations" on this project depending on whether it is standalone or is connected, at Delta Junction, to a transportation pipeline coming from Prudhoe Bay that goes into Canada.
Alaska Natural Gas Transportation System (ANGTS)[1]	2,102	The ANGTS plan is a pipeline system connecting Alaska North Slope gas production through Canada to the lower 48. The new pipeline would run parallel to the TAPS from the North Slope to interior Alaska and then cross the Yukon Territory to connect to existing pipelines in Alberta. The primary market would be consumers in the U.S. Numerous permits, rights-of-way, and approvals have been obtained for the proposed pipeline route through Alaska and Canada. Downward revisions to construction costs and the recent increase in gas prices into the $3-$4-million/cubic-foot range make this project more appealing today. Currently, several variations to routes are being considered for the overland gas-pipeline system.
Natural Gas to Liquids Conversion[2]	Will use existing TAPS pipeline	Atlantic Richfield Co. (ARCO) and Syntroleum Corp constructed a pilot-scale, natural gas to liquids (GTL) conversion facility in Puget Sound, Washington. More recently, BP-Amoco has begun design work on a GTL pilot project on the Kenai Peninsula in Alaska. As a result of the BP-Amoco-ARCO merger, BP-Amoco now holds an equal interest in the gas reserves in the Prudhoe Bay field. All of the major North Slope gas owners (BP-Amoco, Exxon-Mobil, and Phillips-Alaska) are studying the feasibility of various gas-commercialization projects. GTL is an attractive option because it will use the existing TAPS pipeline (extending its life and lowering future tariffs) and produce clean-burning fuels to meet more stringent Environmental Protection Agency emission standards for vehicles. At the present time, the overall cost of a full-scale gas to liquids project is comparable to a similar sized LNG project. As an emerging technology, new cost-reduction breakthroughs are expected for gas to liquids processing, improving the economic potential for future gas to liquid projects.

Notes:
[1] Thomas et al. (1996).
[2] Alaska Report (1997).

Table V-3
Future Lease Sales

Sale	Proposed Sale Date(s)	Area/Description	Resources or *Hydrocarbon Potential*
Federal			
2002-2007 5-Year Program – Beaufort Sea OCS Sale 202	May 2007	As much as 9.9 million acres from the Canadian border on the east to Barrow on the west in the Beaufort Sea (*Federal Register,* 2001c).	340-557 mmbbl Oil (Estimated)
2007-2012 5-Year Program – Beaufort Sea OCS Sales 208 and 216	2009 and 2011, respectively	As much as 33.29 million acres from the Canadian border on the east to Barrow on the west	0.5-1.0 BBO
2007-2012 5-Year Program – Chukchi Sea OCS Sales 193, 212, and 221	November 2007, 2010, and 2012, respectively	As much as 46.75 million acres from Barrow on the east to Point Hope on the south	1.0 BBO
Northeast NPR-A	September 2006	As much as 3 million acres of the Northeast NPR-A Planning Area (USDOI, BLM, 2001).	0.50-2.2 Bbbl Oil (Estimated)
Northwest NPR-A	To Be Determined	As much as 9.98 million acres of the Northwest NPR-A Planning Area (*Federal Register*, 2001d).	To Be Determined
State Of Alaska			
North Slope Areawide	To be determined (Areawide 2006 sale has been delayed)	As much as 5,100,000 acres of State-owned lands between the Canning and Colville rivers and north of the Umiat Baseline (about 69° 20' N.).	*Moderate to High*
Beaufort Sea Areawide	To be determined (Areawide 2006 sale has been delayed)	Unleased State-owned tide- and submerged lands between the Canadian border and Point Barrow and some coastal uplands acreage located along the Beaufort Sea between the Staines and Colville rivers. The gross proposed sale area is in excess of 2,000,000 acres. The State of Alaska was scheduled to hold its first areawide sale in the Beaufort Sea on October 13, 1999. This sale was delayed pending the outcome of the British Petroleum-Amoco and ARCO merger and related uncertainties in future lease holdings.	*Moderate to High*
North Slope Foothills Areawide	May 2006	State-owned lands lying between the National Petroleum Reserve-Alaska and the Arctic National Wildlife Refuge south of the Umiat Baseline and north of the Gates of the Arctic National Park and Preserve. The gross proposed sale area is in excess of 7,000,000 acres.	*Moderate*

Note:
Bbbl = billion barrels.
Source:
USDOI, MMS, Alaska OCS Region (2001).

Table V-4
Undiscovered, Conventionally Recoverable Oil and Gas Resources

Area	Oil (billions of barrels)	Gas (trillions of cubic feet)	Study/Source
Beaufort Shelf	8.2	27.6	USDOI, MMS (2006)[1]
Chukchi Shelf	15.4	76.8	USDOI, MMS (2006)[1]
NPR-A	10.6	61.4	U.S. Geological Survey (2002)
North Slope-State lands	4.0	33.3	U.S. Geological Survey (2005)
Arctic National Wildlife Refuge	10.4	7.4	U.S. Geological Survey (1998)[5]
Total onshore resources	*25.0*	*102.1*	
Total offshore resources	*23.6*	*104.4*	

Notes:
These petroleum resource estimates are mean undiscovered volumes that are recoverable by conventional technology without consideration for economic profitability. Economically recoverable oil and gas resources are likely to be only a small fraction of the total petroleum endowment, as many pools are too small or too remote to be developed profitably under foreseeable conditions. It is not possible to accurately predict the timing of discoveries or rate of future production because it is largely dependent on industry strategies and funding. Exploration in Arctic Alaska is in its early stage and the possibility of discovering giant oil and fields will continue to draw industry to the region, particularly if current high oil and gas prices persist. As an indicator of future activities, we can compare the level of estimated production in the High cumulative case relative to the onshore and offshore endowments shown above. Although the undiscovered petroleum potential is nearly the same in onshore and offshore areas, the anticipated onshore production is approximately five-times higher (16.1 Bbbl onshore compared to 3.3 Bbbl offshore). Higher levels of petroleum activity in onshore areas are promoted by relatively lower costs, more favorable logistics, proximity to existing infrastructure, and the production of remaining reserves (approximately 7 Bbbl).

Table V-5
Past Development: 2003 Production and Reserve Data

				Produced				Reserves[2]	
Unit or *Area*	**Field**	**Type (Oil or Gas)**	**Discovery**	**Began**	**Gas (Bcf)**	**2003 Oil (MMbbl)[1]**	**Production to**	**Oil (MMbbl)[1]**	**Gas (Bcf)**
Duck Island	Endicott	O	1973	1987	–	419.868	Endicott	"	"
—	Sag Delta North[2]	O	1989	1989	–	7.213	Endicott	"	"
—	Sag Delta[2]	O	1976	1989	–	-	Endicott	"	"
—	Eider	O	1998	1998	–	2.572	Endicott	"	"
—	Ivishak	O	–	–	–	.706	Endicott	"l	"
	Duck Island Unit							132	843
Prudhoe Bay	Prudhoe Bay	O	1967	1977	–	10,429.605	Prudhoe	"	"
—	Lisburne	O	1968	1981	–	136.409	Lisburne	"	"
—	Niakuk	O	1985	1994	–	76.529	Lisburne	"	"
—	West Beach	O	1976	1994	–	3.416	Lisburne	"	"
—	N. Prudhoe Bay	O	1970	1993	–	1.984	Lisburne	"	"
—	Point McIntyre	O	1988	1993	–	362.784	Lisburne	"	"
	Prudhoe Bay IPA's	O	–	–	–	–		2,851	23,000
—	Midnight Sun	O	1998	1999	–	7.661	Prudhoe	"	–
—	Aurora	O	1999	2001	–	4.396	Prudhoe	"	–
—	NW Eileen/Borealis	O	1999	2001	–	9.784	Prudhoe	"	–
—	Polaris	O	1999	2001	–	1.626	Prudhoe	"	-
	Orion	O	1968	2003	–	0.097	Prudhoe	"	
—	P. Bay Satellites	O	–	–	–	–	Prudhoe	475	–
Kuparuk River	Kuparuk River	O	1969	1981	–	1,918.004	Kuparuk	960	1,000
—	Tabasco	O	1992	1998	–	8.262	Kuparuk	15	–
—	Tarn	O	1992	1998	–	54.248	Kuparuk	72	50
—	West Sak	O	1969	1998	–	11.356	Kuparuk	530	100
	Meltwater	O	—	2001	–	5.176	Kuparuk	39	–
	Palm	O	—	2002		–	Kuparuk	35	–
Milne Point	Milne Point	O	1969	1985	–	169.294	Milne Point	260	–
—	Cascade[4]	O	1993	1996	–	–	Milne Point	–[4]	–
—	Schrader Bluff	O	1969	1991	–	30.434	Milne Point	99	–
—	Sag River	O	1968	1994	–	0.101	Milne Point	7	–
	Milne Point Unit							481	14
Badami	Badami	O&G	1990	1998	–	4.347	TAPS	8	–
Colville River	Alpine	O	1994	2000	–	101.542	Kuparuk	564	400
	Nanuq	O	—	2001	--	0.019	Kuparuk	40	–
Northstar	Northstar	O	1984	2001	-	42.136	TAPS	154	450
NPR-A[1]	East Barrow	G	1974	1981	0.085	–	Barrow	–	5
—	South Barrow	G	1949	1950	0.421	–	Barrow	–	4
—	Walakpa	G	1980	1993	1.341	–	Barrow	–	25
All Units or Areas Total		—	—	—	—	—	—	**5,284**	**33**

Notes:

[1] Production information is from State of Alaska, Oil and Gas Conservation Commission (2004)

[2] Reserves were estimated by subtracting 2000 production from State of Alaska, Oil and Gas Conservation Commission (2001) from the Reserve Data in State of Alaska, Dept. of Natural Resources (2001,2002). Reserve estimates for Aurora, Borealis, Meltwater, and Polaris are from *PI/Dwight's Drilling Wire* (2001a, 2002, 2001b, and 2001c), respectively.

[3]Endicott includes Endicott, Sag Delta and Sag Delta North.

[4] Cascade is included in Milne Point.

Table V-6
Past Development: Infrastructure and Facilities

UNIT OR *AREA* Field	Gravel Roads, Pads, & Airstrips (acres)	Pipelines: Gathering, Comm. Carr., Unspecified (miles) G	C	U	Gravel Num.	Mines Acres	Wells[5]	Pads	Reserve Num.	Pits Acres	Prod Centers	Camps Base and Const.	Facilities Plants: Power Topping Gas Seawater	Docks and Cause-ways	Airports and Airstrips	Roads (miles)	River Crossings
Duck Island																	
Endicott	392[2]	3	26	–	1[2]	179[2]	129	2[1]	0[2]	0[2]	0	0[1]	3[1]	2[1]	0[1]	15[1]	1[1]
Prudhoe Bay																	
Prudhoe Bay	4,590[2]			145	6[2]	726[2]	1,764	38	106[2]	560[2]	6[1]	4[1]	4[1]	2[1]	2[1]	200[1]	3[1]
Lisburne	213[2]	50	–	–	0[2]	0[2]	80	5[1]	10[2]	16[2]	1[1]	1[1]	1[1]	0[1]	0[1]	18[1]	–
Niakuk	22[2]	5		–	0[2]	0[2]	19		0[2]	0[2]	–	–	–	–	–	–	–
West Beach	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
N. Prudhoe Bay	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Pt. McIntyre	33[2]	12	–	–	0[2]	0[2]	84	–	0[2]	0[2]	–	–	–	–	–	–	–
Aurora	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
Eileen/Orion	0	5			0	0	60	1	0	0	0	0	0	0	0	0	0
Kuparuk River																	
Kuparuk River	1,435[2]	97	37		5[2]	564[2]	996	34[1]	126[2]	161[2]	3[1]	2[1]	4[1]	1[1]	1[1]	94[1]	5
West Sak	–	–	–	–	0	0	17		0	0	0	0	0	0	0	–	0
Milne Point																	
Milne Point	205[2]	30	10		1[2]	43[2]	182	4[1]	20[2]	19[2]	1[1]	0[1]	2[1]	0[1]	0[1]	19[1]	1[1]
Cascade	31[2]	–	–	–	0[2]	0[2]	–	–	0[2]	0[2]	–	–	–	–	–	–	–
Schrader Bluff	–	–	–	–	–	–	52	–	–	–	–	–	–	–	–	–	–
Sag River	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–
Badami	85[2]	–	26	35	1[2]	89[2]	10	2	0[2]	0[2]	1	1	0	1	1	4.5	5
Alpine	97	–	–	34	0	0	150	2	0	0	1	2	–	0	1	3	5
West Of Kuparuk																	
Tarn[3]	72.8	–	–	10	0-1[4]	–	16	2	0	0	0	0	0	0	0	10	2
Northstar	18	26	26	0	0	0	23	1	0	0	1	1	0	0	0	0	0
Totals	**7,126**	**197**	**99**	**224**	**14-15**	**1,601**	**3,537**	**89**	**262**	**756**	**13**	**110**	**14**	**6**	**5**	**364**	**22**
NPR-A																	
East Barrow	–	–	–	–	–	–	**4**	–	–	–	–	–	–	–	–	–	–
South Barrow	–	–	–	–	–	–	**19**	–	–	–	–	–	–	–	–	–	–
Walakpa	–	–	–	–	–	–	**9**	–	–	–	–	–	–	–	–	–	–

Notes:
[1] EG&G Idaho, Inc. (1991).
[2] BPXA (1996).
[3] U.S. Army Corps of Engineers, Public Notice of Application for Permit Reference Number 4-970705.
[4] The gravel would come from Mine Site F and should be sufficient. However, a future aliquot to the north has already been permitted for expansion necessary, this aliquot may need to be opened to support the project.
[5] Alaska Oil and Gas Conservation Commission 1998 Annual Report.

Table V-7
Present Development: Estimated Reserve Data

Unit or Area	Field	Type (Oil, Gas)	Discovery	Status	Oil Reserves (MMbbl)
Colville River	CD North (Fjord)	Oil	1992	Present Development	50
Total for All Units or Areas			–	–	88

Table V-8
Present Development: Proposed Infrastructure and Facilities

	Gravel Roads, Pads, & Airstrips (acres)								Facilities						
			Gravel Mines				Reserve Pits								
Unit or Area/Field		Pipelines (miles)	Num.	Acres	Wells	Pads	Num.	Acres	Prod. Centers	Camps Base and Const.	Plants: Power Topping Gas Seawater	Docks and Cause-ways	Airports and Airstrips	Roads (miles)	River Crossings
Colville River/Fiord CD North	40	7	1	45	40	1	0	0	0	0	0	0	1	0	0

Note:
Fiord (*Petroleum News Bulletin*, 2001a), Nanuq (*Petroleum News Bulletin*, 2001b), and Palm wells estimated using a 2-million-barrel recovery typical of Kuparuk reservoir satellites.

Table V-9a
Reasonably Foreseeable Future Development: Estimated Resources for Purposes of Analysis

Area/Group	Pool	Type (Oil and Gas)	Discovery	Facility Location	Oil Resource (MMbbl)
NPR-A	Spark/Rendezvous	Gas and Oil	2000	Onshore	To Be Determined
	Altamura	O	2002	Onshore	
	Lookout	Gas and Oil	2002	Onshore	
Western Group	Kalubik	O	1992	Offshore	—
—	Thetis Island	O	1993	Offshore	250
	Nikaitchua	O	2004	Offshore	
	Oooguruk	O	2003	Offshore	
	Tuvaaq	O	2005	Offshore	
Central Group (Northstar)	Gwyder Bay	O	1969	Offshore	—
—	Pete's Wicked	O	1997	Onshore	—
—	Sandpiper	Gas and Oil	1986	Offshore	200
Eastern Group (Badami)	Mikkelson	O	1978	Onshore	—
—	Sourdough	O	1994	Onshore	—
—	Liberty	O	1983	Onshore	120
—	Yukon Gold	—	1994	Onshore	—
—	Point Thompson	Gas and Oil	1977	Onshore	—
—	Flaxman Island	O	1975	Offshore	—
—	Stinson	O	1990	Offshore	—
—	Hammerhead	O	1985	Offshore	—
—	Kuvlum	O	1987	Offshore	1,000
—	Sikulik	G	1988	Onshore	—
—					—
Total	—	—	—	—	1,570

Source: USDOI, MMS, Alaska OCS Region.

Notes:
Resource estimates are assumed for purposes of cumulative-effects analysis only. Accurate oil volumes for individual fields generally are unavailable, as these discoveries have not been adequately delineated or studied for their development potential. Most of these discoveries presently are noncommercial and will require new technology or higher oil prices to be economic. It is possible that many of these pools will remain undeveloped. Future development likely would occur in conjunction with the infrastructure for the fields shown in parentheses.

Resource estimates for Hemi Springs and Ugnu are not included in the above table, but they are included in the 2.0 billion barrels expected to be produced from satellites, pools, and enhanced recovery in existing fields. Gas resources are not listed because commercial production from the North Slope will require a new gas-transportation system to reach outside markets.

The oil volume including the Point Thompson pool is largely condensate recovered with associated gas-production wells. We assume that produced gas will be used for field operations (fuel) or be reinjected into reservoirs in nearby oil fields to optimize oil production. Reinjected gas could be recovered at some later date, when a transportation system for North Slope gas is constructed.

Table V-9b
Reasonably Foreseeable Future Development: Estimated New Infrastructure for Purposes of Analysis

Area/Group	Pads	Footprint (Acres)	Wells	Production Facilities	Base Camps	Docks	Airstrips	Roads	Pipeline (Miles)
NPR-A									
Western	4	120	131	1	1	1	0	0	38
Central	3	60	87	0	0	0	0	0	22
Eastern	10	316	343	6	4	2	3	12	131
Southern	1	25	20	0	0	0	0	12	12

Source: USDOI, MMS, Alaska OCS Region.

Notes:
Development Assumptions: (1) Industry will minimize permanent (gravel) roads by using ice roads; (2) new pipelines from satellite fields will tie into pipelines from main fields (Alpine, Northstar, Badami, Kuparuk River); (3) number of pads and wells are estimated from resource volumes; (4) production pad footprints are estimated from pad number, connecting roads, landfall/docks, and airstrips. Hemi Springs and Ugnu are considered to be examples of satellites and enhanced oil recovery, respectively, and will be developed using existing infrastructure of the Prudhoe Bay and Kuparuk River fields.

Table V-10a
Summary of Reserve and Resource Estimates for the Cumulative Analysis

Production Activity	Oil (billions of barrels)	Contribution of by Volume of OCS Oil (%)	Gas (trillions of cubic feet)	Contribution of by Volume of OCS Gas (%)
Low End of the Range (Past and Present)	7.3	4.1	0	0
Middle Portion (Past, Present, and Reasonably Foreseeable)	13.0	17.7	32.0	0
High End (Past, Present, Reasonably Foreseeable, and Speculative)	20.7	17.0	45.3	9.5

Source:

Table V-10b
Detailed Reserve and Resource Estimates for the Cumulative Analysis

Activity	Oil (billions of barrels)	Gas (trillions of cubic feet)	Reference Table
Production of remaining reserves	**7.3**		
Onshore–past (Prudhoe Bay and surrounding fields on State lands)	7.0		
Offshore–past (Duck Island Unit and Northstar)	0.3		
		—	
Reasonably Foreseeable Future Production (resources total)	**5.7**	**32.0**	
Onshore discovered gas		32.0	—
Onshore satellites, heavy oil, and reserve growth	2.0	—	—
Onshore undiscovered (NPRA)	1.7	—	—
Offshore discovered (Beaufort)	0.5	—	—
Undiscovered Offshore (Beaufort and Chukchi)	1.5		—
Speculative Production (resources total)	**7.7**	**13.3**	—
Onshore	5.7	9.0	—
Offshore	2.0	4.3	

Notes:

1. Reserves are proven and economically recoverable oil or gas produced through existing infrastructure.
2. Resources are unproven (undiscovered) oil and gas that could be produced with new infrastructure.
3. Reasonably foreseeable gas production includes gas from stranded reserves in Prudhoe Bay area fields. We subtract the gas consumed for field use (300 Bcf per year) from reserves (35 Tcf) until the expected startup of a North Slope gas pipeline in 2015.
4. Speculative production is entirely from undiscovered oil and gas resources with development delayed several decades in the future. Onshore gas resources are from NPRA as associated and non-associated pools. Offshore gas resources are from associated gas reinjected during oil production. Offshore gas would then be recovered through existing oil field infrastructure. Associated gas estimates assume a GOR of 1000 cf/bbl.

Table V-11
Oil and Gas Production 1969 to December 2003 on the North Slope of Alaska

Production To Date	Oil (billions of barrels)	Gas (trillions of cubic feet)	Reference
Onshore	13.9	-	State of Alaska, Div of Oil and Gas (2004)
Offshore	0.5	-	
Total	**14.4**	**51.8**	

Notes:

1. Oil production includes both crude oil and natural gas liquids that are blended into the stream carried by TAPS.
2. Large volumes of associated natural gas has been recovered with oil production, however 90% of it has been reinjected to increase oil recovery. In 2003, North Slope gas production was 3.3 Tcf (average 9.1 Bcf per day) and a total of 297 Bcf was consumed as fuel for facilities. Small amounts of natural gas have been produced fields in the Barrow area since the mid-1940's largely to supply energy for the village of Barrow.

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APPENDIX I

ESA SECTION 7 CONSULTATION DOCUMENTS TO DATE

KD Chukchi

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

AUG 12 2005

James W. Balsiger, Ph.D.
Regional Administrator, Alaska Region
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Dear Dr. Balsiger:

The Minerals Management Service (MMS) proposes to reinitiate consultation under Section 7 of the Endangered Species Act (ESA) on oil and gas leasing and exploration activities on two Outer Continental Shelf (OCS) Planning Areas in the arctic. Specifically, we propose to reinitiate following the Arctic Regional Biological Opinion (ARBO) approach used in the past, so that the geographic area considered in the consultation is expanded to again include potential activities that could occur within the entire Beaufort Sea Planning Area and within the Chukchi Sea OCS Program Area, as delineated in the Attachment which is reproduced from the Final EIS for our current 5-Year OCS Leasing Program. Note that the current 5-Year Leasing Program excludes the nearshore Polynya area from leasing consideration in the Chukchi Sea. Below we briefly summarize relevant background.

In November 1988, the National Marine Fisheries Service (NMFS) prepared the Arctic Regional Biological Opinion (ARBO) which concerned leasing and exploration activities in the Arctic Region (Beaufort Sea, Chukchi Sea, and Hope Basin OCS Planning Areas). Because of the removal of the gray whale from the list of threatened and endangered species, the availability of new information on the potential impacts of oil and gas-related noise on bowhead whales, the use of new seismic survey technology in the Arctic, and trends in OCS activities in the Arctic Region, MMS proposed to reinitiate consultation with NMFS on November 2, 1999. Because of lack of industry interest in the Chukchi Sea and Hope Basin Planning Areas at that time, MMS proposed, and NMFS agreed, to limit the reinitiated consultation to leasing and exploration activities only in the Beaufort Sea Planning Area. Thus, in the resultant, and most current, Biological Opinion of May 25, 2001, NMFS concluded that

> "Present and foreseeable future oil and gas exploration activities on the Alaskan OCS are likely to occur only in the Beaufort Sea."

Because of this assumption, which was based on the best information available at the time, the action area for the May 2001 biological opinion was defined as the Alaskan Beaufort Sea OCS Planning Area, extending from the Canadian border to the Barrow area.

Due to industry response to our recent Beaufort Sea lease sales and call for information and nominations in the Chukchi Sea, and based on discussions with industry, the aforementioned assumption is no longer valid. Therefore, we would like to reinitiate consultation with your agency on leasing and exploration activities in areas of both the Beaufort Sea and the Chukchi Sea, as specified above.

In accordance with the Endangered Species Act Section 7 regulations governing interagency cooperation, MMS intends to prepare a biological evaluation in which we describe the actions and specific areas being considered in the consultation, describe the listed species and critical habitats that may be affected by those actions, evaluate potential effects and cumulative effects on listed species and critical habitats, and provide other relevant information necessary for NMFS to prepare their biological opinion.

By this letter, we are notifying you of the listed species and critical habitat that we, with your concurrence, expect to include in our biological evaluation. Based on previous correspondence with NMFS on this issue and based on our review of available information, MMS is aware of only one listed species, the endangered bowhead whale, that commonly occurs in these two planning areas. However, based on NMFS' November 1988 Biological Opinion, and, in some cases, other information suggesting the possible occurrence of other listed species in areas within or near these two planning areas, MMS currently intends to review and consider the following listed species in our biological evaluation:

Common Name	Scientific Name	ESA Status
Bowhead whale	*Balaena mysticetus*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Right whale	*Eubalaena glacialis*	Endangered
Sei whale	*Balaenoptera borealis*	Endangered

We have included right and sei whales on this species list because, in your biological opinion of November 1988 (page 3), NMFS stated that these species were among "...six species of endangered whales that inhabit Arctic Region waters of Alaska." On page 4 of the 1988 ARBO, NMFS stated that "The right and sei whales are rare in Arctic waters. They are represented by isolated records in the Chukchi Sea, probably of stray individuals well outside the normal ranges of their populations." We believe that information available since that opinion supports this conclusion.

MMS is not aware of any designated or proposed critical habitat for any species that is under the jurisdiction of NMFS and that occurs within, near, or that could potentially be affected by leasing or exploration activities within, the Beaufort Sea or Chukchi Sea.

Please notify us of your concurrence with, or necessary revisions to, the above list of species and add any critical habitats which you believe need to be considered in our biological evaluation. In addition, we ask that you specify whether we should include Eastern North Pacific gray whales (*Eschrichtius robustus*) in our evaluation. While this population of gray whales was removed from the list of threatened and endangered species in 1994, NMFS's Biological Opinion on Oil and Gas Lease Sales 191 and 199 in the Cook Inlet OCS Planning Area included a "...general assessment of the effects of the action on gray whales as part of NMFS' continuing responsibility to monitor the status of the species." Lastly, we ask that you reaffirm NMFS's conclusion in recent consultations (e.g., the consultation on the Beaufort Sea Lease Sales 186, 195, and 202) that MMS does not need to consult on species along the transportation corridor from Valdez to ports along the Pacific coast and to the Far East.

To facilitate consideration of our request for concurrence, we are sending copies of this letter to your Anchorage Field Office. Upon receipt of your reply within 30 days, we will begin preparation of our biological evaluation reviewing potential effects of Federal oil and gas leasing and exploration by MMS within the Alaskan Beaufort Sea and the Chukchi Sea.

If you have any questions on the issues raised in this letter or require additional information, please contact Dr. Lisa Rotterman, Minerals Management Service, Mail Stop 8303, 3801 Centerpoint Drive, Suite 500, Anchorage Alaska 99503-5823 (commercial and FTS telephone: 907-334-5245)

Sincerely,

John Goll
Regional Director

Enclosure

cc: (w/enclosure)

Mr. Brad Smith
Anchorage Field Office
National Marine Fisheries Service
Federal Building
22 West 7th Avenue, Box 43
Anchorage Alaska 99513-7577

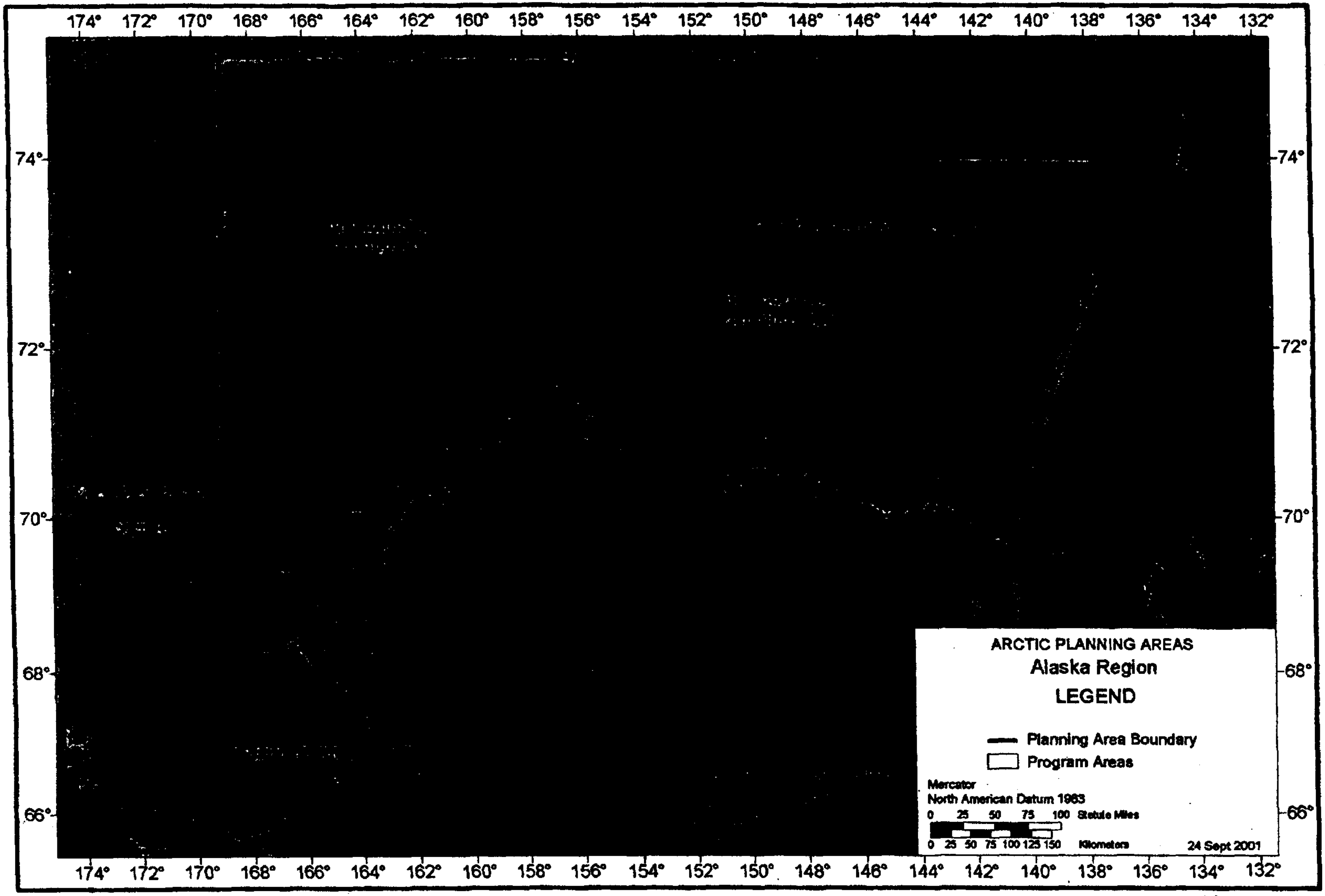

Figure 2-3. Beaufort Sea, Chukchi Sea, and Hope Basin Planning Areas - Alaska Region

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

September 30, 2005

RECEIVED
OCT 0 7 2005
REGIONAL DIRECTOR, ALASKA
Minerals Management Service
ANCHORAGE, ALASKA

John Goll
Regional Director
Minerals Management Service
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, AK. 99503-5823

Dear Mr. Goll:

The National Marine Fisheries Service (NMFS) has received your letter requesting information on the presence of threatened or endangered species and their designated critical habitat which occur in the Alaska Beaufort Sea and Chukchi Sea planning areas.

The following species is listed under the Federal Endangered Species Act and is found in these areas:

Bowhead Whale (Balaena mysticetus)....................Endangered

Critical habitat has not been designated for the bowhead whale.

Additionally, the endangered humpback (Megaptera novaeangliae) and fin whale (Balaenoptera physalus) are found in waters of the Chukchi Sea and Bering Sea outside of the subject planning areas. These animals could be impacted secondarily by OCS activities. NMFS recommends their inclusion in your evaluation. NMFS also recommends the evaluation provide a comprehensive assessment of OCS activities on threatened and endangered species, and, to accomplish this, include all deferrals within these planning areas.

We hope this information will be useful in your section 7 determinations. Please direct any questions to Brad Smith in our Anchorage office, (907) 271-3023.

Sincerely,

Kaja Brix
Assistant Regional Administrator
for Protected Resources

APPENDIX II

DESCRIPTION OF THE PROPOSED ACTIONS

A. General Background about the Proposed Actions. At present, we are consulting with the National Marine Fisheries Service (NMFS) on the potential effects of oil and gas leasing and exploration in the Beaufort Sea and Chukchi Sea Planning Areas. We also provide information about development and production that may occur as a result of such exploration and development in order to permit NMFS to determine whether all the entire action could cause jeopardy to any listed species or result in the destruction or adverse modification of any designated critical habitat. The MMS will consult with NMFS for any future development plan.

The best available information indicates that, within Federal portions of the Arctic Ocean and associated seas, present and foreseeable future oil and gas activities are likely to occur in MMS's Chukchi Sea and Beaufort Sea Planning Areas. These two planning areas are depicted in Figure 1 of the Biological Evaluation. Under the current 5-Year OCS leasing program (2002-2007), the Chukchi Sea Program Area encompasses approximately 34 million acres and the Beaufort Sea Program Area has approximately 9 million acres. In the Draft Proposed Program (DPP) for 2007-2012, announced February 8, 2006, five sales are proposed for the Arctic OCS (Table IV-3): two sales in the Beaufort Sea Planning Area and three sales in the Chukchi Sea Planning Area. The DPP is available at http://www.mms.gov/5-year/2007-2012main.htm#Commenting. Under the 5-Year Program for 2007-2012, Chukchi Sea Program Area encompasses 46.752 million acres and includes the polynya area excluded under the current 5-Year Program; the Beaufort Sea Program Area has 33.295 million acres. We do not anticipate oil and gas leasing or exploration in the foreseeable future in the Hope Basin Planning Area.

Since the Beaufort Sea multiple-sale EIS was issued in February 2003 (MMS, 2003a), the only new oil- and gas-related activities on the Beaufort Sea OCS have been the issuance of the Sale 186 and 195 leases, MMS approval of a permit for on-ice winter geophysical (seismic) exploration in 2004, and the relinquishment of the McCovey leases after unsuccessful exploratory drilling. A series of wells have been drilled nearshore in State waters off Milne Point. Some of these wells resulted in apparent commercial-size discoveries that are moving toward development by Pioneer and Kerr-McGee.

We received no unanticipated information through the Request for Information related to Beaufort Sea Sale 202, published in the *Federal Register* on October 28, 2005. We received no information that would change the scenario as presented in the multiple-sale EIS. The description of the oil and gas resources and the projected activities in the multiple-sale EIS reflect the best available information for proposed activities within the Beaufort Sea OCS. The MMS is still proposing to hold Beaufort Lease Sale 202 in 2007. In the DPP for 2007-2012, MMS has proposed the following schedule of lease sales for the Beaufort Sea Planning Area: Sale 208 in 2009 and Sale 216 in 2011. Therefore, for the Beaufort Sea, this evaluation evaluates the same suite of resource estimates that were assessed in the multiple-sale EIS, but in the context of new environmental information.

In February of 2005, MMS issued a Call for Information (Call), asking industry to nominate focused areas of interest in the Chukchi Sea Planning Area under a special interest sale process. The MMS received broader industry interest in this area than expected. Because of this, MMS is now proceeding with the process to evaluate holding a conventional Chukchi Sea areawide sale (proposed Chukchi Lease Sale 193). The area being considered for assessment in the EIS is the same area depicted for the Chukchi Sea in the February Call. This sale would not include the nearshore "polynya" area that is excluded from the current 5-Year Program. The MMS has initiated its scoping process and is preparing an EIS related to this proposed lease sale. The MMS has proposed to offer areas for lease in the Chukchi Sea Planning Area in this DPP 5-year plan. In the DPP, MMS proposed the following schedule of lease sales for the Chukchi Sea Planning Area: Sale 193 in 2007, Sale 212 in 2010; and Sale 221 in 2012.

A further note about the Chukchi Sea polynya: The 2002-2007 Chukchi Sea Program Area does not include the polynya. Likewise, proposed Chukchi Sea Sale 193, proposed for 2007, does not include the polynya, as the sale process for Sale 193 began in the current 5-Year Program. The 2007-2012 DPP did not include deferrals for the Chukchi Sea, and so presently includes the polynya area in the Chukchi Sea Program Area proposed for the 2007-2012 period. Decisions on whether the polynya would actually be included in a sale will be made following the sale evaluations for Sales 212 and 221 proposed in the 2007-2012 DPP. These sales are presently proposed to be held in 2010 and 2012. Thus no exploration drilling could occur in the polynya until 2010 or beyond, if a future sale included the area. Seismic surveys could be conducted and are evaluated in this Biological Evaluation.

In this Biological Evaluation, we provide description of oil and gas leasing, exploration, development and production activities that we assume will occur for the purposes of analyses. We acknowledge that the exploration and development scenario generated for purposes of environmental analysis is optimistic compared to historical trends in the Beaufort and Chukchi seas. An optimistic development scenario ensures that the environmental analysis covers the potential effects at the reasonable high-end of possible petroleum-activity levels, including those that could occur as a result of any increase in activities due to incentives.

Scenarios are conceptual views of the future and represent what we believe is a reasonable depiction of future activities. To develop the scenarios we consider the petroleum resource potential of the area, the technology to discover and produce oil and gas from the offshore area, and historical trends in industry activity. The scenarios are generated using professional judgment, not rigorous statistical data, because the size and location of oil and gas pools are unknown at the present time and we have no direct knowledge of industry investment strategies. The timing of exploration and development activities and volume of petroleum ultimately produced as a result of the next lease sale in the Chukchi Sea OCS is impossible to predict with any certainty. However, the assumed scenario provides a basis for the analysis of potential environmental impacts should future activities occur similar to those postulated here.

Although all scenarios are hypothetical and therefore uncertain, the projected activities can be categorized as *reasonably foreseeable* and *speculative*. Reasonably foreseeable activities are extensions of current trends and are more likely to occur within a decade or two.

B. Leasing Incentives. To encourage leasing, exploration, and development, MMS implemented royalty reductions on oil production for Beaufort Sea Sales 186 and 195. The MMS also lowered the required minimum bid amount and rental rates for tracts leased in Sales 186 and 195 and MMS anticipates the doing the same for Sale 202. What leasing incentives may be offered under the next 5-Year Program is not know at this time. Decisions on leasing incentives would be based on analysis of the economic conditions at the time of the Final Notice of Sale.

The leasing incentives could provide a counterbalance to the delays and extra costs commonly associated with operations in this challenging frontier area. We believe that the hypothetical development scenario discussed in the multiple-sale EIS is more likely to occur with the new incentives than without them.

C. Scenario of OCS Activities for the Beaufort Sea Planning Area. The analyses in the Beaufort Sea multiple-sale EIS were based on a hypothetical scenario of future industrial activities that could occur as a result of offshore leasing. The MMS used a petroleum-resource assessment of the Beaufort Sea completed during spring 2001 as the basis for the EIS assumptions. The resource assessment represents an optimistic view in that the model conducts a simulated discovery and development of all prospects in the database, many of which are not identified by mapping. However, the EIS goes on to present the resources estimated to be discovered and developed as a result of each of the proposed sales. These are restricted to a very limited number of prospects based on economic and technological criteria. Industry carefully selects the best prospects for leasing and exploration drilling based on economic, regulatory, and technological factors. Realistically, many small, remote, or difficult to identify prospects will not be leased or drilled by industry, because they will not meet the investment standards for leasing and exploration funding. Our resource assessment provides only one view of the economic potential of the area, which may not be shared by industry.

The exploration and development scenario (Table II-1) and environmental effects analysis presented in the multiple-sale EIS are still valid representations of the consequences of any Beaufort Sea sale as scheduled in the current 5-year program.

As we did in the multiple-sale EIS, we still assume three exploration and development scenarios for the three proposed OCS sales in the current 5-year program, including proposed Lease Sale 202. The scenarios indicate that resources for the Lease Sale 202 would range from 340-570 million barrels (MMbbl) of oil. For purposes of analysis, we use a single production estimate of 460 MMbbl of oil.

As assumed in the final multiple-sale EIS, we assume that only crude oil production (i.e., no natural gas production) will result from Beaufort Sea sales under the current 5-year program. The anticipated levels and types of activities associated with exploration and development are grouped into three geographic zones—the Near/Shallow-Water (Near) Zone, Midrange/Medium (Midrange) Zone, and Far/Deepwater (Far) Zone (USDOI, MMS, 2003a:Table II.A-1). The zones were delineated primarily on distance to existing infrastructure and secondarily on water depth. Although leasing is not a direct cause of impacts, leasing must precede exploration and development activities. As explained in Section II.B.2 of the multiple-sale EIS, we assumed that leasing and exploration work would occur primarily in the Near Zone as a result of Sale 186, and that there would be less industry interest in the more remote zones. The assumed pattern of leasing did not occur for Sale 186 (nearly half of the total bids were received in the Far Zone). However, we believe the pattern assumed for exploration and development activities for the three zones is still valid. Thus, we still assume that activities would expand into more remote, deeper water as infrastructure is established in the nearer shore, shallower areas. Table II-1 provides information similar to that provided in the multiple-sale EIS (USDOI, MMS, 2003a:Table II.A-1). While it has been updated to include the leasing results from Sale 195, our estimates for the total sales-related activities remain unchanged.

For Lease Sale 202 in the Beaufort Sea, we assume that the total number of exploration and development wells drilled and the type of exploration and production platforms are the same as analyzed in the multiple-sale EIS (see Table II-3 reproduced from Table IV.A-3 in the final Beaufort Sea multiple-sale EIS [USDOI, MMS, 2003a]).

C.1. Exploration Activities in the Beaufort Sea. For purposes of analyses, we assume that a maximum of two drilling rigs would operate at any time, with a total of six exploration and six delineation wells expected to be drilled over the 8-year exploration period. The first commercial discovery would be confirmed in 2008. Between 2012 and 2017, two production platforms are assumed to be installed. One platform would be in the Near Zone, and one would be in the Midrange Zone. Drilling of production and injection wells would begin in 2012 and finish in 2019, with a total of 102 wells drilled. Offshore pipeline construction would begin in 2012 and finish in 2016, with 40 miles (mi) of new offshore pipeline installed. The offshore pipeline would connect to existing onshore pipelines and, therefore, construction of new onshore pipelines would be minimal. Oil production from sales under the current 5-year program would end by 2036.

We anticipate that exploration activity (seismic surveys and drilling) will begin with seismic surveying in summer of 2006 and continue through 2013, with delineation wells drilled through 2014. For a sale scenario a production platform is assumed to be built 4 years after a commercial discovery is verified. Following the next discovery, we assume delineation wells would employ the same drilling rig and continue over a 2-year period. Because of the short open-water drilling season in the Beaufort Sea, it is likely that a single drilling rig would drill a single well at any drilling site in any one year. However, in the event of a discovery, two delineation wells could be drilled by the same exploration rig in the same season. The type of units that might be used in exploration drilling would depend on water depth, sea-ice conditions, ice-resistance of the units, and availability of drilling units. Artificial ice islands grounded on the seabed are likely to be used as drilling platforms in shallow water (less than 10 meters [m]), and nearshore operations would be supported by ice roads over the landfast ice. Gravel islands are not likely to be constructed for exploration drilling in OCS waters (generally deeper than 10 m), although older artificial islands or natural shoals could be used as a base for temporary gravel or ice islands. Movable platforms resting on the seafloor likely would be used for exploration drilling. These platforms are designed to withstand winter ice forces, and drilling could be conducted year-round. Bottom-founded platforms (set on the seafloor) could be used to drill prospects in water depths of 10-20 m, and drillships or other types of floating platforms would be used in deeper water. These floating systems can operate only in open-water and broken-ice conditions and not in midwinter pack-ice conditions. Because mobile ice conditions in deeper water make ice roads unfeasible, deeper water (Far Zone) operations would take place during the summer open-water season and would be supported by icebreakers and supply boats. They would be stored in protected inshore areas when not in use.

Based on geologic studies, MMS assumes that exploration and delineation wells generally would test prospects from 3,000-15,000 feet (ft) (914-4,572 m), and we assume a representative exploration-well depth of 7,000 ft (2,133 m). At this depth, each exploratory or delineation well would require 425 short tons of drilling muds (dry weight) and produce approximately 525 short tons of dry rock cuttings. We assume that 80% of the drilling muds would be recycled, leaving 85 tons of "spent mud" to be discharged along with all the drill cuttings at each exploration site or disposed of onshore. We estimate that 935-1,040 short tons (dry weight) of drilling muds and 5,775-6,300 short tons (dry weight) of bore cuttings would need to be disposed of for the exploration and delineation activities for each sale. The higher figures are the estimates for Sale 195 (and applied also to Sale 186). These materials would be disposed of primarily at the drill site under conditions prescribed by the Environmental Protection Agency's National Pollution Discharge Elimination System (NPDES) (Clean Water Act of 1977, as amended [33 U.S.C. 1251 et seq.).

C.1.a. High-resolution Seismic Surveys in the Beaufort Sea. Before exploration and production activities, the MMS requires the lessee/operator to identify any shallow hazards or archaeological resources that may be present. A high-resolution seismic survey is the preferred method used by the oil and gas industry to provide required information on shallow hazards, archaeological resources, and potential benthic communities to the MMS in support of proposed exploration and development plans in OCS leased areas.

Typical high-resolution seismic survey operations are described in Section E.4. below.

For purposes of analysis, we assume that up to three high-resolution site-clearance surveys would occur in the Beaufort Sea OCS in 2006 and two surveys would occur annually in 2007-2010.

C.1.b. Support and Logistic Activities in the Beaufort Sea Associated with Exploration. Offshore exploration-drilling operations in the Beaufort Sea OCS would require onshore support facilities. Where possible, existing facilities within the Prudhoe Bay or Kuparuk unit areas would be used or upgraded. These onshore facilities would have to provide the following:

- a staging area for construction equipment, drilling equipment, and supplies;

- a transfer point for drilling and construction personnel;
- a harbor to serve as a base for vessels required to support offshore operations; and
- an airfield for fixed-wing aircraft and helicopters.

Existing systems would be used to transport equipment, material, supplies, and personnel. Descriptions of North Slope transportation systems can be found in Section III.C of the Northeast National Petroleum Reserve-Alaska final EIS (USDOI, BLM and MMS, 1998); and Sections 3.2 and 3.3 of the Beaufort Sea Oil and Gas Development/Northstar Project final EIS (U.S. Army Corps of Engineers, 1999).

Existing transportation routes, including both pipelines and roads, extend from the Endicott field facilities located offshore in the Beaufort Sea to the western parts of the Kuparuk field. Gravel roads, which parallel existing pipelines, connect existing oil-production facilities in numerous fields across the central portion of the North Slope. The Alpine field contains one short gravel road connecting its two production pads, but this field is not connected by permanent road to the North Slope infrastructure. In remote areas, most exploration wells are supported by seasonal ice roads that must be reconstructed each year. The Prudhoe-Kuparuk infrastructure is linked to interior Alaska by the Dalton Highway. The majority of the vehicles traveling the Dalton Highway are commercial-freight vehicles associated with oil-field activities, although privately owned vehicles and commercial tour operators also travel the Dalton Highway. Summer-traffic levels for the Dalton (June-August) are substantially higher than traffic levels for the rest of the year.

Air transportation is the primary means of passenger travel to the NSB and Prudhoe Bay/Kuparuk area. All public airstrips, except those at Barrow and Deadhorse, are gravel. The NSB continually upgrades local roads and airports. A private airfield capable of handling jet aircraft also is located at the Kuparuk Unit base camp.

Barges transport most heavy and bulky cargo to the NSB. Prudhoe Bay has barge-docking facilities at both the East Dock and the West Dock; however, the West Dock facility is larger and more active. Crowley Maritime operates several heavy-lift cranes, barges, and barge docks in addition to support vessels from the West Dock. Oliktok Dock was constructed in 1982 to expedite shipping to the Kuparuk Field. Barge traffic in support of continued development on the North Slope of Alaska typically has ranged from 10-15 barges per year. During the initial development of the Prudhoe Bay Unit in 1970, 48 barges were used; however, newer barges are larger and more efficient and would sharply reduce that number. Barges supporting exploration activities would travel directly to the drill site to offload any cargo. Typically, a mobile drilling platform used for exploration drilling would enter its area of operation fully supplied for the drilling season.

The number of support vessels required for each bottom-founded drilling unit would depend, at least in part, on the type and characteristics of the unit and the sea-ice conditions. If drilling operations occur during the open-water season, MMS requires an emergency-standby vessel within the immediate vicinity (5 mi or a 20-minute steaming distance, whichever is less) of the drilling unit to ensure emergency evacuation of personnel. This vessel also could assist in deploying the oil boom in the event of an oil spill. If operations are planned during broken-ice conditions, two or more icebreaking vessels may be required to perform ice-management tasks for the floating units. One to two potential drilling units might be operating during the open-water period.

During the open-water season (again, assuming a 45-day season), a supply boat would make one trip per rig per week. We estimate the total number of supply boat trips per open-water season could be as high as 14 trips during years that exploration drilling is occurring. The level of support-boat traffic would vary by distance from shore and/or support base and whether or not the facility can be supported by vehicles using ice roads in the winter.

The estimated numbers of vessel, helicopter, or vehicle trips are calculated as round trips (Table II-1). Estimates of vehicle trips do not include operations that may be necessary for rig demobilization or for emergencies.

Ice roads are assumed to be the principal route for transporting routine supplies and materials to ice islands and/or nearshore gravel islands. For drilling platforms farther offshore in the broken-ice zone, material and supplies would be transported by support/supply boats (with icebreaking capacity, if necessary) during the open-water season and by helicopter at all other times. For both types of drilling structures, it is probable that most personnel would be transported by helicopters. The number of helicopter trips flown in support of exploration and delineation well drilling is assumed to range from about 90-270 each year, depending on the number of wells (1-3) that are drilled. For each drilling operation, we assume there would be one flight per day of drilling. The time required to drill and test a well is about 90 days. For Sales 186, 195, and 202, the annual number of helicopter trips to the drill sites should average between 140 and 155.

C.2. Development and Production Activities in the Beaufort Sea

C.2.a. Development- and Production-Related Seismic-Survey Activity in the Beaufort Sea. A three-dimensional (3D), multichannel, prospect-defining, seismic-reflection survey would be conducted for each offshore field. It is assumed that a typical survey would cover approximately 35 mi^2 (92 km^2). A field might be surveyed several years before submission of a Development and Production Plan and before installation of any platform or subsea well templates. Surveys would be conducted during open-water, ice-free periods.

High-resolution seismic data would be collected for shallow hazard and archaeological resource information at proposed platform locations and along proposed pipeline routes. These high-resolution, site-clearance surveys are described in Section E.4. below. These surveying operations for proposed production facilities are included in the scenario numbers presented in Section C.1.a. above. For proposed pipeline routes, the total trackline distance is estimated to be four times the length of the offshore trunk pipelines assumed for each sale, which assumed to be approximately 460 line-miles in support of the Beaufort Sea sales under the current 5-year program.

C.2.b. Production Activities in the Beaufort Sea. Assumed hydrocarbon development and production information is given in Table II-1 of this appendix and Tables IV.A-1, IV.A-2, and IV.A-3 of the multiple-sale final EIS, should commercial discoveries result from the above exploration activities. For Beaufort Sea sales under the current 5-Year Program, we assumed 206 production wells and 100 injection wells would be drilled from 8 production platforms. Drilling of each production and service well would require 650 short tons (dry weight) of drilling mud per well and generate 825 tons of rock cuttings. We assume that 80% of the mud is recycled. The disposal of muds and cuttings and any produced water would be in accordance with approved NPDES permits for development-well drilling. The amount of disposed drilling muds would be about 13,300 tons for all wells drilled for each sale under the current 5-year program. The total amount of disposed cuttings for each sale would amount to 84,000 short tons (dry weight). These calculations are based on a production well with a representative depth of 10,000 ft (3,050 m). These wastes would be would be loaded onto barges for transport to shore for treatment and disposal or transport to the offshore platform to be treated and injected in subsurface-disposal wells. We project a total of 8-10 barge trips related to drilling waste disposal over the next 20 years.

Depending on the water depth, seafloor conditions, ice conditions, and size of the reservoir, several types of platforms could be used. In water depths less than or equal to 30 ft (10 m), artificial (gravel) and or caisson-retained islands may be used as production platforms. For water depths between 30 and 100 ft (10 and 30 m), bottom-founded structures designed with ice-management systems are likely. Icebreaking support ships may be required onsite. For waters deeper than 100 ft (30 m), a combination of extended-reach wells and/or subsea well tied back to the main production platform in shallower water is most likely.

A variety of steel and concrete structures of various designs can be built and used for a production platform that resists seawater, ice, and freeze-thaw cycles and operates safely in low-temperature, offshore environments such as the Beaufort Sea. Bottom-founded production platforms would be constructed and outfitted in ice-free harbors and towed to the production site. Modular units would be transported during the open-water season and assembled and installed in less than 45 days. In addition to the vessels (8-10 tugboats) used to tow the platform components to the site, installation also might require a large-capacity derrick barge and a vessel to accommodate the workers. Each platform could use two rigs to maximize development drilling and shorten startup times.

Gravel needs and transportation requirements for island construction would vary according to water depths. The BPXA proposal for the Liberty Project, estimated 800,000 cubic yards (yd^3) of gravel would be needed to construct a production island in 22 ft (7 m) of water (USDOI, MMS, 2002). For Northstar Island, an estimated 700,000-800,000 yd^3 of gravel was hauled to the site of a relic exploration island. At the former exploration island site, about 400-500,000 yd^3 of gravel remained. Consequently, Northstar Island, which lies in 39 ft (12 m) of water, required approximately 1.2 million yd^3 of gravel. For both islands, construction material was carried on ice roads, with needed additional gravel excavated from onshore sites (U.S. Army Corps of Engineers, 1999).

For analysis purposes, the first OCS production from Beaufort Sea sales under the current 5-Year Program is assumed to come online in 2013. Production rates would ramp up over several years to peak production rates that would last another for 3 years before slowly declining. Production from Sale 186 leases is projected to continue until 2033, production from Sale 195 leases is assumed to continue about 3 years beyond the projected end of Sale 186 production; production from Sale 202 is assumed to end in 2038 (see Tables IV.A-1 through 3; see also Appendix B in the Beaufort Sea multiple-sale EIS).

At the end of production, the platform is decommissioned and the lease is abandoned as described in Section II.C.5 below.

C.3. Support Activities in the Beaufort Sea Associated with Development and Production. For this scenario, it is assumed that the infrastructure at Prudhoe Bay would provide the major support for construction and operation activities associated with the development, production, and transportation of crude oil. However, as the development of the proposed sale area progresses into tracts farther from Prudhoe Bay and/or into deeper waters, new shore-base locations may be required. One new shore base is assumed for the development of Sale 202 resources and is assumed to be located at Point Thomson in the east or Smith Bay in the west, although other sites are possible (e.g., Barrow or Kaktovik).

Support and logistics operations after discovery can be divided broadly into three phases: construction, development drilling, and production. Transportation needs for each project are initially and briefly intense and then decline over time. During construction of Northstar in 2000 during break up and the open water season (nominally 16 June to 31 October 2000), the crew boat Hawk (18.7 m (61 ft) vessel) made about 1337 departures from West Dock 2 (Williams and Rodrigues, 2004). Additionally, off-loading operations at Northstar in 2000 during this period were supported by two self-propelled flexi-float barges. These “served as mobile docks or pontoons for crew and equipment transfer” (Williams and Rodrigues, 2004:2-15). Other tugs and barges also made periodic trips to Northstar and a sealift barge transported permanent living quarters and other major equipment. In 2001 break-up and open water season, usual helicopter and vessels continued to provide routine island support and the main production equipment was brought in by sealift. In 2001, crew boats completed 824 round trips from West Dock to Northstar and there were about 989 round-trip helicopter flights, not counting additional flights in the 4-15 June period (Williams and Rodrigues, 2004). In 2001, there were 69 round trips by barges to Northstar, 17 vessels were used for cargo transport, 11 Alaska Clean seas tugs and barges were deployed nearby on 23 days, and 11 vessels transported diesel fuel to the island (Williams and Rodrigues, 2004 and see additional detail in this reference). For over-ice vehicle transport during the construction phase, estimates for

Northstar and Liberty were roughly 36,000 round trips (400 per day), assuming a 90-day season. Surface transport estimates are expected to decline to 100-200 per season during the operations/production phase.

As construction/development operations move farther from existing infrastructure and into deeper water, beyond the landfast-ice zone, the burden of transport would shift increasingly to helicopter and, more importantly, marine transport. Personnel, perishable goods, and emergency material would be transported by helicopter during all but the open-water season. During the construction phase, dredges would prepare the seafloor for bottom-founded structures; any fill or gravel required would be barged to site from shore or dredged from offshore sites. The open-water season would be the focus of activity as barges from outside the sale area and local support vessels fulfill the platforms' yearly construction and operating requirements. Icebreaking vessels would be on standby to extend the open-water season and to support ships in case of emergency activities.

Marine transport requirements during construction for facilities in the Far Zone most likely would range between 150 and 250 vessel trips during the open-water season. This number would include barges carrying construction supplies from outside ports, dredges, survey vessels, pipelaying barges, and local support vessels. Should subsea completions be used to produce deepwater finds, gathering lines would transport production to platforms that could be located in shallower waters. In this event, air and marine transport requirements would be reduced. During the period of developmental drilling (8 years for Sale 186, 7 years for Sale 195, and 5 years for Sale 202), helicopter trips for far/deepwater platforms would range from 7-14 per week per platform. During the production phase, average weekly helicopter operations could range between 3 and 7 trips per platform.

Table IV.A-4 in the multiple-sale EIS summarizes the exploration, development, production, and transportation assumptions for all Alternatives for each of the three sales. Transportation information presented in this table is based on the assumption that all three production platforms constructed as a result of Sale 186 would be in the shallow-water landfast-ice zone; that one of the three production platforms assumed for Sale 195 would be in the shallow-water zone and the other two would be in the Midrange or Far Zone; and that both production platforms from Sale 202 would be beyond the landfast-ice zone and located in the Midrange or Far Zone.

We assume that six new fields would be discovered in the Beaufort Sea OCS as a result of the 3 sales in the current 5-Year Program. For the analysis scenario, one new field is attributed to Sale 202. Each sale is assumed to result in total oil production of 460 MMbbl. Proportioning total production by the assumed number of fields for each of the sales gives a range of 150-460 MMbbl per field, with smaller fields being economic to develop closer to shore. The MMS assumes that the fields in this size range could be produced from one production platform with satellite subsea completions or satellites with minimal onsite processing. Each host platform would include capabilities for development-well drilling and well-workover operations. Gravel islands would be the favored design for production facilities in water depths approximately 15 m or less, and bottom-founded platforms would be employed for production facilities in water depths to 35 m. Some production facilities may employ extended-reach drilling technology, which would enable the operators to reach oil pools located farther distances from the platform.

C.4. Activities Associated with Oil Transportation in the Beaufort Sea

C.4.a. Pipelines. For Sales 186 and 195, we assumed that the route selection and installation of offshore pipelines between production platforms and onshore facilities would take 1-2 years and would occur either in the summer open-water season, during mid- to late winter when landfast ice has stabilized, or both. For the assumed more remote, deeper water activities from Sale 202, route selection and installation would take 2-4 years and pipelaying would take place only during the relatively short open-water season. For Sale 186, we assumed that, because of their relatively small size, new offshore projects would use the existing infrastructure (processing facilities and pipeline-gathering systems) wherever possible. Produced oil would be gathered by existing pipeline systems within the Prudhoe Bay/Kuparuk field areas and transported to Pump Station 1 of the TAPS. We assume that Oliktok Point (using the Kuparuk or Milne Point field infrastructure), the Northstar pipeline landfall, West Dock (using the Prudhoe Bay field infrastructure), and the Badami field would be the primary potential landfalls. For Sale 195, we assumed that new offshore projects would tie into existing onshore pipeline-gathering systems at the nearest possible points. Produced oil would be gathered by existing pipeline systems and transported to Pump Station 1 of the TAPS. We assume that Oliktok Point, the Northstar pipeline, West Dock, and Bullen Point would be the primary potential landfall.

Because new fields leased in Sale 202 or subsequent sales could be farther from existing infrastructure, a new onshore support facility could be needed in either the National Petroleum Reserve-Alaska (NPR-A) or the eastern North Slope. Plans are proposed for an expansion of development surrounding the Alpine field, and these facilities could gather oil production from the Beaufort OCS. A new onshore pipeline would be required to reach the existing North Slope gathering system connecting to Pump Station No. 1 of the TAPS. Depending on the location of the field, a new landfall would be constructed in Smith Bay (discovery in the western Beaufort) and traverse south of Teshekpuk Lake through the NPR-A to the Kuparuk field infrastructure, a distance of approximately 100 mi. Although a recent development plan (Exxon Corporation) has been postponed for the Point Thomson field, this area remains a likely area for industrial expansion on the eastern North Slope. Future onshore projects in the Point Thomson area are likely to be used by OCS operations in the eastern Beaufort Sea. The pipeline would pass along the coast and join the Badami pipeline, a distance of approximately 20 mi.

We assume that offshore pipelines would be trenched as a protective measure against damage by ice in all water depths less than 50 m (164 ft). Trenching and pipeline laying would take place during the relatively short open-water season or during mid- to late winter when the landfast ice has stabilized. At coastal landfalls, pipelines would be elevated on short gravel causeways to protect them against shoreline erosion. Booster stations at the landfalls would be required to maintain pressure in the long pipeline segments. New onshore-pipeline sections would take 1-2 years to complete, with construction activities taking place simultaneously with the offshore-pipeline installation. Onshore pipelines would be elevated at least 5 ft above ground level on vertical support members. The onshore pipeline corridor, and shore-facility construction would be concurrent with the offshore platforms' installation.

C.4.b. Tankering Related to OCS Activities Beaufort Sea. We assume that crude oil produced from Beaufort Sea Planning Area leases would be transported by the existing TAPS pipeline to the oil terminal at Valdez, where it would be loaded into tankers. Oil from all fields in northern Alaska is commingled for transport through TAPS. From Valdez, the oil would be transported primarily to the U.S. west coast, with smaller quantities traveling to the Kenai Peninsula, Hawaii, the Gulf of Mexico, or refineries in the Virgin Islands. Tankers loaded with oil produced as a result of Beaufort Sea Sale 186 in 2003 are expected to depart Valdez beginning in 2010. Oil from production resulting from Sale 195 should begin sometime in 2013, and oil from Sale 202 should begin at some point during 2019. Tanker-transport traffic in support of production resulting from the Beaufort Sea sales under the current 5-Year Program is approximated in Table IV.A-4 of the multiple-sale EIS. Production from the Beaufort Sea OCS would contribute to the continuing operation of the TAPS pipeline and tankering system. Production from the Beaufort Sea OCS may slow the decline in TAPS throughput.

C.5. Abandonment of Oil and Gas Developments in the Beaufort Sea. After the economic limit is reached, where income from production does not cover operating and transportation expenses, procedures to shut-down the facility will be implemented. Abandonment operations generally include removal of all equipment and the plugging of all wells. In a typical situation, wells will be permanently plugged (with cement). Wellhead equipment removed from the seafloor and processing modules will be moved off the platform. This equipment will be loaded onto barges for transport for recycling or disposal. Lastly, the platform will be disassembled and removed from the area and the seafloor site will be restored to some practicable, pre-development condition. Environmental studies will continue to evaluate the site during and after restoration. The abandonment process could take several years, with studies continuing for longer.

A gravel island's protective concrete or sandbag berm would be removed and the artificial island would be allowed to erode from wave action. Another option would be that the island's gravel resources may be removed and used for other construction projects.

Pipelines will be decommissioned, which involves cleaning the pipeline, plugging both ends, and leaving it in-place buried in the seabed. Any overland pipeline is likely to be left in place or moved to be used by other oil fields.

D. Scenario for OCS Activities in the Chukchi Sea Planning Area. In this section, we describe scenarios for petroleum activities in the Chukchi Sea Planning Area. For the present Biological Evaluation, we consider oil production from the Chukchi shelf as reasonably foreseeable because the area has high oil resource potential and there is existing transportation infrastructure to move oil from northern Alaska to distant markets. We consider offshore gas production to be speculative for the current Chukchi leasing program because although the area has a high potential for natural gas occurrence there is no existing transportation infrastructure to move produced gas to markets.

Natural gas has been produced in low quantities (0.7 Bcf/yr) for local use in the village of Barrow since the mid-1940's and in high quantities (8 Bcf/d) from Prudhoe Bay area fields since 1969. Associated gas produced from North Slope oil fields has been reinjected to increase oil recovery and also used for fuel in facilities. It is estimated that approximately 35 Tcf of natural gas is contained in known accumulations and another 200 Tcf could occur in undiscovered pools throughout northern Alaska (U.S. Geological Survey, 2005). However, natural gas in northern Alaska is described as "stranded" until a gas transportation system to outside markets is constructed. At the present time, a large-diameter gas pipeline seems to be the most likely future system with possible completion of the project in 2015 at the earliest. Various plans to transport North Slope gas to market have been discussed for decades and have not resulted in a transportation system. Until a future system is operational and has available capacity, it is unrealistic to include gas production in a reasonably foreseeable scenario.

Future oil production from the Chukchi Sea will depend on many factors, including the access to prime areas for exploration and sustained high oil prices which will attract industry investments to this remote, high-cost location. Offshore petroleum development in the Chukchi Sea OCS will face a number of logistical and regulatory hurdles. These hurdles could negatively impact industry activities to convert undiscovered resources to producing reserves. Although theoretically present and potentially viable, all of the modeled economic resources will not be developed in the foreseeable future because exploration will target only the largest prospects. Marginal projects will probably not be developed by industry because the risk of economic failure is too high. This means that future production is unlikely to reach the full economic potential as modeled by petroleum resource assessments (USDOI, MMS, 2005).

No petroleum development has occurred in this frontier area, so the most appropriate scenario includes only the discovery, development, and production of the first offshore project. When the first project addresses the cost, logistical, and regulatory conditions more projects are more likely to follow. If the hurdles are not overcome, the area will remain undeveloped. As typical of many frontier areas, development starts with a relatively large project that supports the cost of initial infrastructure. Progressively smaller fields are then developed using this infrastructure and activity expands away from the core area.

A scenario that assumes even one offshore oil development in the Chukchi Sea OCS represents an abrupt increase in the level of activity compared to the past. There have been no lease sales and virtually no petroleum exploration in the Chukchi Sea since 1991. Four lease sales were held on different parts of the Chukchi shelf between 1988 and 1991 but only a small fraction of the tracts were leased by industry (483 leases, or approximately 5% of those offered). Five exploration wells drilled in 1989-1991 tested 5 large prospects, none of which resulted in commercial-size discoveries. There have been no active leases in the Chukchi Sea since 1998.

Future leasing and exploration in the Chukchi Sea OCS will be supported by high oil prices and advancements in exploration and production technology. High prices and new technology are both vital in overcoming the challenges of this difficult setting. The Chukchi Sea OCS is viewed as one of the most petroleum-rich offshore provinces in the country, with geologic plays extending offshore from some of the largest oil and gas fields in North America on Alaska's North Slope. Our current petroleum assessment indicates that the mean recoverable oil resource is 12 Bbbl with a 5% chance of 29 Bbbl. Most government and industry analysts agree that this province could hold large oil fields comparable to any frontier area in the world. Thus it is reasonable to assume that exploration of this area could lead to oil discoveries and offshore development.

The following scenario assumes active leasing and exploration by industry followed by development that is unhindered by regulatory delays. Estimates for infrastructure are given in Table II-1, and a possible schedule for the scenario is given in Table II-4.

The scale of future activities will be largely controlled by industry perceptions of the Chukchi Sea OCS relative to other worldwide exploration opportunities. Industry decisions are primarily influenced by their opinions regarding the petroleum potential, future market prices, and the regulatory regime. Individual companies could have widely varying views of these factors, and these views could change (positive or negative) through time. As stated previously, the scenario represents a possible set of circumstances, but the specific location and scale of offshore development will not be known for decades.

The scenario assumed for environmental analysis involves the discovery, development, and production of the first offshore oil field in the Chukchi Sea OCS. Ultimately recoverable oil resources from this field are assumed to be 1 billion barrels (Bbbl), as lower oil volumes are not likely to be economic and larger volumes in a single pool are rare. If oil prices drop below $30.00 per barrel (they are above $50.00 when this scenario was written), exploration in the Chukchi Sea OCS is expected to be minimal and oil discoveries may not be developed. The "exploration only" scenario represents situations where discoveries are too small or costly for commercial development. As previously discussed, offshore natural gas discoveries will not be developed until a gas transportation system from the North Slope to outside markets is operational and has capacity to accept gas deliveries from new fields.

D.1. Exploration Activities in the Chukchi Sea. Exploration work could begin before a lease sale to identify prospective tracts for bidding. This pre-sale work will likely include 2D/3D seismic surveys. Approximately 100,000 line-miles of 2D seismic surveys have been collected to-date in the Chukchi Planning Area, so we assume that additional geophysical surveys will be 3D surveys focusing on specific leasing targets. The 3D surveys are likely to be proposed during the early phase of exploration. For proposed Chukchi Sea Sale 193, scheduled for 2007, prelease, 3D, exploration seismic surveying is expected to occur in the open-water season of 2006, with possible additional surveying in 2007. The number of surveys is expected to decrease over time as data is collected over most prospects. **We assume that up to four surveys could be conducted during each open-water season. The 3D seismic surveys can only be conducted during open water (approximately June to November).** Seismic surveys in the Chukchi OCS will probably be coordinated with surveys in the Beaufort OCS to employ the same vessels. Typical 3D survey operations are described in Section E.1. of this appendix. An icebreaker may be used as a support boat and this would ensure that the large seismic vessel could exit the area at the end of the season. We estimate that the rate of seismic survey will average 20-30 days (with downtime) to cover a 200-mi^2 area. At normal vessel speeds, the airgun array would produce a sound signal every 10-15 seconds. One or more seismic surveys may be conducted (with down time) during the entire open water period as compatible with mitigation requirements. Each permit may authorize multiple surveys in a planning area. So, surveys in different parts of a planning area may overlap in time.

Based on mapping of the subsurface structures using 3D seismic data, several well locations will be proposed. Prior to drilling deep test wells, high-resolution site-clearance seismic surveys and geotechnical studies will examine the proposed exploration drilling locations for geologic hazards, archeological features, and biological populations. Site clearance and studies required for exploration will be conducted during the open water season before the drill rig is mobilized to the site.

Considering water depth and the remoteness of this area, **drilling operations are likely to employ drillships with icebreaker support vessels**. Water depths greater than 100 ft and possible pack-ice incursions during the open water season will preclude the use of bottom-founded drilling platforms. Using drillships allows the operator to temporarily move off the drill site, if sea or ice conditions require it, and the suspended well is controlled by so-called blow-out-prevention equipment installed on wellheads on the seabed. Bottom-founded platforms that are more permanently installed are better choices for production platforms. **Drilling operations are expected to range between 30 and 90 days at different well sites**, depending on the depth to the target formation, difficulties during drilling, and logging/testing operations. Considering the relatively short open water season in the Chukchi (June-November), only **1-2 wells are expected per drilling season**. We expect that one well could be drilled, tested, and abandoned and another well could be started each summer season. Five exploration wells have been drilled to-date on the Chukchi shelf and we assume that 7-14 additional wells will be needed to discover and delineate the first commercial field.

D.2. Development Activities in the Chukchi Sea. When a large oil discovery is tested and defined by additional delineation wells, several project designs will be considered as alternatives for development. Because we have no knowledge of the site-specific conditions, we can only offer a general description of a possible future project and a hypothetical timeline for development.

Water depth and sea conditions are the two main factors in selecting a platform type. Because the continental shelf is relatively deep in the Chukchi (mostly deeper than 100 ft) and affected by ice movements most of the year, **a large bottom-founded platform is likely be used as a central facility**. The platform would hold 1-2 drilling rigs, production and service (injection) wells, processing equipment, fuel and production storage capacity, and quarters for personnel. Although bottom-founded platforms have been used in high-latitude settings worldwide, no platform is has operated in environmental conditions equivalent to the Chukchi shelf. Conceptual designs have been proposed that are typically circular in cross-section with wide bases and constructed out of concrete. The platform could be constructed in several component sections which would be transported to the site and then mated together. The seafloor is expected to be relatively firm, so a prepared berm may not be required. The platform base is pinned to the seafloor and stabilized by its wide base, anchoring system, and ballast in cavities in the concrete structure to resist ice forces.

Because of limited topside space on the platform and the assumed widespread area of the oil pool, approximately half of the total production wells could be subsea wells. The subsea wells would be completed in templates (4 wells per template) and production would be gathered to the central platform by flowlines. Subsea well templates would be located within about 15 mi from the central platform. Pending the information collected by site-specific surveys, the subsea equipment and pipelines could be installed below the seafloor surface for protection against possible deep-keeled ice masses. Drilling on the platform would occur year-round, while subsea wells would be drilled by drillships during the summer open-water season.

The production slurry (oil, gas, water) will be gathered on the central platform where gas and produced water will be separated and the produced water reinjected into the subsurface. Associated and solution gas recovered with oil production will be used as fuel for the facility or reinjected into the main reservoir to increase oil recovery. Shallow disposal wells will handle waste water and treated well cuttings for on-platform wells. Drilling cuttings and mud wastes from subsea wells could be barged to an onshore treatment and disposal facility at the shorebase.

Installation of the flowlines from subsea templates to the hub platform and installation of the main oil pipeline from the platform to landfall will occur during summer open-water seasons. These pipeline operations would occur during the same timeframe as platform construction and installation. We assume that offshore sales oil pipeline will be larger than 18 inches in diameter to handle production rates ranging from 200,000-250,000 barrels per day (bpd). The **offshore pipeline could run 30-150 mi between the offshore platform and landfall and will be trenched in the seafloor as a protective measure against damage by floating ice masses. At the coast, a new facility will be constructed to support the offshore operations and will also serve as the first pump station. A likely location for the shorebase would be between Icy Cape and Point Belcher (near Wainwright)**.

The overland pipeline to the TAPS, or a nearer gathering point will require coordination of different land managers and oil field owners along the route through NPR-A. In contrast to offshore pipelines, the new onshore pipeline will be installed during winter months. Various pipeline and communication lines will be installed on vertical supports above the tundra in a corridor stretching eastward up to 300 mi to connect to the North Slope gathering system. Pump stations may be required along the onshore corridor and are likely to be collocated with oil fields along the corridor.

An approximate timeframe for these activities is given in Table II-4. The time from leasing to production startup is expected to be 10-15 years. We assume a time lag of 3 years from the lease sale (2007) to the discovery well (2010). Delineation drilling would take 3 years, followed by permitting activities for the offshore project and a Development EIS. When the project is approved the design, fabrication, and installation of the central platform could take another 4-5 years. Offshore and onshore pipeline permitting and construction would occur simultaneously with the offshore work. Drilling of subsea wells could start before platform installation to allow a quicker ramp-up of production. Drilling on the platform and subsea wells would take 6 years. A new shorebase would be constructed (2015) to support offshore work and then serve as the pipeline landfall.

D.3. Production Activities in the Chukchi Sea. The total life-cycle (exploration through production activities) of the offshore project could last 30-40 years with oil production for 25 years (see Table II-1). When the oil resources are depleted, the platform and wells could be used for gas production with installation of new gas sales lines to a future North Slope gas pipeline. However, gas production is not expected before 2030 at the earliest.

Once the project is constructed, operations largely involve re-supply of materials and personnel, inspection of various systems, and maintenance and repair. Little maintenance and repair work is expected on the platform itself, but it is likely that processing equipment might be upgraded to remove bottlenecks in production systems. Well workovers will be made at intervals of 5-10 years to restore flow rates in production wells. Pipelines will be inspected and cleaned regularly by internal devices (“pigs”). Crew changes are usually at weekly intervals.

D.4. Transportation Activities in the Chukchi Sea. Operations at remote locations in the Chukchi lease sale area would require transportation of materials, supplies, and personnel by different means, depending on seasonal constraints and phase of the operations. The general assumptions discussed in this section can be integrated with the scenario schedule shown in Table II-4 to determine the full extent of transportation activities associated with the single large offshore development project.

During exploration seismic surveys, the vessels are largely self-contained, so there would be a minimum amount of helicopter flights (assume 1 per day) to transport personnel, seismic data, and light supplies. As previously discussed, seismic operations would be in the summer open-water season. Since we assume up to four seismic surveys may be operating during the open water period in the Chukchi Sea, we assume that up to four helicopter flights /day would occur into the region. We assume that the smaller support vessel would make occasional trips (once every 2 weeks) to refuel and re-supply (probably at Barrow). Thus, as above, because we assume up to four operations, we assume approximately four smaller support vessel trips every 2 weeks.

During exploration drilling, operations would be supported by both helicopters and supply vessels. Helicopters would probably fly from Barrow at a frequency of one to three flights per day. Support vessel traffic would be one to three trips per week, also out of Barrow. For exploration drilling operations that occur after a new shore base is established near Point Belcher, both helicopter and vessel traffic would be out of either Barrow or the new shore base.

Construction of a new shorebase would begin after a commercial discovery is made. Heavy equipment and materials would be moved to the coastal site using barges, aircraft, and perhaps winter ice roads. Transportation activities would be more frequent during the construction phase, beginning about 3 years after the discovery is made and will take another 3 years for completion of the new facility. During this construction phase, there could be **one to two barge trips** (probably from either West Dock or Nome) in the summer open water season. Aircraft (C-130 Hercules or larger) trips could be up to five per day during peak periods. The overall level of transportation in and out of the shorebase would drop significantly after construction is completed for both the shore base and offshore platform. During production operations aircraft would generally be smaller with less frequent flights (2 per day). Ice-road traffic would be intermittent during the winter months.

Offshore construction (platform and pipeline installation) and development drilling operations would be supported by both helicopters and supply vessels from the new shorebase. **Helicopters would probably fly from either Barrow or the new shorebase at a frequency of one to three flights per day during development operations. Support vessel traffic would be one to three trips per week from either Barrow of the new shore base. During normal production operations the frequency of helicopter flights offshore would remain the same (1-3 per day) but the marine traffic would drop to about one trip every 1-2 weeks to the production platform. Marine traffic would occur during the open-water season and possibly during periods of broken ice with ice-reinforced vessels.** Assuming that barges will be utilized to transport drilling cutting and spent mud from subsea wells to an onshore disposal facility, we estimate one barge trip per subsea template (4 wells). This means that there could be 2 barge trips (during summer) to the new onshore facility over a period of 6 years.

D.5. Abandonment Activities in the Chukchi Sea. After the economic limit is reached, where income from production does not cover operating and transportation expenses, procedures to shut-down the facility will be implemented. Abandonment operations generally include removal of all equipment and the plugging of all wells. In a typical situation, wells will be permanently plugged (with cement). Wellhead equipment removed from the seafloor and processing modules will be moved off the platform. This equipment will be loaded onto barges for transport for recycling or disposal. Lastly, the platform will be disassembled and removed from the area and the seafloor site will be restored to some practicable, pre-development condition. Environmental studies will continue to evaluate the site during and after restoration. The abandonment process could take several years, with studies continuing for longer.

Pipelines will be decommissioned, which involves cleaning the pipeline, plugging both ends, and leaving it in-place buried in the seabed. Any overland pipeline is likely to be left in place or moved to be utilized by other oil fields.

D.6. Estimates of Drilling Wastes and their Disposal in the Chukchi Sea. Geologic studies indicate that exploration will usually test prospects from 3,000-15,000 ft in the subsurface. Based on the characteristics of the geologic plays, we assume that exploration wells will average 8,000 ft. Production and service wells are assumed to average 10,000 ft (drilled depth) because they will include deviated wells. We assume that from 25-33% of the total wells will be service wells that are used for waste disposal and reservoir pressure maintenance.

Estimates for drilling wastes are given in Table II-1. For the assumed drilling depths a typical exploration well will use 475 tons (ton = 2,000 pounds) of dry mud and produce 600 tons of dry rock cuttings. Considering the cost of synthetic drilling fluids now commonly used, we assume that 80% of the drilling mud will be reconditioned and reused. Only 20% (or 95 tons) of “spent mud” per well will be discharged at the exploration site. All of the rock cuttings will be discharged at the exploration site. A typical 10,000-ft production well will use approximately 625 tons of dry mud and produce approximately 825 tons of rock cuttings. We assume that 80% of the drilling mud will be recycled in the development drilling program, so 125 dry tons per well will be waste product. All waste products (drilling mud, rock cuttings, and produced water) for on-platform wells will be treated and then disposed of in shallow wells on the production platform. For the surrounding subsea wells, drilling waste products could be barged to the coastal facility for treatment and disposal.

There is a variety of drilling fluid that could be used in well operations, each with a different composition. The type of drilling fluid used depends on its availability, the geologic conditions, and experiences of the drilling contractor. Often, several different types of drilling fluids are used in single well and most of the drilling fluids are recycled (80%). We assume that the discharged drilling fluid (20% of the total) will be a common water-base mud of the generic composition shown below. All of the expensive synthetic drilling muds are assumed to be reconditioned and not discharged. In any case, all fluid discharges are regulated by several Federal and State agencies so as not to have adverse environmental consequences.

Composition of Typical Drilling Mud (EPA Type 2, Lignosulfonate Mud) discharged at well site**:**

Bentonite	6.5%
Lignosulfonate	2.0%
Lignite	1.4%
Caustic	0.7%
Lime	0.3%
Barite	75.0%
Drilled solids	13.0%
Soda ash/Sodium Bicarbonate	0.4%
Cellulose Polymer	0.7%
Seawater/Freshwater	as needed

E. Description of Projected Seismic Survey Activities in both Areas

E.1. Marine Streamer 3D/2D Surveys. Marine streamer 3D surveys vary markedly depending on client specifications, subsurface geology, water depth, and geological target reservoir. A typical 3D seismic survey consists of a large seismic vessel that tows the airgun and receiving cable arrays. The vessels conducting these surveys are generally 70-90 m long.

Airguns are the acoustic source for 2D/3D seismic surveys. Their individual size can range from tens to several 100 cubic inches (in^3). A combination of airguns is called an array, and operators vary the source array size during the seismic survey to optimize the resolution of the geophysical data collected. Airgun array sizes can vary from 1,800-4,000 in^3, and even approach 6,000 in^3 (however, arrays of this size are not likely to be used).

A 3D source array typically consists of two to three subarrays of six to nine airguns each, and is about 12.5-18 m long and 16-36 m wide. Vessels tow one to three source arrays, depending on the survey design technical specifications required for the geological target, which generate the acoustic energy. The arrays are usually aligned parallel with one another and towed 50-200 m behind the vessel. Following behind the source arrays by another 100-200 m are multiple (4-12) streamer receiver cables, and each streamer can be 3-8 km long and spread out over a width of 400-900 m. Streamers are passive listening equipment consisting of multiple hydrophone elements.

Marine 3D surveys are acquired at typical vessel speeds of 4.5 kn (8.3 km/hour). A source array is activated approximately every 10-15 seconds, depending on vessel speed. The timing between sources being activated varies between surveys to achieve the desired spacing required to meet the geological objectives of the survey, which is commonly either 25 or 37.5 m. Usually, airguns are fired between 20 and 70 times per mile.

The 3D survey data are acquired on a line-by-line basis, whereby the vessel continues down a track-line to provide adequate subsurface coverage from the beginning of the survey boundary. Acquiring a single line may take several hours, depending upon the size of the survey area. The vessel then takes 2-3 hours to turn around at the end of the track-line and starts acquiring data along the next line. Seismic vessels operate day and night and a survey may continue for days, weeks, or months, depending upon the size of the survey, data acquisition capabilities of the vessel, and weather conditions. It should be noted, however, that data are not being acquired continuously, as streamer and source deployment, in-sea equipment maintenance, and other operations also add to the survey time.

Adjacent lines for a modern 3D survey are generally spaced several hundred meters apart and are parallel to each other across the survey area. Modern marine seismic vessels tow up to 16 streamers with an equipment tow width of up to approximately 1,500 m. The areal extent of this equipment limits both the turning speed and the area a vessel covers. It is, therefore, common practice to acquire data using a “racetrack” pattern, whereby the next acquisition line is several kilometers away from and traversed in the opposite direction of the line just completed. It should be noted that the towed marine source is not static and is continually activated at different spatial locations throughout the period of the survey.

Vessel transit speeds are highly variable, ranging from 8-20 kn depending on a number of factors including, but not limited to the vessel itself, sea state, urgency (the need to run at top speed versus normal cruising speed), and ice conditions.

Marine streamer 2D surveys use similar geophysical survey techniques as 3-D surveys, but both the mode of operation and general vessel type used are very different from those used in modern 3D marine surveys. The 2D surveys are designed to provide a less-detailed, coarser sampled subsurface image as compared to 3-D surveys, and they are conducted over wide areas or on a regional basis to identify potential prospective areas.

The 2D seismic survey vessels are generally smaller than modern 3D survey vessels, although larger 3D vessels are able to conduct 2D surveys. The source array typically consists of three or more subarrays of 6-8 sources each, and it is about 12.5-18 m long and 16-36 m wide. Following behind the source arrays is a single hydrophone streamer approximately 8-12 km long, depending on the geophysical objectives of the survey.

The 2D surveys acquire data along single track lines that are spaced more widely apart than for 3D surveys. Therefore, considerably less source effort (less acoustic energy) is required to cover a given area of the subsurface compared to a 3D survey.

Marine seismic vessels are designed to operate for several months without refueling or replenishments. A support boat would be used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data. Helicopters also may be used when available for vessel support and crew changes.

Marine streamer 2D/3D surveys in the Beaufort and Chukchi seas require that areas in which they operate be essentially ice-free in order to maneuver the long streamers and airgun arrays. Because of their operational requirements, we assume that 2D/3D seismic surveys in the Chukchi Sea could only be conducted during open water (approximately June to November). However, the analyses in this Biological Evaluation explicitly assume that seismic surveys will be conducted to avoid adverse effects on the spring migration, on females and newborn calves, and on calving of bowhead whales. **Thus, we explicitly assume that to avoid potential adverse effects on the spring migration of bowhead whales, on calving, and on females with newborn calves, MMS will not allow any seismic survey operation in the spring lead system until July 1 unless authorized by NMFS.**

The MMS anticipates a maximum of four 2D/3D marine streamer seismic operations to be conducted in the Chukchi Sea evaluation area starting in 2006 and continuing through 2008. Beginning in 2009, the level of activity is expected to decline to a maximum of three marine streamer seismic operations per year. In the Beaufort Sea program area, MMS anticipates a maximum of four 2D/3D marine streamer or bottom-cable seismic operations to be conducted annually over the next 3 years. The level of activity is not expected to decline due to the number of active leases in the Beaufort.

E.2. Ocean-Bottom-Cable Survey. Ocean-bottom-cable (OBC) surveys are used in Alaska primarily to acquire seismic data in water that is too shallow for the data to be acquired using a marine streamer vessel and too deep to have static ice in the winter. The survey requires the use of multiple vessels (usually two vessels for cable layout/pickup, one vessel for recording, one vessel for shooting, and may include two smaller utility boats). These vessels are generally but not necessarily smaller than those used in streamer operations, and the utility boats can be very small, in the range of 10-15 m.

The OBC operations begin by laying cables off the back of the layout boat. Cable length is typically 4-6 km but can be up to 12 km. Groups of seismic receivers (usually a combination of both hydrophones and vertical motion geophones) are attached to the cable in intervals of 12-50 m. Multiple cables are laid on the seafloor parallel to each other using this layout method, with a cable spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the survey. When the cable is in place, a vessel towing the source array passes over the cables with the source being activated every 25 m. Sometimes a faster source ship speed of 6 kn instead of the normal 4.5 kn speed is used with a decrease in the time the source is being activated.

After a source line is acquired, the source ship takes about 10-15 minutes to turn around and pass over the next cables. When a cable is no longer needed to record seismic data, it is recovered by the cable-pickup ship and moved to the next recording position. A particular cable can lay on the seafloor anywhere from 2 hours to several days, depending upon operation conditions. Normally, a cable is left in place about 24 hours.

An OBC survey covers a smaller area (approximately 10 by 20 mi) and may spend days in an area compared to a 2D/3D survey, which typically covers a much larger area (thousands of square miles) and may actually pass over a particular area for only hours.

OBC surveys might occur in the Beaufort Sea. The MMS projects a maximum of one OBC survey per year. OBC surveys are not expected to occur in the Chukchi OCS because of its great water depths and the greater efficiency of streamer operations in deep water. However, recent technological developments have been introduced that provide improved operational flexibility for equipment deployment, recovery, and data collection in the field, but the costs are high compared to streamer collected data.

E.3. Mitigation Measures for 2D/3D Seismic Surveys. These mitigation measures are included as part of the Proposed Actions. Although not required by NMFS or MMS, both agencies believe an IHA under the MMPA from NMFS (for cetaceans and pinnipeds other than walrus) is warranted because seismic-survey noises have the potential to harass marine mammals. Therefore, in any seismic-survey permits to be issued by the MMS Alaska OCS Region MMS will state that seismic survey operations shall not commence until such time that the marine mammal small-take authorization has been obtained from NMFS.

Mitigating measures that were required during recent activities to protect bowhead whales and availability of whales to subsistence hunters will continue to be applied in both the Chukchi and Beaufort seas as applicable. For the purposes of analyses, we explicitly assume that the mitigating measures to protect bowhead whales as specified by NMFS's IHA's (Appendix VI) for the last two open water seismic surveying permitted by the Alaska Region of MMS will be continue to be required for any 2D/3D seismic permits in open water in either the Beaufort Sea or the Chukchi Sea Planning Areas. We further explicitly assume that MMS will not allow any seismic survey operations in the spring lead system until July 1 unless authorized by NMFS, to avoid potential adverse effects on the spring migration, on calving, and on females with newborn calves. We discuss these measures more directly in the section on 2D/3D seismic surveys.

In the Beaufort Sea, the MMS has also previously identified and applied mitigation for post-lease activities, including seismic surveys, during the bowhead whale migration and the subsistence bowhead whale hunt. We explicitly assume these measures will also continue to be applied and these assumptions underlie our analyses. Thus, we assume that stipulations 1-6 as numbered in the Beaufort Sea Lease Sale 195 (provided in Appendix V) will apply to future on-lease actions in the two arctic evaluation areas as applicable. These measures would apply to any post-lease seismic activity, including 3D, 2D, and site-clearance surveys. Under lease stipulation 4, the MMS requires companies to conduct site-specific bowhead whale-monitoring programs to determine when bowhead whales are present in the vicinity of lease operations and the extent of behavioral effects on bowhead whales due to these operations. The stipulation lists specific timeframes when the migration occurs for specific leases and when the stipulation applies. The requirements of this stipulation may be satisfied by an LOA or IHA from NOAA. In addition, lease stipulation 5 requires companies to also consult with directly affected subsistence communities, the North Slope Borough and the Alaska Eskimo Whaling Commission to discuss potential conflicts with the siting, timing, and methods of proposed operations, as well as safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. Finally, the MMS issues a clear statement of intent by including Information to Lessee clause (d) in the notice of sale: "The MMS may limit or require operations be modified if they could result in significant effects on the availability of the bowhead whale for subsistence use" and that "The MMS and NOAA Fisheries will establish procedures to coordinate results from site specific surveys required by Stipulation 4 and NOAA Fisheries LOA's or IHA's to determine if further modification to lease operations are necessary."

An inability to effectively perform mitigation measures will result in the suspension of a G&G permit until such time that the mitigation measures can be successfully performed and demonstrated.

E.4. High-resolution Site-Clearance Surveys. A high-resolution seismic survey is the preferred method used by the oil and gas industry to provide required information to the MMS about its proposed exploration and development plans in OCS leased areas.

High-resolution surveys primarily are used by the oil and gas industry to locate shallow hazards; obtain engineering data for placement of structures; and detect geohazards, archaeological resources, and certain types of benthic communities. A typical site-clearance survey operation consists of a vessel towing suite of geophysical equipment, and would typically include instrumentation to gather information on bathymetry and topography of the seafloor (similar to depth finders and fish finders), near-surface sediments (to detect shallow-buried channels or other features that might indicate differences in soil bearing strength), shallow geology (to identify faults or unstable sediments), and side scan sonar (to detect seafloor features and resources such as hard substrate and shipwrecks). The system used to gather information about shallow geology (to about 1,000 ft) would likely be an airgun towed about 25 m behind the ship and a 600-m streamer (receiver cable) with a tail buoy. The ship travels at 3-3.5 kn (5.6-6.5 km/hour), and the sound source is activated every 7-8 seconds (or about every 12.5 m). The ships are designed so that their operational sound signatures do not interfere with data collection, as the higher frequencies used in high-resolution work are easily lost in the noise if special attention is not paid to keeping the ships quiet.

The MMS regulations require information be gathered on a 4,800 m^2 area. The grid spacing required for specific survey conditions are illustrated on Figures 1 and 2 of Notice to Lessees and Operators (NTL) No. 05-A01. A site-clearance survey as specified by the NTL would result in 74 km (45mi) of data. Including line turns, the time to survey a lease block is approximately 36 hours. Airgun volumes for high-resolution surveys are typically 90- to 150-in^3, and the output of a 90-inch airgun is 229 dB re 1µPa at 1 m. Airgun pressures are typically 2,000 psi, although they can be used at 3,000 psi for more output.

The **MMS does not anticipate any high-resolution surveys being conducted in the Chukchi Sea Planning Area until after proposed Chukchi Sea Sale 193**, currently scheduled for 2007. For purposes of analysis, one high-resolution, site-clearance survey is projected annually in 2008-2010.

High-resolution surveys are expected to occur in the Beaufort Sea in 2006 and subsequent years. For purposes of analysis, three high-resolution, site-clearance surveys are projected for 2006 and two are projected annually for 2007-2010.

Appendix III

Oil-Spill Analysis for the Beaufort Sea Planning Area

A. Introduction. This appendix reproduces the updated oil-spill analysis for Beaufort Sea Sale 195. This material was previously provided to the National Marine Fisheries Service (NMFS) in Appendix B of the Environmental Assessment (EA) for Beaufort Sea Lese Sale 195 (USDOI, MMS, 2004). At present, this, along with the information presented in Appendix A of the Beaufort Sea multiple-sale final EIS, represents the best available information for evaluating oil-spill-risk analysis in the Beaufort Sea. The Minerals Management Service (MMS) will be working on an EA for proposed Beaufort Sea Sale 202 in 2006. When this information is updated, MMS will provide NMFS with the new information and with a summary of any important changes to oil-spill-risk analysis results relevant to understanding the potential adverse effects on endangered whales.

B.1. Oil-Spill Analysis. This appendix clarifies information presented in Appendix A of the Beaufort Sea multiple-sale final environmental impact statement (EIS) (USDOI, MMS, 2003a) regarding the estimates of large oil-spill occurrence and updates those estimates specific to Sale 195. Information regarding the source, type, and sizes of oil spills; their behavior and the estimated path they follow; and the conditional and combined probabilities remain the same as discussed in the multiple-sale final EIS and is summarized in Section IV.A of the EA for Beaufort Sea Sale 195.

B.2. Large Oil-Spill Analysis. The definition of a large spill is greater than or equal to 1,000 barrels. The following section elaborates on how the chance of one or more large oil spills occurring was derived for this Environmental Evaluation. To estimate large oil-spill occurrence for future exploration, development and production in the Beaufort Sea OCS, and to identify their principal causal factors and sensitivities to these, a fault-tree analysis was used.

B.2.a. Chance of One or More Large Spills Occurring. The chance of one or more large spills occurring is derived from two components: (1) the spill rate and (2) the resource-volume estimates. The spill rate is multiplied by the resource volume to estimate the mean number of spills. Oil spills are treated statistically as a Poisson process, meaning that they occur independently of one another. If we constructed a histogram of the chance of exactly 0 spills occurring during some period, the chance of exactly 1 spill, 2 spills, and so on, the histogram would have a shape known as a Poisson distribution. An important and interesting feature of this distribution is that it is entirely described by a single parameter—the mean number of spills. Given its value, you can calculate the entire histogram and estimate the chance of one or more large spills occurring. The oil resource volume estimate remains 460 million barrels (MMbbl) for Alternative I, the Proposed Action, as discussed in Section II.B of the multiple-sale final EIS (USDOI, MMS, 2003a). Alternatives III, IV, V, and VI resource volumes are reduced by 1%, 5%, 3%, and 3%, respectively, from 460 million barrels (MMbbl). The following sections elaborate on how the spill rates were estimated and applied for Sale 195.

B.2.a(1) Spill-Rate Foundation. We derived the spill rates for large spills from a fault-tree study done by the Bercha Group, Inc. (2002). This study examined alternative oil-spill-occurrence estimators for the Beaufort and Chukchi seas using a fault-tree method. Because sufficient historical data on offshore Arctic oil spills for the Beaufort Sea region do not exist, a model based on fault-tree methodology was developed and applied for the Beaufort Sea multiple-sale EIS (Bercha Group, Inc., 2002). Using fault trees, oil-spill data from the offshore Gulf of Mexico and California were modified and incremented to represent expected Arctic performance.

B.2.a(2) Fault-Tree Analysis. Fault-tree analysis is a method for estimating the spill rate resulting from the interactions of other events. Fault trees are logical structures that describe the causal relationship between the basic system components and events resulting in system failure. Fault-tree models are a graphical technique that provides a systematic description of the combinations of possible occurrences in a system, which can result in an undesirable outcome. Figure III-1 shows the generalized parts of a fault tree starting with the top event. The top event is defined as the failure under investigation. In this case, it is either a large pipeline or platform spill. A series of events that lead to the top event are described and connected by logic gates. Logic gates define the mathematical operations conducted between events.

Figure III-2 shows a typical fault tree for large pipeline spills. The most serious undesirable outcome, such as a large pipeline spill, was selected as the top event. A fault tree was constructed by relating the sequences of events that, individually or in combination, could lead to the leak or spill. The tree was constructed by deducing, in turn, the preconditions for the top event and then successively for the next levels of events, until the basic causes were identified. In Figure III-2 these events included corrosion, third-party impact, operation impact, mechanical failure, and natural hazards—unknown and Arctic. These subresultant events were further elucidated to determine their base cause. For example, corrosion could be internal or external corrosion; third-party impact could be due to fishing, trawling, jackup, or anchor impact. Figure III-3 shows a typical fault tree for a large platform spill. The most serious undesirable outcome, such as a large platform spill, was selected as the top event. Events include a process facility release, a storage tank release, structural failure, hurricane or storm, collision, and Arctic. The subresultant events that make up the Arctic included ice force, low temperature, and others.

Probabilities were assigned to each event so that the probability of the top event was estimated. This required knowledge of the probable failure rates for each event. At an OR gate in a fault tree, the probabilities were added to give the probability of the next event. The fault trees in the Bercha Group, Inc. (2002) report were composed entirely of OR gates. The computation of resultant events consisted of the addition of the probabilities of events at each level of the fault tree to obtain the resultant probability at the next higher value.

In the Bercha Group Inc. (2002) study, fault trees were used to transform historical spill statistics for non-Arctic regions to predictive spill-occurrence estimates for the Beaufort Sea program area. The Bercha Group, Inc. fault-tree analysis focused on Arctic effects. Arctic effects were treated as a modification of existing spill causes as well as unique spill causes. Modification of existing spill causes included those that also occur in other OCS regions but at a different frequency, such as trawling accidents. Unique spill causes included events that occur only in the Arctic, such as ice gouging, strudel scour, upheaval buckling, thaw settlement, and other for pipelines. For platforms, unique spill causes included ice force, low temperature, and other.

The treatment of uncertainties in the probabilities assigned to each arctic event was estimated as discussed in the following.

Treatment of Uncertainties: The measures of uncertainty calculated were restricted to the Arctic effects in each fault-tree event. The treatment of uncertainties was examined through numerical simulation. To assess the impact of uncertainties in the Arctic effects incorporated fault trees, ranges around the expected value were estimated for all the Arctic effects, both modified and unique for Arctic effects. The numerical distributions generated through these perturbations in the expected values were modeled as triangular distributions and input to the numerical simulation analysis conducted as part of the result generation (Bercha Group Inc., 2002).

Numerical simulation methods are tools for evaluating the properties of complex, as well as nondeterministic, processes. Problems can have an enormous number of dimensions or a process that involves a path with many possible branch points, each of which is governed by some fundamental probability of occurring.

A type of numerical simulation, called Monte Carlo simulation, was used to obtain the outcome of a set of interactions for equations in which the independent variables are described by distributions of any arbitrary form. The Monte Carlo simulation is a systematic method for selecting values from each of the independent variable distributions and computing all valid combinations of these values to obtain the distribution of the dependent variable. This was done using a computer, so that thousands of combinations can be rapidly computed and assembled to give the output distribution.

Consider the example of the following equation:

$$X = X_1S + X_2$$

Where, X is the dependent variable (such as spill persistence in days), S is the size of the spill in barrels, and X_1 and X_2 are correlation coefficients. Suppose now that X_1 and X_2 are some arbitrary distributions that can be described by a collection of values X_1 and X_2. What we do in the Monte Carlo process, figuratively, is to put the collection of the X_1 values into one hat, the X_1 hat, and the X_2 values into an X_2 hat. We then randomly draw one value from each of the hats and compute the resultant value of the dependent variable, X. This is done several thousand times. Thus, a resultant or dependent variable distribution, X, is estimated from the computations of all valid combinations of the independent variables (X_1 and X_2), for a given S.

Generally, the resultant can be viewed as a cumulative distribution function as illustrated in Figure III-4. Such a cumulative distribution function (CDF) also is a measure of the accuracy or, conversely, the variance of the distribution. As can be seen from this figure, if the distribution is a vertical line, no matter where one draws on the vertical axis, the same value of the variable will result, that is, the variable is a constant. At the other extreme, if the variable is completely random, the distribution will be represented as a diagonal straight line between the minimum and maximum value. Intermediate qualitative descriptions of the randomness of the variable follow from inspection of the CDF in Figure III-4. For example, if we are interested in confidence intervals, we simply take the value of the abscissa corresponding to the appropriate confidence interval, say 0.95 or 95%.

B.2.a(2)(a) Fault-Tree Input Data and Their Uncertainty Variations. The Arctic effects include modifications to events associated with the historical data set from other OCS regions, hereafter called Arctic modified effects, and adding spill events unique to the arctic environment, hereafter called Arctic unique effects. Arctic modified effects are those changing the frequency component of certain contributions to events such as anchor impacts which could occur both in the Arctic and temperate zones. Arctic modified effects for pipelines apply to external corrosion, internal corrosion, anchor impact, jackup rig or spud barges, trawl/fishing net, rig anchoring, workboat anchoring, mechanical connection failure or material failure, and mudslide events. Table III-1a shows the input rationalization of the Arctic modified effects for pipelines. Arctic modified effects for platforms apply to process facility release, storage tank release, structural failure, hurricane/storm, and collision events. Table III-2 shows the input rationalizations of the Arctic modified effects for platform events. The frequency increments in this table are given as the median values calculated using the Monte Carlo method with inputs as the low, expected, and high values.

Arctic unique effects are additive components that are unique to the Arctic environment. Quantification of existing events for the Arctic was done in a relatively cursory way restricted to engineering judgment.

For pipelines, Arctic unique effects included ice gouging, strudel scour, upheaval buckling, thaw settlement, and other. Table III-1b shows the input rationalization of the Arctic unique effects for pipelines. A reproducible but relatively elementary analysis of gouging and scour effects was carried out. The ice-gouge failure rate was calculated using an exponential failure distribution for a 2.5 meter (m) cover, 0.2 m average gouge depth, and 4-gouges-per-kilometer-year flux. Strudel scour was assumed to occur only in shallow water with an average frequency of 4 scours per square mile and 100 feet of bridge length with a 10% conditional pipeline failure probability. Upheaval-buckling and thaw-settlement effect assessments were included on the basis of professional judgment; no engineering analysis was carried out for the assessment of frequencies to be expected for these effects. Upheaval buckling was assumed to have a failure frequency of 20% of that of strudel scour. Thaw settlement was assumed to have a failure frequency of 10% of that of strudel scour. Table III-3 shows the variance in the pipeline Arctic effect inputs. The existing MMS databases on pipeline mileage were used as they stood with all their inherent inaccuracies. Arctic unique effects for platforms included ice force, low temperature and other. Table 4 shows the variance in the platform Arctic unique effect inputs. No Arctic unique effects were estimated for the wells, which were considered to blow out with frequencies the same as those for the Gulf of Mexico. The above information summarizes the input data to the fault trees and their uncertainty variation.

For further information the reader is directed to Bercha Group Inc. (2002).

B.2.b. Results for Large Spill Rates for Sale 195. Based on the Bercha Group, Inc. (2002) fault-tree analysis for Sale 195, MMS estimates the mean spill rates for platforms, pipelines, and platforms and pipelines total over the life of the project as follows:

Platforms	0.15 spills per billion barrels produced	3.0 spills per thousand years
Pipelines	0.10 spills per billion barrels produced	1.9 spills per thousand years
Total	0.25 spills per billion barrels	4.9 spills per thousand years

The annual rates were weighted by the annual production over the total production or the year over the total years, and the prorated rates were summed to determine the rates over the life of the project as shown above. Dr. Bercha (2004, pers. commun.) calculated confidence intervals on the total spill rate per billion barrels at the 95% confidence level as follows:

Type	Mean	95%
Total	0.25	0.21-0.30

These confidence limits include only variance in the Arctic effects. The confidence limits do not consider the variance in the baseline data (Gulf of Mexico and Pacific OCS spill statistics). Inclusion of that variance would, in our opinion, increase the above variance. Bercha Group, Inc. (2002) clearly identified the lack of accounting for the variance of non-Arctic effects as a possible limitation in their final report. The MMS began funding a study beginning in fiscal year 2004 titled *Improvements in the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas*. The variability in the non-Arctic effects are being addressed in this study and this information will be included in the 202 EA.

B.2.c. Estimates for the Number of Large Spills Occurring for Sale 195. The spill rates discussed in this section are all based on spills per billion barrels. Using the above mean large spill rates, Table III-5a shows the estimated mean number of large oil spills for Alternative I, the Proposed Action and alternatives. For the Proposed Action and alternatives, we estimate 0.04-0.05 pipeline spills and 0.07 platform (and well) spills for a total over the life of Sale 195 production of 0.11-0.12 spills. Table III-5b shows the estimated total number of oil spills for the Proposed Action and alternatives using spill rates at the 95% confidence interval. For the Proposed Action and alternatives, total spills over the life of the Sale 195 production range from 0.09-0.14 spills; that is, still only over a fraction of a spill. For purposes of analysis, one large spill was assumed to occur and was analyzed in the Beaufort multiple-sale EIS and this EA.

B.2.d. Method for Estimating the Chance of a Spill Occurring. The Poisson distribution is used for estimating oil-spill occurrence. Spill occurrence has been modeled previously as a Poisson process (Smith et al.,1982; Lanfear and Amstutz, 1983; Anderson and LaBelle, 1990, 1994; 2000). Because spill occurrences meet the criteria for a Poisson process, the following equations were used in our estimation of spill occurrence. The estimated volume of oil handled is the exposure variable.

Smith et al. (1982), using Bayesian inference techniques, presented a derivation of this process, assuming the probability of n spills over some future exposure t is expected to occur at random with a frequency specified by equation (1):

$$\text{P (n spills over future exposure t)} = \frac{(\lambda t)^n e^{-\lambda t}}{n!} \quad (1)$$

where λ is the true rate of spill occurrence per unit exposure. The predicted probability takes the form of a negative binomial distribution specified by equation (2):

$$P(n) = \frac{(n+v-1)!\,t^n \tau^v}{n!(v-1)!(t+\tau)^{n+v}} \quad (2)$$

where τ is past exposure and v is the number of spills observed in the past. The negative binomial is then shown to converge over time to the Poisson, with λ estimated using equation (3) (Smith et al., 1982):

$\lambda = v / \tau$ = (3)

Using the spill rate and the volume of oil assumed to be produced, the estimated mean number of spills is calculated. That number of spills is distributed as a Poisson distribution. The probability of one or more is equal to 1 minus the probability of zero spills. The probability of one or more spills occurring is calculated using the following equations.

$$P(n) = \frac{e^{-\lambda} * \lambda^n}{n!}$$

P(n) = probability of n spills occurring
n = specific number of spills
e = base of the natural logarithm
λ = parameter of the Poisson distribution (mean number of spills)

B.2.e. Estimates for the Chance of One or More Large Spills Occurring. The frequency distribution of larger oil spills, when corrected for decreasing spill rate in more recent decades, can be modeled as Poisson distribution (see the following section). An assumption of Poisson distribution allows the calculation of the chance of one or more oil spills. Using the above mean spill rates, Table III-5c shows the chance of one or more large pipeline spills is 4-5%, and the chance of one or more large platform spills is 7% for the Proposed Action and alternatives. The total is the sum of the platform and pipeline spills. The chance of one or more large spills total ranges from 10-11 % for the Proposed Action and alternatives based on the mean spill rate (Figure III-5). Table 5d shows the chance of one or more large spills total for the Proposed Action and alternatives using spill rates at the 95% confidence interval. For the Proposed Action and alternatives, the percent chance of one or more large spills total ranges from 9-13% (Figures B-6 and B-7).

B.2.f. Background Statistical Work. The basis for using a Poisson process for determining the probability of spill occurrence is found within the peer-reviewed literature. Anderson and LaBelle (2000) is the fourth of a series of independently peer-reviewed papers presented in support of oil-spill-rate assumptions used for oil-spill-occurrence estimates, with two earlier Anderson and LaBelle efforts (1994, 1990) and Lanfear and Amstutz (1983). The Lanfear and Amstutz (1983) report examines the cumulative frequency distributions of oil spills, tests pipeline miles as an alternative exposure variable for pipeline spills, and discusses the trend analysis of offshore spills performed by Nakassis (1982). These spill-rate papers tier off earlier work performed by Department of the Interior in support of the Oil-Spill-Risk Analysis (OSRA) Model, and work performed by other oil-spill researchers, as referenced in the papers.

The Smith et al. (1982) report documents the fundamentals of the Department of the Interior's OSRA Model. It describes the approach of using lambda, the unknown spill-occurrence rate for a fixed class of spills, as a parameter in a Poisson process, with volume of oil handled as an exposure variable to predict the probability of spill occurrence (Smith et al., 1982:18-24). A Bayesian methodology, described in detail in Appendix A of Smith et al., *Distribution Theory of Spill Incidence*, provides one way to weight the different possible values of lambda given the past frequency of spill occurrence for a fixed class of spills. Smith et al. (1982) selects volume as an exposure variable in that it is a quantity that would be more practical to estimate future exposure (a necessity for using it to forecast future spill occurrence) than the other exposure variables considered.

In support of using the Poisson process for spill occurrence and examinations of different exposure variables, Smith et al. (1982) references the works of Devanney and Stewart (1974), Stewart (1976), and Stewart and Kennedy (1978). These references, and other pertinent ones, can be found at Oil Spill Rates - Additional References on the MMS Web site located at http://www.mms.gov/eppd/sciences/osmp/spillraterefs.htm.

B.3. Summary. The chance of one or more large pipeline spills is 4-5%, and the chance of one or more large platform spills is 7% for the Proposed Action and alternatives. The total is the sum of the platform and pipeline spills. The chance of one or more large spills total ranges from 10-11 % for the Proposed Action and alternatives based on the mean spill rate. Using spill rates at the 95% confidence interval for the Proposed Action and alternatives, the percent chance of one or more large spills total ranges from 9-13%.

C.1. Oil-Spill-Risk Analysis (material from Section IV.A.1. of the Beaufort Sea Sale 195 Environmental Assessment). This section summarizes information on the oil-spill data and assumptions we used in the analysis of large spills in the EA for Beaufort Sea Sale 195, including information that was new since publication of the Beaufort Sea multiple-sale EIS in February 2003.

Information regarding the source, type, and sizes of oil spills; their behavior; the estimated path they follow; and the conditional and combined probabilities remain the same as discussed in the multiple-sale EIS in Section IV.A and Appendix B. For purposes of analysis, we assume one large spill of 1,500 barrels (bbl) or 4,600 bbl for crude or diesel oil, depending upon whether the assumed spill originates from a platform or a pipeline.

In our analysis, we assume the following fate of the crude oil without cleanup. After 30 days in open water or broken ice:

- 27-29% evaporates,
- 4-32% disperses, and
- 28-65% remains.

The chance of one or more large spills occurring is derived from two components: (1) the spill rate and (2) the resource volume estimates. The oil resource volume estimate remains 460 MMbbl, as discussed in USDOI, MMS (2003:Section II.B). Because sufficient historical data on offshore Arctic oil spills for the Beaufort Sea region do not exist to calculate a spill rate, a model based on a fault-tree methodology was developed and applied for the Beaufort Sea multiple-sale EIS (Bercha Group, Inc., 2002). Using fault trees, oil-spill data from the offshore Gulf of Mexico and California were modified and incremented to represent expected performance in the Arctic.

A recent laboratory study on the biodegradation of weathered Alaska North Slope crude indicates that low-dose oil locations are bioremediated more effectively than high-dose locations (Lepo et al., 2003). Prince et al. (2003) discuss three northern spills and demonstrate that photo-oxidation and biodegradation play an important role in the long-term weathering of crude oils. Photo-oxidation and biodegradation would continue to weather the 28-65% of the oil remaining.

After 30 days under landfast ice:

- nearly 100% of the oil remains in place and unweathered.

Oil spreading and floe motion were studied to determine how floe motion, ice concentration, slush concentration, and oil types affect spreading in ice. Spreading rates were lowered as ice concentrations increased; but for ice concentrations less than 20-30%, there was very little effect. Slush ice rapidly decreased spreading. If the ice-cover motion increased, then spreading rates increased, especially with slush ice present (Gjosteen and Loset, 2004). The new information helps to determine the specific behavior of oil under ice but does not change the above assumptions.

The chance of one or more large spills occurring is derived from two components: (1) the spill rate and (2) the resource volume estimates. The oil resource volume estimate remains 460 MMbbl, as discussed in the Beaufort Sea multiple-sale EIS (USDOI, 2003a:Section II.B). Because sufficient historical data on offshore Arctic oil spills for the Beaufort Sea region do not exist to calculate a spill rate, a model based on a fault-tree methodology was developed and applied for the Beaufort Sea multiple-sale EIS (Bercha Group, Inc., 2002). Using fault trees, oil-spill data from the offshore Gulf of Mexico and California were modified and incremented to represent expected performance in the Arctic.

Considering only the variance in the Arctic effects, our best estimate of the spill rate for large spills (greater than or equal to 1,000 bbl) from platforms and pipelines total is that there may be 0.25 oil spills (95% confidence interval 0.21-0.30 oil spills) per billion barrels produced. Considering only the variance in the Arctic effects, we are 95% confident that the spill rate for large spills from platforms and pipelines will be no more than 0.30 spills per billion barrels produced.

Using the platform and pipeline spill rates to estimate the mean spill number, we estimate the following: the chance of one or more large pipeline spills would be 4-5%, and the chance of one or more large platform spills would be 7% for Alternative I, the Proposed Action and its alternatives. The chance of one or more large spills from platforms and pipelines combined ranges from 10-11% for Alternative I, the Proposed Action and its alternatives based on the spill rate. Using the spill rate at the 95% confidence interval, the chance of one or more large spills from platforms and pipelines combined for Alternative I, the Proposed Action, and its alternatives ranges from 9-13%. Appendix B discusses how these spill rates were derived, and the reader is directed to Appendix B for more detail.

Regardless of the chance of spill occurrence, for purposes of analysis we analyzed the consequences of one large oil spill.

The multiple-sale EIS explains that the confidence estimate includes only part of the variability in the Arctic effects on the spill rate. The confidence estimate does not consider the variance in the baseline data (Gulf of Mexico and Pacific OCS spill statistics) or in the Sale 195 production estimate. Inclusion of these variances would, in our opinion, increase the range in the confidence interval.

During Fiscal Year 2004, the MMS prepared the procurement of the study NSL AK-04-02, entitled *Improvements in the Fault Tree Approach to Oil Spill Occurrence Estimators for the Beaufort and Chukchi Seas*. The confidence intervals due to non-Arctic effects were addressed in this study. The study was based on a fault-tree method that modifies the Gulf of Mexico oil-spill rates to expected Arctic oil. The results of this study were not available for Sale 195 analysis, but we expect they will be available for the Sale 202 analysis. We anticipate that this information will be available prior to the conclusion of this Endangered Species Act Section 7 consultation.

C.2. Oil-Spill Responses. The multiple-sale EIS explains that spill-response capability is required for OCS operations, and that an industry consortium stockpiles response equipment in the Prudhoe area for all three operating seasons in the Arctic: solid ice, open water, and broken ice (USDOI, MMS, 2003:Section IV.A.6). For the solid-ice season, spill-response demonstrations have shown that there are effective tactics and equipment for oil recovery. For the open-water season, the effectiveness of spill-response equipment is similar to that for other OCS areas. For the broken-ice season, the multiple-sale EIS (in Section IV.A.6.d) explained that research was ongoing. Recent spill demonstrations and drills have shown that the effectiveness of response equipment is still reduced greatly by broken ice. An industry spill-response consortium has designed tactics and equipment for the small pools of oil that tend to form around broken pieces of ice. For example, response demonstrations have been conducted on small test “spills” with skimmers on hydraulic booms that were mounted on ice-strengthened barge and with fireproof booms and in situ burning.

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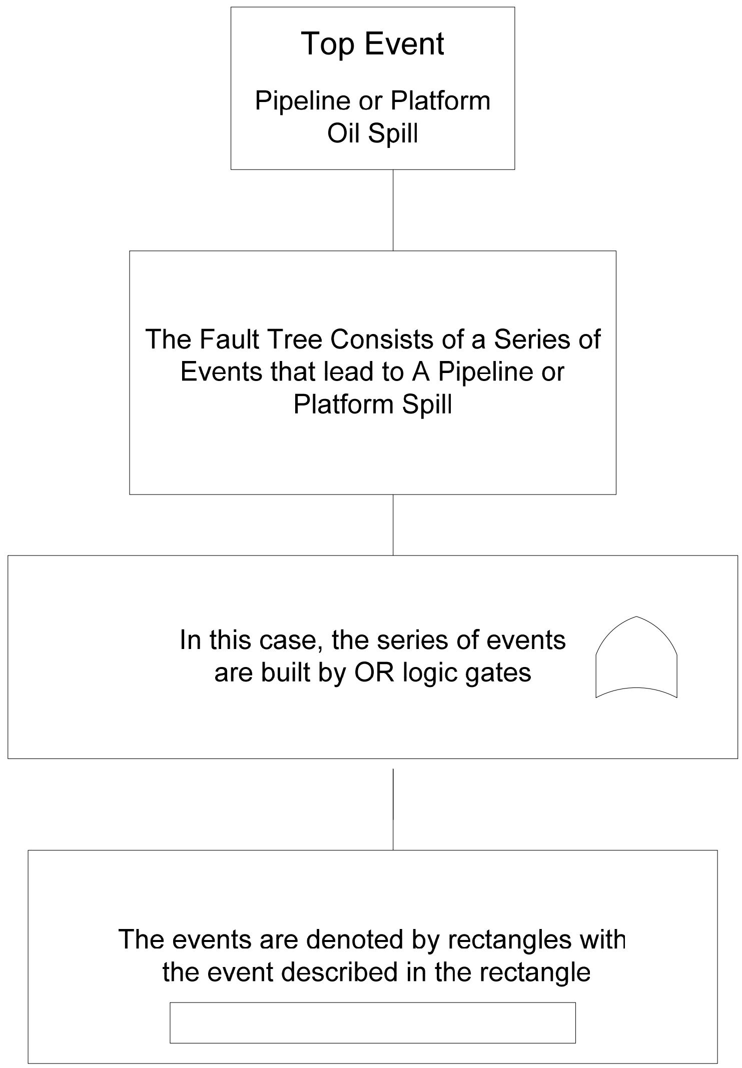

Figure B-1. Basic Parts of a Fault Tree

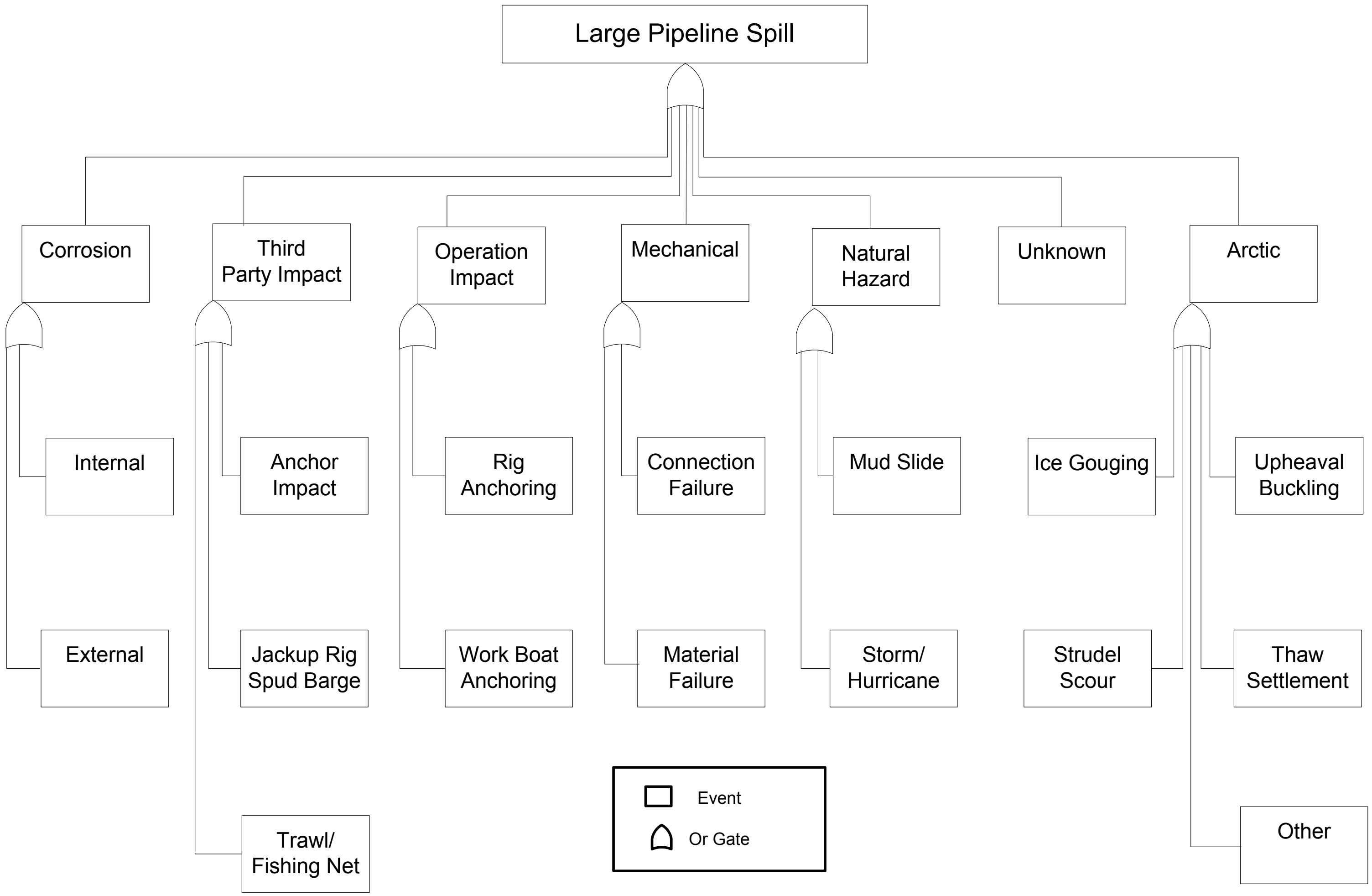

Figure III-2 Typical Fault Tree for A Pipeline Spill.

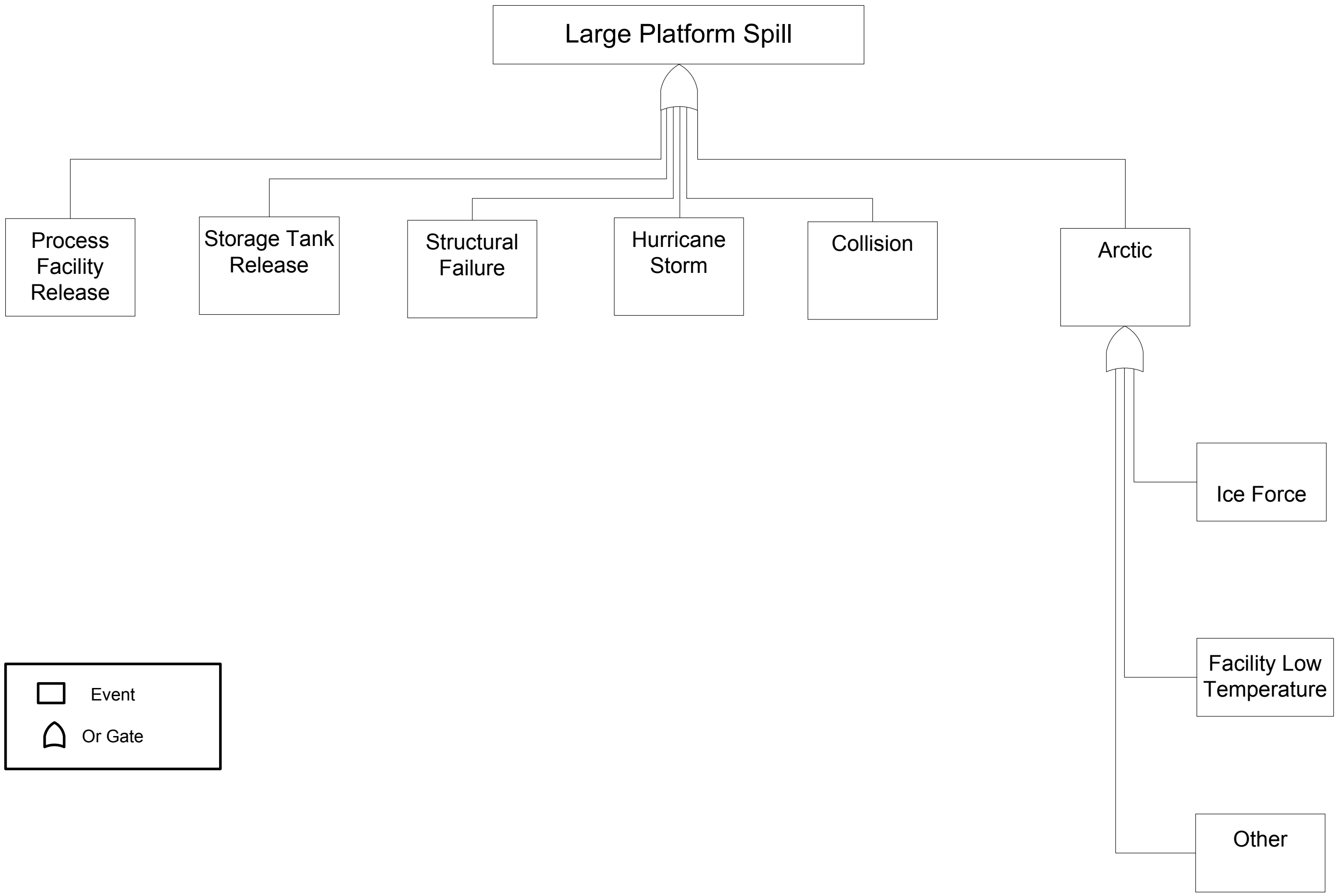

Figure III-3 Typical Fault Tree for a Platform Spill.

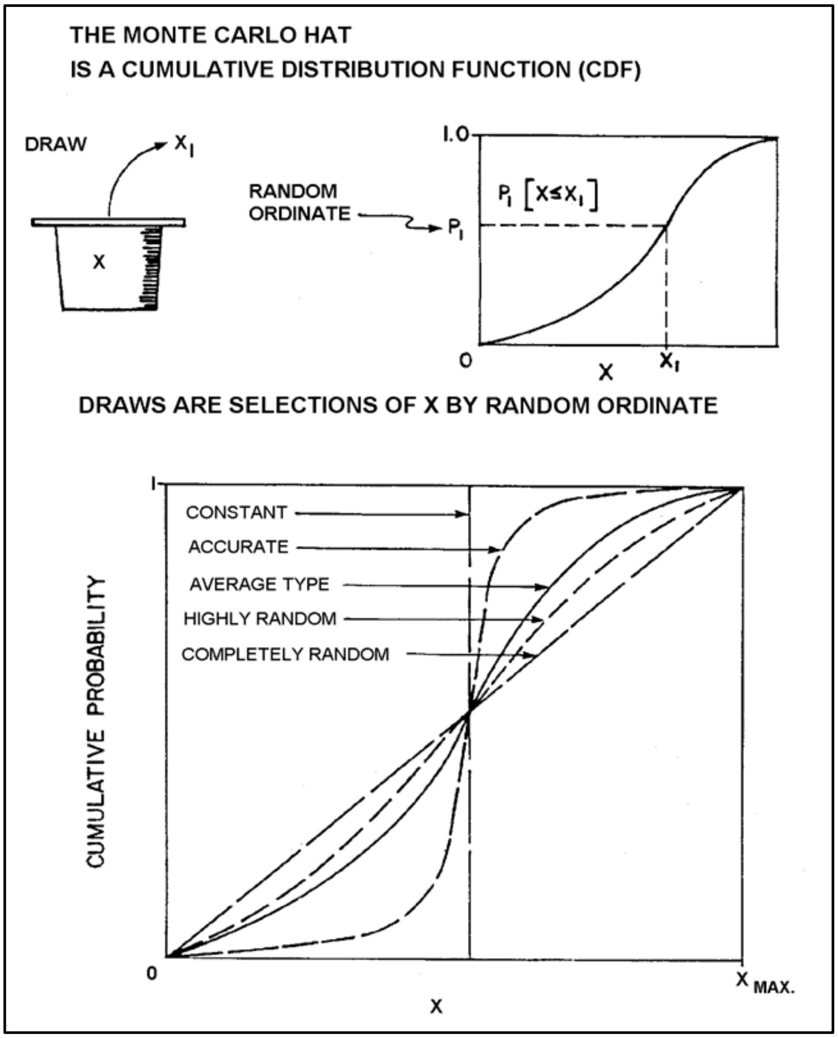

Figure III-4 Schematic of Monte Carlo Process as a Cumulative Distribution Function

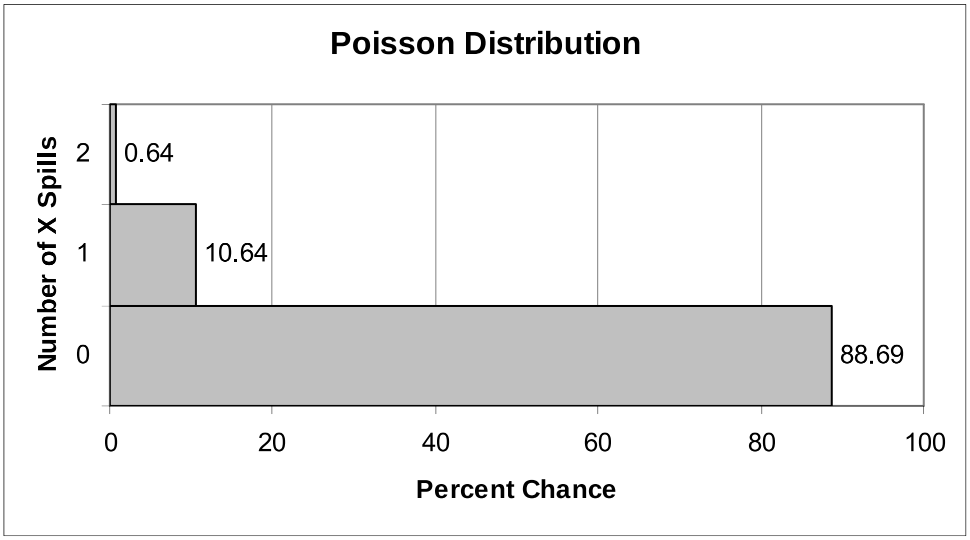

Figure III-5a. Alternative I Total (Pipeline and Platform)

Mean Number of Spills =0.12
Percent Chance of One or More = 11%
Percent Chance of No Spills = 89%

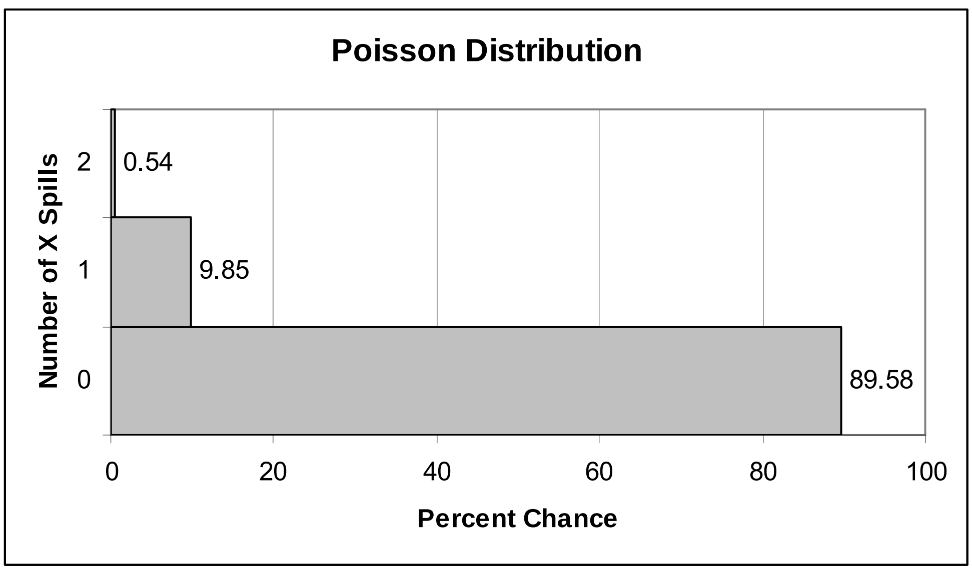

Figure III-5b. Alternatives III, IV, V and VI Total (Pipeline and Platform

Mean Number =0.11
Percent Chance of One or More = 10 %
Percent Chance of No Spills = 90%

Figure III-5 Poisson Distribution of Spill Occurrence Probabilities for Alternative I, the Proposed Action (Sale 195) and the Alternatives using the Mean Spill Rate.

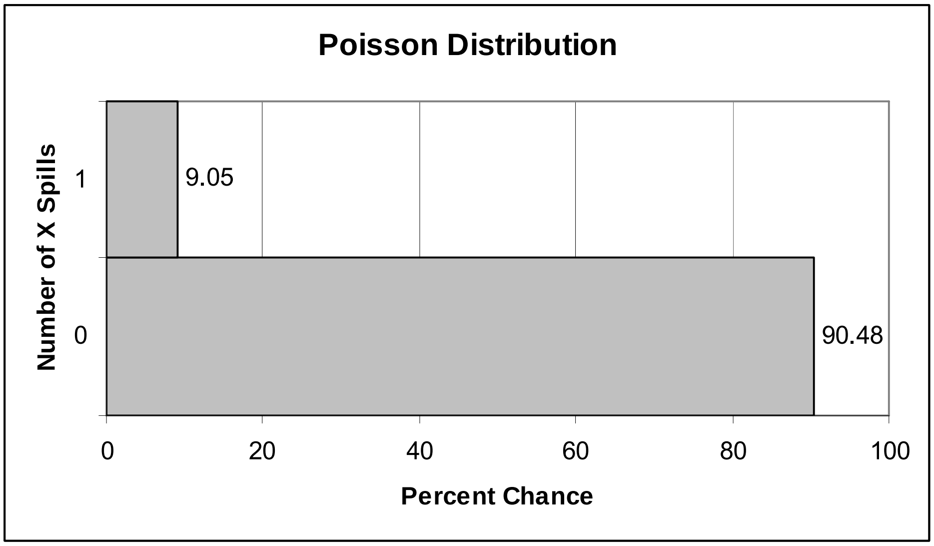

Figure III-6a. Alternative I and III Total (Pipeline and Platform)

Number of Spills = 0.1
Percent Chance of One or More = 10%
Percent Chance of No Spills = 90%

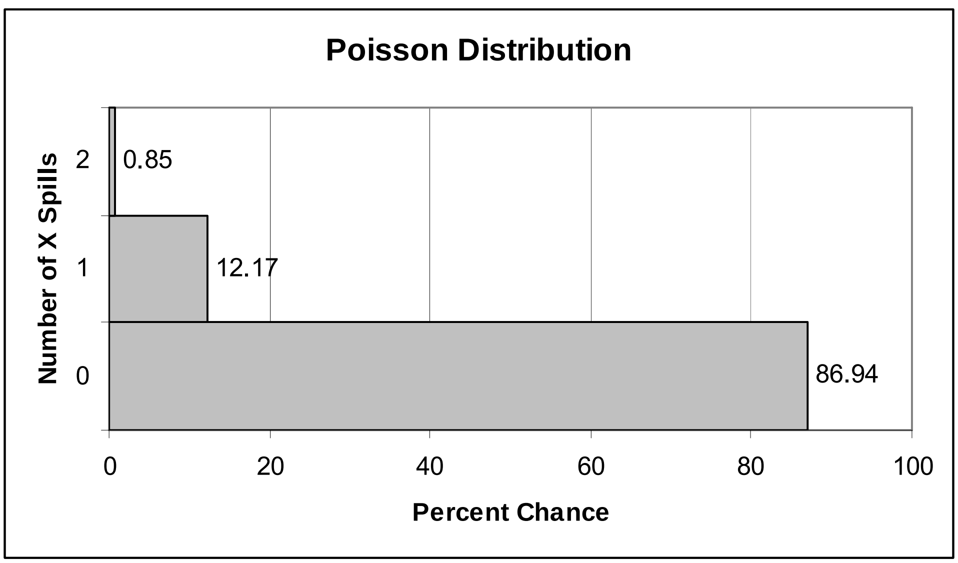

Figure III-6b. Alternative I and III Total (Pipeline and Platform)

Number of Spills = 0.14
Percent Chance of One or More = 13%
Percent Chance of No Spills = 87%

Figure III-6 Poisson Distribution of Spill Occurrence Probabilities for Alternative I, the Proposed Action and Alternative III (Sale 195) using the Spill Rates at the 95% Confidence Interval.

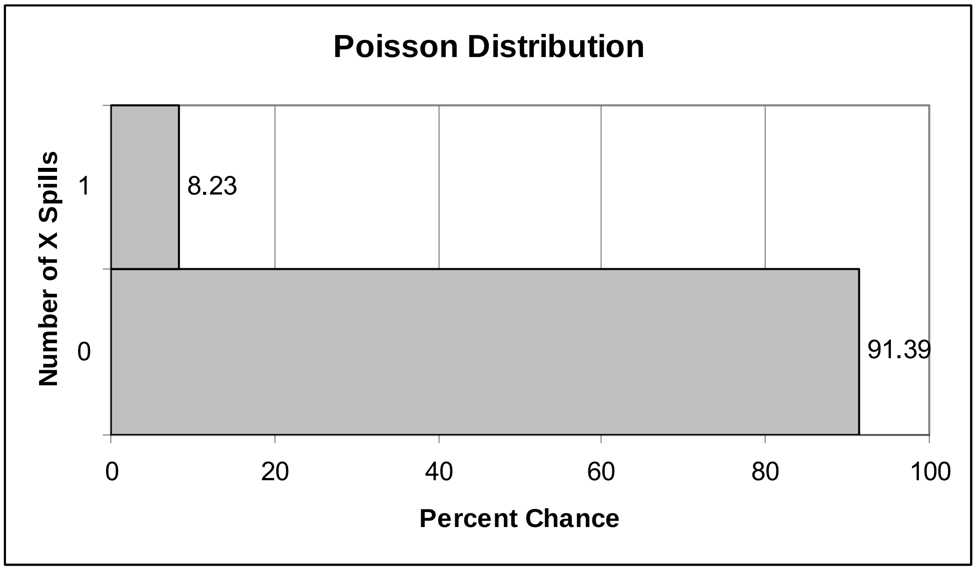

Figure III-7a. Alternative IV, V and VI Total (Pipeline and Platform)

Number of Spills = 0.09
Percent Chance of One or More = 9%
Percent Chance of No Spills = 91%

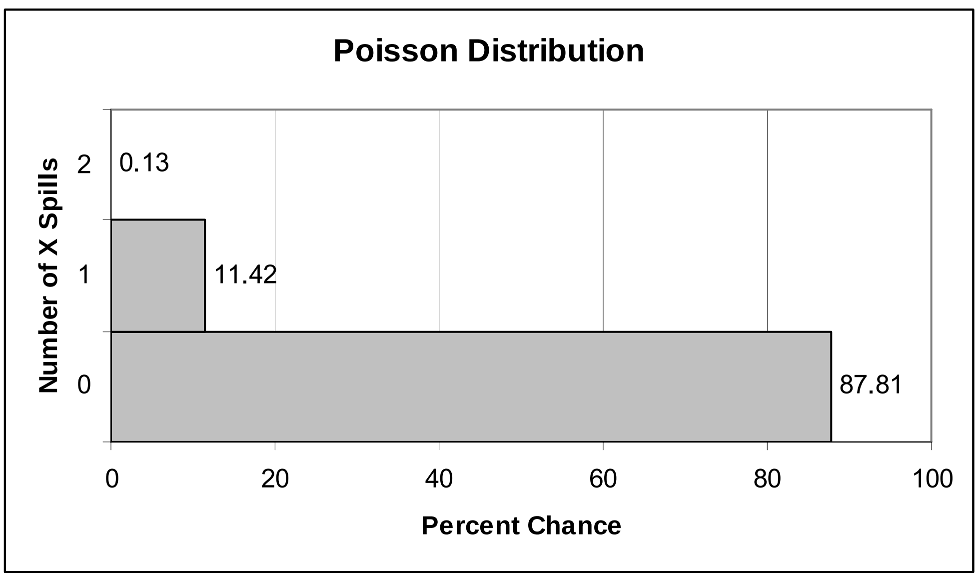

Figure III-7b. Alternative IV, V and VI Total (Pipeline and Platform)

Number of Spills = 0.13
Percent Chance of One or More = 12%
Percent Chance of No Spills = 88%

Figure III-7 Poisson Distribution of Spill Occurrence Probabilities for Alternatives IV, V and IV (Sale 195) using the Spill Rates at the 95% Confidence Interval.

Table III-1a
Pipeline Fault Tree Analysis Input Rationalization for Arctic Modified Events

Event Classification	Spill Size	Shallow	Medium	Deep	Reason
		Frequency Change %			
Arctic Modified					
Corrosion					
External	**All**	(50)	(50)	(50)	Lower temperature and biological effects. Extra smart pigging. State of art coatings
Internal	**All**	(30)	(30)	(30)	Additional inspection and smart pigging above historical levels.
Third Party Impact					
Anchor Impact	**All**	(90)	(90)	(90)	Low vessel traffic of third party shipping.
Jackup Rig or Spud Barge	**All**	(50)	(50)	(50)	Low facility density than historic data population in other OCS areas.
Trawl/Fishing Net	**All**	(90)	(90)	(90)	Low commercial-fishing activity.
Operation Impact					
Rig Anchoring	**All**	(20)	(20)	(20)	No marine traffic during ice season (8 months).
Work Boat Anchoring	**All**	(20)	(20)	(20)	No work boat traffic during ice season (8 months).
Mechanical					
Connection Failure	**All**	–	—	—	No change was made to account for Arctic effects.
Material Failure	**All**	—	—	—	No change was made to account for Arctic effects.
Natural Hazard					
Mud Slide	**All**	(80)	(60)	(40)	Gradient low. Mud slide potential (gradient) increases with water depth.
Storm/ Hurricane	**All**	(50)	(50)	(50)	Fewer severe storms. Damping of ocean surface by ice cover for 8 months.

Note:

All = All spill sizes combined

Table III-1b
Pipeline Fault Tree Analysis Input Rationalization for Arctic Unique Events

Arctic Unique Event Classification		Freq. Inc. per 10^5 km-yr			Reason
		Median	Median	Median	
Ice Gouging	S	0.3495	0.1747	–	Ice-gouge failure rate calculated using exponential failure distribution Hnatiuk and Brown, 1983; Weeks et al, 1983) for 2.5-m cover, 0.2-m average gouge depth, 4 gouges per km-yr flux (Leidersdorf et al., 2001; Lanan & Ennis, 2001). Frequency is distributed among different spill sizes.
	M	0.6178	0.3089	—	
	L	1.3438	0.6719	—	
	H	0.3762	0.1881	—	
Strudel Scour	S	0.0021	—	—	Only in shallow water. Average frequency of 4 scours/mile^2 and 100 ft of bridge length with 10% conditional P/L failure probability. The same spill size distribution as above.
	M	0.0038	—	—	
	L	0.0082	—	—	
	H	0.0023	—	—	
Upheaval Buckling	S	0.0004	0.0004	0.0004	All water depth. The failure frequency is 20% of that of Strudel Scour (Paulin et al., 2001).
	M	0.0008	0.0008	0.0008	
	L	0.0016	0.0016	0.0016	
	H	0.0005	0.0005	0.0005	
Thaw Settlement	S	0.0002	0.0002	0.0002	All water depth. The failure frequency is 10% of that of Strudel Scour (Paulin et al., 2001).
	M	0.0004	0.0004	0.0004	
	L	0.0008	0.0008	0.0008	
	H	0.0002	0.0002	0.0002	
Other	S	0.0881	0.0438	0.0002	To be assessed as 25% of above.
	M	0.1557	0.0775	0.0003	
	L	0.3386	0.1686	0.0006	
	H	0.0948	0.0472	0.0002	

Note:
S = Small (≥50and < 100 bbl)
M = Medium (≥100and < 1000 bbl)
L = Large (≥1000and < 10,000 bbl)
H = Huge (≥10,000)

Table III-2
Platform Fault Tree Input Rationalization

Event Classification	Spill Size	Frequency Change % Shallow	Medium	Deep	Reason
Arctic Modified					
Process Facility Release	All	(50)	(50)	(50)	State of the art now, High QC, High Inspection and Maintenance Requirements
Storage Tank Release	All	(30)	(30)	(30)	State of the art now, High QC, High Inspection and Maintenance Requirements
Structural Failure	All	(30)	(30)	(30)	High safety factor, Monitoring Programs
Hurricane/Storm	All	(80)	(80)	(80)	Less severe storms.
Collision	All	(90)	(90)	(90)	Very low traffic density.
–		Freq. Increment per 10^4 well-year Median Expected	Median Expected	Median Expected	–
Arctic Unique					
					Assumed 1/10000 years ice force causes spill. 85% of the spills are SM.
					Assumed 10% of Historical Process Facilities release frequency and corresponding spill size distribution.

						10% of above

Note:

All = All spill sizes combined
SM = Small (≥50and < 100 bbl) and M = Medium (≥100and < 1000 bbl)
LH= Large (≥1000and < 10,000 bbl) and H = Huge (≥10,000)

Table III-3
Arctic Pipeline Effects Uncertainty Variations

Event Classification	Spill Size	Water Depth								
		Shallow			Medium		Deep			
		Frequency Change %								
		Low	Expected	High	Low	Expected	High	Low	Expected	High
Arctic Modified										
Corrosion										
External	**All**	(25)	(50)	(75)	(25)	(50)	(75)	(25)	(50)	(75)
Internal	**All**	(15)	(30)	(45)	(15)	(30)	(45)	(15)	(30)	(45)
Third Party Impact										
Anchor Impact	**All**	(60)	(90)	(95)	(60)	(90)	(95)	(60)	(90)	(95)
Jackup Rig Or Spud Barge	**All**	(25)	(50)	(75)	(25)	(50)	(75)	(25)	(50)	(75)
Trawl/Fishing Net	**All**	(60)	(90)	(95)	(60)	(90)	(95)	(60)	(90)	(95)
Operation Impact										
Rig Anchoring	**All**	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)
Work Boat Anchoring	**All**	(10)	(20)	(30)	(10)	(20)	(30)	(10)	(20)	(30)
Mechanical										
Connection Failure	**All**	–	–	–	–	–	–	–	–	–
Material Failure	**All**	–	–	–	–	–	–	–	–	–
Natural Hazard										
Mud Slide	**All**	(50)	(80)	(90)	(30)	(60)	(90)	(20)	(40)	(60)
Storm/ Hurricane	**All**	(25)	(50)	(75)	(25)	(50)	(75)	(25)	(50)	(75)
Frequency Increment per 10^5 km-year										
Arctic Unique										
Ice Gouging	**S**	0.0060	0.0680	0.8290	0.0030	0.0340	0.4145	–	–	–
	M	0.0090	0.1210	1.4670	0.0045	0.0605	0.7335	–	–	–
	L	0.0210	0.2610	3.1900	0.0105	0.1305	1.5950	–	–	–
	H	0.0060	0.0730	0.8930	0.0030	0.0365	0.4465	–	–	–
Strudel Scour	**S**	0.0004	0.0012	0.0044	–	–	–	–	–	–
	M	0.0006	0.0020	0.0078	–	–	–	–	–	–
	L	0.0014	0.0045	0.0170	–	–	–	–	–	–
	H	0.0004	0.0012	0.0048	–	–	–	–	–	–
Upheaval Buckling	**S**	0.00007	0.00023	0.00088	0.00007	0.00023	0.00088	0.00007	0.00023	0.00088
	M	0.00013	0.00041	0.00156	0.00013	0.00041	0.00156	0.00013	0.00041	0.00156
	L	0.00028	0.00089	0.00340	0.00028	0.00089	0.00340	0.00028	0.00089	0.00340
	H	0.00008	0.00025	0.00095	0.00008	0.00025	0.00095	0.00008	0.00025	0.00095
Thaw Settlement	**S**	0.00004	0.00012	0.00044	0.00004	0.00012	0.00044	0.00004	0.00012	0.00044
	M	0.00006	0.00020	0.00078	0.00006	0.00020	0.00078	0.00006	0.00020	0.00078
	L	0.00014	0.00045	0.00170	0.00014	0.00045	0.00170	0.00014	0.00045	0.00170
	H	0.00004	0.00012	0.00048	0.00004	0.00012	0.00048	0.00004	0.00012	0.00048
Other	**S**	0.00162	0.01738	0.20869	0.00078	0.00859	0.10396	0.00003	0.00009	0.00033
	M	0.00246	0.03092	0.36929	0.00117	0.01528	0.18396	0.00005	0.00015	0.00059
	L	0.00571	0.06670	0.80303	0.00273	0.03296	0.40003	0.00011	0.00033	0.00128
	H	0.00163	0.01865	0.22480	0.00078	0.00922	0.11198	0.00003	0.00009	0.00036

Note:
All = All spill sizes combined
S = Small (≥50and < 100 bbl)
M = Medium (≥100and < 1000 bbl)
L = Large (≥1000and < 10,000 bbl)
H = Huge (≥10,000)

Table III-4
Arctic Platform Effects Uncertainty Variations

Cause Classification	Spill Size	Shallow			Medium			Deep		
		Frequency Change %								
		Low	Expected	High	Low	Expected	High	Low	Expected	High
Arctic Modified										
Process Facility RIs.	**All**	(30)	(50)	(80)	(30)	(50)	(80)	(30)	(50)	(80)
Storage Tank RIs.	**All**	(20)	(30)	(40)	(20)	(30)	(40)	(20)	(30)	(40)
Structural Failure	**All**	(20)	(30)	(40)	(20)	(30)	(40)	(20)	(30)	(40)
Hurricane/Storm	**All**	(25)	(50)	(75)	(25)	(50)	(75)	(25)	(50)	(75)
Collision	**All**	(60)	(90)	(95)	(60)	(90)	(95)	(60)	(90)	(95)
		Frequency Increment per 10^4 well-year								
Arctic Unique										
Ice Force	**SM**	0.003	0.034	0.340	0.005	0.051	0.510	0.008	0.077	0.765
	HL	0.001	0.006	0.060	0.001	0.009	0.090	0.001	0.014	0.135
Facility Low Temperature	**SM**	0.050	0.100	0.150	0.050	0.100	0.150	0.050	0.100	0.150
	HL	0.004	0.008	0.012	0.004	0.008	0.012	0.004	0.008	0.012
Other	**SM**	0.005	0.013	0.049	0.006	0.015	0.066	0.006	0.018	0.092
	HL	0.000	0.001	0.007	0.000	0.002	0.010	0.001	0.002	0.015

Note:

All = All spill sizes combined
SM = Small (≥50and < 100 bbl) and M = Medium (≥100and < 1000 bbl)
LH= Large (≥1000and < 10,000 bbl) and H = Huge (≥10,000)

Table III-5a
Estimated Mean Number of Large Platform, Pipeline and Total Spills for Alternative I, the Proposed Action (Sale 195) and its Alternatives

Alternative		Mean Number of Platform Spills	Mean Number of Pipeline Spills	Mean Number of Spills Total
I	Alternative I	0.07	0.05	0.12
II	No Sale	0	0	0
III	Barrow Subsistence Whale Deferral	0.07	0.05	0.11
IV	Nuiqsut Subsistence Whale Deferral	0.07	0.04	0.11
V	Kaktovik Subsistence Whale Deferral	0.07	0.05	0.11
VI	Eastern Deferral	0.07	0.05	0.11

Note:

Mean Number of Spills is rounded to two decimal places after multiplying the spill rate times the resource volume. Hence total may not equal platform plus pipeline.

Table III-5b
Estimated Number of Total Spills for Alternative I, the Proposed Action (Sale 195) and its Alternatives Using Spill Rates at the 95% Confidence Interval

Alternative		Number of Spills Total
I	Alternative I	0.10-0.14
II	No Sale	0
III	Barrow Subsistence Whale Deferral	0.10-0.14
IV	Nuiqsut Subsistence Whale Deferral	0.09-0.13
V	Kaktovik Subsistence Whale Deferral	0.09-0.13
VI	Eastern Deferral	0.09-0.13

Note:

Mean Number is rounded to the two decimal places after multiplying the spill rate times the resource volume.

Table III-5c
Estimated Percent Chance of One or More Large Platform, Pipeline and Total Spills for Alternative I, the Proposed Action (Sale 195) and its Alternatives

Alternative		Percent Chance of One or More Platform Spills	Percent Chance of One or More Pipeline Spills	Percent Chance of One or More Spills Total
I	Alternative I	7	5	11
II	No Sale	0	0	0
III	Barrow Subsistence Whale Deferral	7	5	10
IV	Nuiqsut Subsistence Whale Deferral	7	4	10
V	Kaktovik Subsistence Whale Deferral	7	5	10
VI	Eastern Deferral	7	5	10

Table III-5d
Estimated Percent Chance of One or More Total Spills for Alternative I, the Proposed Action (Sale 195) and its Alternatives Using the Spill Rates at the 95% Confidence Interval

Alternative		Percent Chance of One or More Spills Total
I	Alternative I	10-13
II	No Sale	0
III	Barrow Subsistence Whale Deferral	10-13
IV	Nuiqsut Subsistence Whale Deferral	9-12
V	Kaktovik Subsistence Whale Deferral	9-12
VI	Eastern Deferral	9-12

Appendix IV

Preliminary Oil-Spill Analysis for the Chukchi Sea Planning Area

A. Introduction. The MMS previously provided oil spill analyses to NMFS in Section IV and Appendix C of the final EIS for Chukchi Sea Oil and Gas Lease Sale 126 (USDOI, MMS, 1990). These analyses are more than 15 years old, and new information is now available. The MMS currently is undertaking analyses to re-evaluate oil-spill risks for the Chukchi Sea Planning Area, and the full results of those analyses are expected to be available in the near future. When the new analyses are available, MMS will provide this information to NMFS with a full evaluation of the potential risk to ESA-listed whales from oil spills potentially resulting from oil and gas development and production in the Chukchi Sea Planning Area. Below, we provide very preliminary findings from these analyses.

These large spill rates are preliminary results provided to MMS by the Bercha Group Inc. on January 26, 2006. These results will be subjected to further quality assurance/quality control tests prior to the final report. Changes in the results may occur during the review of the results and report writing. The final report is not anticipated until May 2006.

The chance of a spill occurring does not factor in the chance that a development project occurs. Given the many logistical, economic, and engineering factors, there is probably less than 10% chance that a commercial field will be leased, discovered, and developed. However, because leasing and exploration could lead to a development project, MMS must evaluate what would happen if a development occurred, even though the chance of that happening is probably very small in a frontier area like the Chukchi Sea. Our oil spill risk analysis for a large spill occurring assumes there is a 100% chance that a project will be developed and 1 Bbbl of oil will be produced. Clearly, this overstates the risks associated with leasing and exploration in the Chukchi Sea. If development were to occur, then this oil spill risk analysis would represent the inherent risk.

B. Preliminary Draft Results for Large Spill Rates for Chukchi Sea Sale 193. Based on the Bercha Group, Inc. (2006, pers. commun.) fault-tree analysis for Sale 193, MMS estimates the mean spill rates for platforms, pipelines, and platforms and pipelines total over the life of the project as follows:

Type	Mean	Mean
Platforms	0.21 spills per billion barrels produced	6 spills per thousand years
Pipelines	0.30 spills per billion barrels produced	8 spills per thousand years
Total	0.51 spills per billion barrels	14 spills per thousand years

The annual rates were weighted by the annual production over the total production or the year over the total years, and the prorated rates were summed to determine the rates over the life of the project, as shown above. Dr. Bercha (2006, pers. commun.) calculated confidence intervals on the total spill rate per billion barrels at the 95% confidence interval (CI) are as follows:

Type	Mean	95% CI
Total	0.51	0.32-0.77

Preliminary Draft Estimates for the Number and Chance of One or More Large Spills Occurring for Chukchi Sea Sale 193. The large spill rates discussed in this section are all based on spills per billion barrels. Using the above mean large spill rates, Table IV-1 shows the estimated mean number of large oil spills for Alternative I, the Proposed Action. For the Proposed Action, we estimate 0.30 pipeline spills and 0.21 platform (and well) spills, for a total over the life of Sale 193 production of 0.51 spills. Table IV-1 shows the estimated total number of oil spills for the Proposed Action using spill rates at the 95% confidence interval. For the Proposed Action, total spills over the life of the Sale 195 production range from 0.32-0.77 spills at the 95% confidence interval. For purposes of analysis, one large spill was assumed to occur and is analyzed.

Using the above mean spill rates, Table IV-1 shows the chance of one or more large pipeline spills is 26%, and the chance of one or more large platform spills is 19% for the Proposed Action and alternatives. The total is the sum of the platform, wells and pipeline spills. The chance of one or more large spills total is 40% for the Proposed Action. Table IV-1 shows the chance of one or more large spills total for the Proposed Action using spill rates at the 95% confidence interval. For the Proposed Action, the percent chance of one or more large spills total ranges from 27-54% at the 95% confidence interval.

Table IV-1. Preliminary Draft Estimated Mean Number and Percent Chance of No and One or More Large Platform, Pipeline and Total Spills for Alternative I, the Proposed Action (Sale 193)

Sale 193 Proposed Action	Oil Volume (Bbbl)	Spill Rate Per Bbbl	Mean Number of Spills	Percent Chance of No Spills	Percent Chance of One or More Spills
Platform & Wells	1	0.21	0.21	81	19
Pipeline	1	0.30	0.30	74	26
Total	1	0.51	0.51	60	40
Total					
95% Confidence Interval Lower Bound	1	0.32	0.32	73	27
95% Confidence Interval Upper Bound	1	0.77	0.77	46	54

Bercha Group Inc. (2006). Email dated January 26, 2006, to Richard Prentki and Caryn Smith, MMS, Alaska OCS Region, from Dr. Frank Bercha; subject: Emailing: C5 Conclusions, C4_1ChukchiSeaResults, Attachments: C5 Conclusions, C4_1ChukchiSeaResults

APPENDIX V

INDUSTRIAL ACTIVITIES CONSIDERED IN BASELINE AND CUMULATIVE EFFECTS ANALYSIS FOR THE ARCTIC REGION BIOLOGICAL EVALUATION

The following discussion updates the cumulative effects analysis of the Beaufort Sea multiple-sale (Sales 186, 195, and 202) final Environmental Impact Statement (EIS) and the Environmental Assessment (EA) for Proposed Oil and Gas Lease Sale 195, Beaufort Sea Planning Area. Two sections have been added that were not included in the multiple-sale final EIS or Sale 195 EA. These sections are:

- **Beaufort Sea Exploration History** - This section provides a summary of historic offshore seismic surveys and exploration activities in the Beaufort Sea. Previous cumulative effects analyses have not included historic geophysical seismic surveys or exploratory drilling activities. Previous leasing and exploration activities (both seismic surveying and exploration drilling) were more intense that what we anticipate might occur in the near future. However, MMS has decided to include this information in the cumulative effects assessment for the ARBO because of the increased potential for offshore seismic and exploratory drilling activity in the Beaufort Sea following the success of the Beaufort Sea lease sales 186 and 195 and in consideration of the relative importance of noise-generating sources in assessing effects to marine mammals.
- **Chukchi Sea** - This section provides a discussion of activities to consider in the cumulative effects analysis for the Chukchi Sea.

A. North Slope/Beaufort Sea. Oil and gas development is the main agent of industrial-related change on the North Slope. Oil and gas exploration and production activities have occurred on the Alaska North Slope/Beaufort Sea region for more than 50 years. Past industrial development that occurred in association with this production included the creation of an industry support community and airfield at Deadhorse and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. In 1977, the Trans-Alaska Pipeline System (TAPS) was developed to transport North Slope crude oil to a year-round marine terminal in Valdez, Alaska, and it continues today and for the foreseeable future to transport the entire production from the North Slope. In November 2002, an EIS was written and the TAPS Right-of-Way was renewed for another 30 years by both State and Federal agencies.

For our analysis, we formulate oil and gas scenarios based on our estimate of future activities. Our scenarios are conceptual views of the future. Underlying the cumulative-effects assessment, we offer scenarios on the timing and extent of future petroleum activities in the Beaufort Sea and on the North Slope. Estimates of anticipated production consider many factors, including the economically recoverable resources of the area, past industry leasing and exploration efforts, and future economic conditions.

In the Beaufort Sea, 9 of 25 scheduled Federal sales were held, and of the 13,629 tracts (13,699 blocks) offered for lease in the 9 sales, 839 were leased. Some tracts have been leased multiple times; many tracts have been offered for lease multiple times and have not received bids. Few of the leases were tested by exploratory drilling (30 wells on 20 prospects). Most discoveries (9 wells determined to be producible) were too small or too costly to become viable fields at the time of discovery (one field, Northstar, is now producing). Under optimum conditions, the chance that commercial fields will be discovered could be 10-20%. However, on the North Slope and Beaufort Sea, the success rate for finding new commercial fields is likely to be lower.

For the three lease sales analyzed in the multiple-sale EIS (Sales 186, 195, and 202), MMS looked at a range of fields–from those located nearshore in shallow waters to those at remote locations in deeper water. For development of the scenario, MMS assumed that industry would first lease and explore tracts that are nearer to existing infrastructure. The MMS still expects that more than 50% of the tracts leased in the three lease sales will be located in the Near Zone (Table III.A.1 of the multiple-sale EIS). As a result of Sales 186 and 195, a total of 151 leases were awarded.

We focus our cumulative analysis on the following:

- Oil and gas discoveries that have a reasonable chance of being developed during the next 5-20 years.
- Exploration and development of additional undiscovered resources (onshore and offshore) that could occur during the next 5-20 years.
- Some exploration and development activities that could occur after the 5-20 years from future State and Federal lease sales.
- Transportation of oil in the TAPS and tankering of oil to western ports.
- Activities other than oil and gas such as sport and subsistence hunting and fishing, commercial fishing, sport harvest, loss of overwintering range, tourism, and recreational activities.

Table V-1 lists North Slope oil and gas discoveries. Table V-2 lists the current and proposed transportation projects and Table V-3 lists future lease-sale activities we consider in this cumulative analysis. Figure III.A-1 shows the location of fields and discoveries in Table V-1and areas of exploration.

For purposes of this cumulative scenario, we divide oil and gas discoveries listed in Table V-1 into the following categories:

- **Past Development/Production:** 33 fields and satellites. Endicott, Sag Delta, Sag Delta North, Point McIntyre, Niakuk, Badami, Eider, and Northstar fields are located offshore.
- **Present Development/Production:** 1 discovery, the onshore CD North (Fjord) field, is expected to start up within the next few years.
- **Reasonably Foreseeable Future Development:** 19 discoveries that might see some development-related activities (site surveys, permitting, appraisal drilling, or construction) within the next 5-20 years. Offshore discoveries in this category are Oooguruk, Tuvaaq, Liberty, Kalubik, Thetis Island, Gwydyr Bay, Flaxman Island, Sandpiper, Stinson, Hammerhead, Kuvlum, and Nikaitchua. Additional onshore resources (estimated 2.30 billion barrels [Bbbl]) and offshore resources (estimated 1.38 Bbbl) currently are undiscovered.

- **Speculative Development:** Additional new discoveries could be made and developed beyond 20 years. The chance for development is too uncertain for detailed analysis at this time. All gas resources fit into this category because of the lack of a transportation system. Additional exploration activities (wells and seismic surveys) are likely to occur and have been factored into the analysis.

We focus on the first three categories and consider exploration activities of the fourth category. We recognize that oil companies may produce oil from pools in the speculative development category. However, there is no way to know this with any degree of certainty, because insufficient information exists to estimate the development activities associated with undiscovered pools. Some discoveries date back to 1946 without subsequent development. It is possible that oil companies also would not develop some prospects in the reasonably foreseeable category within the 5- to 20-year timeframe. We estimate a total resource amount for the speculative category from industry and government reports. Offshore undiscovered resource estimates are based on MMS's 2006 National Assessment minus discoveries included as possible outer continental shelf (OCS) projects (Table V-4).

A.1. Past Development/Production. This category includes producing fields on the North Slope and nearshore areas of the Beaufort Sea. Infrastructure, cumulative production, and remaining reserves are well defined. Individual oil pools can be developed together as fields that share common wells, production pads, and pipelines. Fields can be grouped into production units with common infrastructure, such as processing facilities. Impacts associated with development have occurred over the past three decades, and there are data from monitoring that accurately reflect some of the long-term effects.

This category contains 33 discoveries, all of which are now producing oil (see numbers 1 through 33 in Table V-1). Table V-5 lists production and reserve data, and Table V-6 lists infrastructure and facilities for these producing fields. Endicott, Sag Delta, Sag Delta North, Point McIntyre, Niakuk, Badami, Eider, and Northstar production facilities located offshore. All of the others are onshore on State leases.

A.2. Present Development/Production (Within the Next Few Years). This category includes fields that are in planning stages for development but that have not begun production. Infrastructure components, scheduling, and reserve estimates are fairly well defined, although reserve volumes could be revised later. Commonly, new planned developments will be tied into existing infrastructure, and they depend on the continued operation of this infrastructure.

This category contains one discovery: CD North (Fjord) (Table V-1). Table V-7 lists reserve estimates, and Table V-8 lists the infrastructure the oil companies propose for this discovery.

A.3. Reasonably Foreseeable Future Development/Production (Within the Next 5-20 Years). The MMS developed the information about reasonably foreseeable future development and production and considers it the best available information. This category includes activities for which development-related activities reasonably foreseeable within the next 5-20 years. It is reasonable to expect that development would begin with discoveries in close proximity to existing (past and present) fields to share infrastructure. Resource volumes are uncertain in this category. There generally are inadequate drilling data to define reserves or engineering studies to support development. We cannot predict the development timing for future fields. Many of these discoveries were made decades ago and remain noncommercial today. Without technology advancements and higher petroleum prices, many of these discoveries could remain undeveloped.

This category includes 19 discoveries that oil companies may begin to develop in the next 5-20 years (see numbers 35 through 53 in Table V-1). Offshore discoveries in this category are Oooguruk, Tuvaaq, Liberty, Kalubik, Thetis Island, Gwydyr Bay, Flaxman Island, Sandpiper, Stinson, Hammerhead, Kuvlum, and Nikaitchua. (Kuvlum and Hammerhead are names of two prospects drilled and discovered in the early 1990s, but the original leases were relinquished and some of the tracts reacquired in lease sale 195.) Table 6.A lists the resource estimates for these fields. Liberty, Sandpiper, Hammerhead, and Kuvlum are on offshore Federal leases Spark/Rendezvous is a recent discovery in northeastern National Petroleum Reserve-Alaska. All of the others are on State leases or North Slope Borough lands. Liberty, Gwydyr Bay, and Kalubik are offshore discoveries that are likely to be developed from onshore sites.

While the list of reasonably foreseeable future developments includes only discoveries, there could be significant amounts of oil produced by enhanced oil recovery from existing fields as well as from undiscovered satellite pools close to infrastructure areas. Enhanced recovery adds additional production from known reservoirs, creating “reserve growth.” For example, the Prudhoe Bay field was originally estimated to hold 9.6 Bbbl of reserves, and now it has reserves approaching 13 Bbbl.

More than 3 Bbbl were added by using enhanced recovery technologies. In addition, industry has indicated that they have a large number of prospects very close to existing infrastructure that may become future satellite pools. Although both of these new resources (reserve growth and satellites) are as yet undiscovered, it is reasonable to assume that a significant portion would be brought into production in the next 20 years or sooner. For purposes of analysis, we assume that half of the total (4 Bbbl) estimate for enhanced recovery and satellite fields (or 2 Bbbl) would be brought into production in the foreseeable future. Because satellite fields largely would be developed from existing infrastructure, the incremental addition of new infrastructure is minor.

The discussion of reasonably foreseeable future development/production will include the effects of production decline from existing fields, the current proposals for new development, and estimates of potential development associated with recent and proposed lease sales. Tables V-9a and V-9b indicate the possible development infrastructure, should these discoveries be commercially developed. Oil produced from the Gwydyr Bay, Pete’s Wicked, and Sandpiper discoveries could be transported through the Northstar pipeline, while the Badami field trunk pipeline could provide transport for other discoveries in the eastern North Slope listed in Table VI-9a. An indication of the infrastructure that may be required if these discoveries are developed is listed in Table VI-9b.

A.4. Speculative Development (After 20 Years). This category includes small discoveries and undiscovered resources that are very unlikely to be developed in the timeframe of less than 20 years. Some of the discoveries listed in Table V-1 were made 50 years ago and remain noncommercial today. There are a variety of reasons that make near-term or mid-term development of these discoveries unlikely. These factors include very remote locations, low production rates, and lack of gas-transportation systems. The influence of these factors is expected to continue into the foreseeable future.

Speculative resources include both discovered (uneconomic) and undiscovered (speculative) resources that may be developed after more than 20 years (Tables V-10a and V-10b). Future development depends on favorable economic conditions. This category also includes undiscovered oil resources expected to be developed as a result from future State and Federal lease sales (Table V-3). Table V-10b lists speculative production from three sources: (1) enhanced recovery and satellite onshore accumulations near existing onshore infrastructure (50% of the 4.0-Bbbl total); (2) another 0.3 and 0.37 Bbbl and assumed to be discovered and developed in the northeast and northwest National Petroleum Reserve-Alaska; and (3) a portion of the undiscovered resource base for offshore. Because these resources are undiscovered, no specific location or potential field size can be provided. Although the individual resource volumes are not known, this category also includes 15 discoveries that may be developed after 20 years (see numbers 54 through 68 in Table V-1). All these discoveries are located onshore.

With respect to undiscovered resources, it is not reasonable to estimate new infrastructure or predict the effects of development for prospects that have not been located or leased to industry for exploration. Accurate predictions of the location, size, or development schedule are not possible at this time. Various government and industry groups publish resource estimates that often vary widely for a given area. However, these groups use very different methodologies and reporting criteria. It is difficult to discern how these speculative undiscovered resource estimates would translate in future infrastructure and effects.

Development of gas resources on the North Slope is included in the speculative category, because gas has been uneconomic to produce for several decades and may continue to be uneconomic in the future. Various plans have been studied to bring North Slope gas to market. Several proposals for gas pipelines from the North Slope have been put forth and are being considered, but no agreement to build any of the projects has been reached. The potential for a natural gas transportation system is discussed further in Section A.9.b.

A.5. Oil Production on the North Slope of Alaska

A.5.a. Production through 2000. Since the first production well was drilled on the Prudhoe Bay structure, North Slope developments produced 13.306 Bbbl of oil by the end of 2000 (Table V-11). Production on the North Slope peaked in 1988 at 2.0 MMbbl of oil per day, declining to its current rate of 0.95 MMbbl per day. Of the producing fields on the North Slope, the most productive, in order, are Prudhoe Bay, Kuparuk River, Point McIntyre, and Endicott.

A.5.b. Resource Estimates We Used for This Cumulative Scenario. Tables V-10a and V-10b show the reserve and resource estimates we use for this cumulative scenario. We use a low estimate of 6 Bbbl, a midrange estimate of 11 Bbbl, and a high estimate of 15 Bbbl for oil reserves and resources that may be produced on the onshore North Slope and in the Beaufort Sea.

A.5.b(1) The Low Range-Past and Present Production. The low end of the range for this cumulative scenario is 6 Bbbl (rounded) and includes past and present production (Tables V-10a and V-10b). This estimate includes reserves (5.284 Bbbl) in currently producing fields and resources (0.305 Bbbl) in discoveries in the planning or development stage. Each Beaufort Sea OCS sale in the current 5-Year Program (Sales 186, 195, and 202) represents approximately 7.0% by reserve volume of the past and present production volumes (Table V-10a).

A.5.b(2) The Midrange - Past, Present, and Reasonably Foreseeable Future Production. The midrange estimate for the cumulative analysis is 11 Bbbl (rounded) and includes past, present, and reasonably foreseeable future production. This includes the 6 Bbbl (rounded) from the low range estimate (above) plus discoveries that may be developed in the next 20 years. Reasonably foreseeable future production (5.62 Bbbl) consists of discoveries totaling 0.500 Bbbl onshore and 1.070 Bbbl offshore (Table V-10b). In addition, undiscovered onshore resources of 2.670 Bbbl in satellite accumulations and new fields in the National Petroleum Reserve-Alaska, plus 1.38 Bbbl from tracts expected to be leased on the OCS (Tables V-10a and V-10b). Each Beaufort Sea OCS sale in the current 5-Year Program (Sales 186, 195, and 202) represents about 4% by reserve volume of the past, present, and reasonably foreseeable future production (Table V-10a).

A.5.b(3) The High Range - Past, Present, Reasonably Foreseeable Future, and Speculative Production. The high range estimate for the cumulative analysis is 15 Bbbl (rounded) and includes existing, planned, possible, and speculative production. This estimate includes 11 Bbbl from the midrange estimate (above) plus speculative future production (3.59 Bbbl), which includes undiscovered resources that may be developed after 20 years. Speculative production includes an estimated 2.300 Bbbl in currently undiscovered onshore resources in satellite fields and enhanced oil recovery (2.000 Bbbl), plus the remaining half of the leased and undiscovered volume in the northeast and northwest National Petroleum Reserve in Alaska (NPR-A) (0.300 and 0.370 Bbbl, respectively) (Table V-10b). It also includes an estimated 0.92 Bbbl of undiscovered offshore resources that could be developed as a result of future Federal lease sales. Each Beaufort Sea OCS sale in the current 5-Year Program (Sales 186, 195, and 202) represents about 3% by reserve volume to the total of past, present, reasonably foreseeable future and speculative production (Table V-10a).

A.6. State Lease Sales We Consider in This Cumulative Scenario. Since December 1959, the State has held 48 oil and gas lease sales on North Slope, North Slope Foothills, and Beaufort Sea State waters. More than 6.5 million acres have been leased; some of the areas have been leased more than once, because some leases had expired or were relinquished. Historically, only about half of the tracts offered in State oil and gas lease sales have been leased. Of the leased tracts, about 10% actually have been drilled, and about 5% have been developed commercially. About 78% of the leased areas are onshore, and about 22% are offshore. From the early 1960's through 1997, 401 exploration wells were drilled in State onshore and offshore areas. During this period, the number of exploration wells drilled annually has ranged from 2-35. From 1990 through 1998, the number of exploration wells drilled annually has ranged from about 7-12; the average number is about 10. Fifty-three of the exploration wells have resulted in discoveries, a success ratio of about 5%.

The State develops and approves an oil and gas leasing plan for a 10-year period, reassesses the plan, and publishes a schedule every other year. Except Northstar, all of the North Slope and Beaufort Sea's commercially producible crude oil is on 931 active State leases (as of December 2000: 1.35 million acres onshore along the Slope, 498,000 acres offshore in the Beaufort Sea, and 456,000 acres of active leases that straddle on and offshore acreage). The majority of production to date is from State leases (15-20% of production from the Northstar prospect is allocated to Federal OCS leases) and totals 13.306 Bbbl (Table V-11). The latest State lease sales, the North Slope Areawide and Beaufort Sea Areawide sales, were held in October 2004. The State is expecting to hold annual areawide lease sales in the North Slope Foothills, North Slope, and Beaufort Sea Areas during 2005-2010. The State has not estimated oil and gas resources for these future lease sales (see Table V-3).

A.7. Federal Lease Sales We Consider in This Cumulative Scenario. We consider Federal OCS and NPR-A lease sales in this scenario. Although no significant production has yet occurred from the Federal OCS off Alaska, possible future production from the Beaufort OCS is estimated at 460 MMbbl. Speculative future production from the OCS is 1.38 Bbbl.

Since December 1979, the U.S. Department of the Interior has held nine lease sales in Federal waters of the Beaufort Sea. The latest Beaufort Sea sale, Sale 195, was held in March 2005. Overall, 839 leases have been issued in the Beaufort Sea. There are 181 active leases on Federal submerged lands in the Beaufort Sea. Thirty exploratory wells have been drilled on these Federal leases, with 9 wells determined to be producible. All the exploratory wells were plugged and abandoned, however, because field economics have not favored production. Existing OCS leases in the Beaufort Sea are estimated to contain 220-550 MMbbl of oil.

The Bureau of Land Management (BLM) held its most recent lease sale in the northeast NPR-A in June 2002. Overall, 60 tracts received bids. More recently, BLM held a lease sale in the northwest NPR-A in June 2004. A total of 123 leases were awarded encompassing 1,403,561 acres. Some of the leases straddle the line between the northwest and northeast NPR-A. ConocoPhillips is seeking permits to expand its Alpine field through satellite developments at five new fields; two of these fields are located in the eastern part of the northeast NPR-A. In 2004, BLM completed the EIS on the proposed Alpine Satellite Development Plan.

A.8. Classified Drilling. In addition to the discoveries mentioned above, a number of wells have been drilled that are "classified" (or in field jargon, "tight holes"). If a well is termed classified, no information is released to the public. Presumably, some of these may include discoveries that may be developed in the future; however, without information on these wells, no useful estimate of their contribution to cumulative effects can be made.

A.9. Infrastructure and Transportation. Given the decline of production in the fields surrounding Prudhoe Bay, the infrastructure and transportation system (including the TAPS pipeline) should be able to process and transport any oil produced from the OCS and other projects.

The TAPS terminal at Valdez presently handles about 1 MMbbl of crude daily. At peak production, the Beaufort Sea OCS would produce about 19 MMbbl of crude oil annually. The daily production rate from the Beaufort Sea OCS would be approximately 5% of the throughput the pipeline system now handles. If we estimate future production on the North Slope (including offshore) at the high end of projections, oil tankers still could be moving this daily amount of oil from Valdez in 2009.

A.9.a. Trans-Alaska Gas-Transportation System. Various plans have been studied to bring North Slope gas to market. Several proposals for gas pipelines from the North Slope have been put forth and are being considered, but no agreement to build any of the projects has been reached. Given the uncertainty associated with construction of such a transportation system in the foreseeable future, its potential effects are not included in this cumulative analysis. The general consensus seems to be that gas sales from Prudhoe Bay would not begin until at least 2015. Ample natural gas reserves exist in the Prudhoe Bay field to supply a large-scale gas export project for at least 20 years. The surrounding oil fields also have gas resources that could feed into the North Slope gas-transportation system. It is very unlikely that development of remote, undiscovered, or higher cost gas resources would occur while there are adequate known, readily available reserves. The existing North Slope oil infrastructure is capable of handling large amounts of natural gas (38.7 trillion cubic feet have been cycled through its facilities through 1999).

A.10. Water and Gravel Resources

A.10.a. Water Resources. The Arctic Coastal Plain is the predominant feature of the North Slope. It is a mosaic of tundra wetlands with extremely low relief and poor drainage and numerous shallow lakes, ponds, marshes, and slow-moving streams. Permafrost prevents water from entering the ground, and the low relief limits runoff. The coastal plain extends south approximately 30 mi into the coastal lowlands, which are dominated by tundra vegetation, meandering streams, and thousands of shallow thaw lakes.

On the North Slope, the industry uses in the neighborhood of 1 billion gallons of water annually (Fay, 2001, pers. commun.). Freshwater is used for construction maintenance, on-tundra roads, and to provide a freshwater cap for the established sea-ice road. Water volumes for sea-ice-roads consist primarily of saltwater. Ice roads have not been mapped from past activities. Projecting the need for ice roads for reasonably foreseeable projects is difficult at best. Many of these new developments will be developed as roadless sites.

A.10.b. Gravel Resources. Gravel in the area of Alaska north of the Brooks Range has been used for a variety of construction and maintenance purposes. These uses include construction of the following:

- “Haul Road”/Dalton Highway in support of the development of the North Slope oil fields and the Trans-Alaska Pipeline;
- pads for camps, exploration drilling, development and production drilling sites, and operations and maintenance facilities;
- airports in the oil-field area and in the communities of the North Slope Borough;
- roads in the oil-field area and in the communities of the North Slope Borough;
- manmade islands for offshore exploration drilling and development and production facilities;
- docks and causeways; and
- beach nourishment in several of the North Slope Borough communities.

In general, North Slope gravel usage for the oil fields has been declining. There also is a trend toward consolidating facilities and using technological advances that minimize the surface area disturbed (Gilders and Cronin, 2000).

A.11. Beaufort Sea Exploration History. Thirty exploratory wells have been drilled in the Federal Beaufort Sea. Drilling has been conducted from bottom-founded structures including manmade ice islands, manmade gravel islands, purpose-built steel and concrete structures, and floating drilling units. Drilling with bottom-founded structures generally was conducted during the winter solid-ice season. Drilling with floating drilling units was conducted during the open-water season and was supported by one or more icebreakers or ice-reinforced support vessels. Floating drilling units were stored in the Canadian Beaufort Sea and mobilized in to the U.S. Beaufort in the spring when ice conditions allowed and returned to the Canadian Beaufort Sea prior to freezeup. Table V-11 summarizes exploratory drilling history for the Federal Beaufort Sea.

Seismic survey operations have also been conducted in the Beaufort Sea. Seismic operations include 3D surveys to explore and delineate deep subsurface geological features and high-resolution surveys to identify surface and shallow subsurface geological features and geohazards for planning and designing an exploratory well and surface facilities. Both 2D/3D and shallow-hazards surveys were generally conducted in the open-water season and scheduled to avoid overlap with bowhead whale subsistence activities.

The MMS study 2002-071 titled *GIS Geospatial Data Base of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea* provides a compilation of data on the location, timing, and nature of oil- and gas-related activities.

A.12. Non-Oil and Gas Activities. The non-oil and gas activities in the Beaufort are mainly marine-type activity. The two main type of traffic are local communities' use of boats in harvesting of game, and commercial marine-barge traffic. Barges are used seasonally in the summer when the Beaufort Sea is ice free, carrying supplies and fuel to the village along the Beaufort Sea. Villages rely on these barges for large items and diesel to generate electricity for the village for the following year. There are also barges that traverse the U.S. Beaufort Sea carrying supplies for the Canada Beaufort Sea villages.

B. Chukchi Sea. Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. There are no existing offshore leases and, except for the Barrow gas fields (local use only), no substantive existing development. Future oil and gas activities that the MMS considered in the cumulative case for the Chukchi Sea include MMS proposed Chukchi Sea sale 193, onshore oil and gas lease sales in the NPR-A, and an Alaska Natural Gas Pipeline. These activities are described in the previous discussion for the North Slope/Beaufort Sea.

B.1. Chukchi Sea Exploration History. Five exploratory wells were drilled in the Chukchi Sea OCS. All five wells were drilled using a drillship. Drilling operations were conducted between July and October. The drillship was demobilized well in advance of the pack ice advancing into the area of operations. A dedicated support barge with oil-spill-response equipment also was anchored in the area of operations to provide immediate oil-spill-response capability..

Two-dimensional marine geophysical seismic surveys were conducted in the Chukchi Sea OCS between 1970 and 1991. About 85,500 line miles of data were collected.

B.2. Non-Oil and Gas Activities. Onshore, the non-oil and gas activity in the Chukchi Sea area is the mining operation of the Red Dog Mine. The mine and mill site are in the Delong Mountains of the Brooks Mountain Range. Red Dog Mine is the world largest producer of zinc concentrate. Red Dog mine has produced 1.5 million tons of ore concentrate per year since 1989; there are reserves for 20 plus years at the rate that the mine is producing.

The primary activity onshore and nearshore is associated with the Red Dog Mine and is the transfer and transporting of ore concentrate. The mined and milled ore is transported to the Delong Mountain Terminal Port (DMT) where it is stored in buildings until the open-water season. The ore is loaded into barges and transported 6 mi offshore, where it is offloaded to a large, deepwater-draft ship that carries it to different parts of the world. The Red Dog mining operation receives fuel for operating by barges into the DMT. There is a tank farm at the DMT that stores fuel.

The U.S. Army Corps of Engineers (Corps) recently published a draft EIS related to the DMT. This draft EIS reports the studies and coordination conducted to determine whether the Federal Government should participate in navigation improvements in Northwest Alaska. The Corps also has prepared the *Navigation Improvements, DeLong Mountain Terminal, Alaska, Draft Interim Feasibility Report* (draft feasibility report). The scope of Federal actions addressed by this study is limited to navigation improvements that could meet criteria established by Federal water-resources development principles and guidelines. Alternatives to those potential navigation improvements, including alternatives outside Corps authorities, also are evaluated to determine whether they also might effectively meet navigation-related needs. Initial phases of this study considered a wide range of potential navigation improvements, but they focused mainly on actions that would more efficiently transport ore concentrate. Navigation improvements considered for constructed under existing authorities include channels and maneuvering areas, breakwaters, and other features to reduce waves or allow vessels safer and more efficient use of U.S. waters. The feasibility report and EIS, along with supporting appendices and documentation, may be revised and submitted to the Assistant Secretary of Defense for approval. Congress would need to authorize and fund this project before any construction could occur.

In the last few years, work has being done on the Shishmaref and Kivalina coastal areas to try to stop or slow the erosion of the coastline and protect the villages. This work is expected to continue in the future.

Barges are used seasonally in the summer when the Chukchi Sea is ice free, carrying supplies and fuel to the village along the Chukchi Sea. Villages rely on these barges for large items and diesel to generate electricity for the village for the following year. There are also barges that traverse the Chukchi Sea to carry supplies and fuel for Beaufort Sea and the Canada Beaufort Sea.

APPENDIX VI

NMFS INCIDENTAL HARASSMENT AUTHORIZATIONS FOR MARINE SEISMIC SURVEYS IN THE BEAUFORT SEA PLANNING AREA, 1999 AND 2001

[Federal Register: August 13, 2001 (Volume 66, Number 156)]
[Notices]
[Page 42515-42523]
From the Federal Register Online via GPO Access [wais.access.gpo.gov]
[DOCID:fr13au01-42]

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[I.D. 072301F]

Small Takes of Marine Mammals Incidental to Specified Activities; Seismic Activities in the Beaufort Sea

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of issuance of an incidental harassment authorization

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SUMMARY: In accordance with provisions of the Marine Mammal Protection Act (MMPA) as amended, notification is hereby given that an Incidental Harassment Authorization (IHA) to take small numbers of bowhead whales and other marine mammals by harassment incidental to conducting ocean bottom cable (OBC) seismic surveys in the Alaskan Beaufort Sea, has been issued to WesternGeco, LLC (formerly Western Geophysical) for the open water period of 2001.

DATES: Effective from July 31, 2001, until November 1, 2001.

ADDRESSES: The application, authorization, monitoring plan, Biological Opinion, and a list of references used in this document are available by writing to Donna Wieting, Chief, Marine Mammal Conservation

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Division, Office of Protected Resources, NMFS, 1315 East-West Highway, Silver Spring, MD 20910-3225, or by telephoning one of the contacts listed here.

FOR FURTHER INFORMATION CONTACT: Simona Perry Roberts, Office of Protected Resources (301) 713-2322, ext. 106, or Brad Smith, Alaska Region (907) 271-5006.

SUPPLEMENTARY INFORMATION:

Background

Sections 101 (a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review

Permission may be granted if NMFS finds that the taking will have no more than a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses and that the permissible methods of taking and requirements pertaining to the monitoring and reporting of such taking are set forth.

On April 10, 1996 (61 FR 15884), NMFS published an interim rule establishing, among other things, procedures for issuing incidental harassment authorizations (IHAs) under section 101 (a)(5)(D) of the MMPA for activities in Arctic waters. For additional information on the procedures to be followed for this authorization, please refer to 50 CFR 216.107.

Summary of Request

On April 16, 2001, NMFS received an application from WesternGeco requesting an authorization for the harassment of small numbers of several species of marine mammals incidental to conducting OBC seismic surveys during the open water season in the south central Beaufort Sea off Alaska between western Camden Bay and Harrison Bay. The primary area of seismic activity is expected to be an area approximately 16 by 7 kilometers (km) (10 miles (mi) by 4 mi) in and near Simpson Lagoon, west of Prudhoe Bay and offshore of Oliktok Point. Weather permitting, the survey is expected to take place between approximately July 27 and mid- to late-October, 2001.

WesternGeco's OBC survey involves dropping cables from a ship to the ocean bottom, forming a patch consisting of 4 parallel cables 8.9 km (5.5 mi) long, separated by approximately 600 meters (m) (1,968 feet (ft)) from each other. Hydrophones and geophones, attached to the cables, are used to detect seismic energy reflected back from rock strata below the ocean bottom. The source of this energy is a submerged acoustic source, called a seismic airgun array, that releases compressed air into the water, creating an acoustical energy pulse that is directed downward toward the seabed. WesternGeco will use two source vessels for the open-water 2001 seismic surveys, one for deep water and one for shallow water, primarily shoreward of the barrier islands. The deep water vessel, the R/V Arctic Star, will utilize an airgun array with an air discharge volume of 1,210 cubic inches (in\3\) (19.8 liters, L). The maximum source levels for the Arctic Star will be at 249 dB re 1 micro Pascal at 1 meter (Pa-m) when the acoustic pressure is 29.4 bar-meters (zero to peak), which is equivalent to 253 dB re 1 micro Pa-m when the acoustic pressure is 45.9 bar-meters (peak-to-peak). Most operations utilizing the 1,210 in\3\ array are expected to operate at a gun depth of 2.3 m (7.5 ft) and water depth of 10 m (32.8 ft). The shallow water source vessel, the R/V Peregrine, will utilize an airgun array with an air discharge volume of 640 in\3\ (10.48 L). The source level maximums for the Peregrine will be at 237 dB re 1 micro Pa-m when the acoustic pressure is 6.7 bar-meters (zero to peak), which is equivalent to 242 dB re 1 micro Pa-m when the acoustic pressure is 12.2 bar-meters (peak to peak). These airgun arrays are smaller and less powerful than the arrays used in some other seismic programs in the Beaufort Sea prior to 1999 and are expected to operate at a gun depth of 1 m (3.3 ft) in very shallow water.

It is anticipated that the seismic vessels will sail along pre-plotted source lines arranged orthogonally to the OBCs. Each source line will be 5 km (3.1 mi) long and adjacent source lines will be approximately 500 m (1,640 ft) apart. There will be 34 source lines for each seismic patch. The overall grid of source lines for a given patch will be 4.7 km by 16.5 km (2.9 mi by 10.2 mi) and the source line for

one patch will overlap with those from adjacent patches.
After sufficient data have been recorded to allow accurate mapping of the rock strata, the cables are lifted onto the deck of one of the two self-powered cable vessels (R/V Western Endeavor and R/V Western Frontier), moved to a new location (ranging from several hundred to a few thousand feet away), and placed onto the seabed again. A small utility vessel (Ski Barge) may also be used to transfer seismic crew and/or marine mammal observers, as well as supplies and refuse, between the seismic vessels and Prudhoe Bay. Air support will be limited to infrequent (if any) helicopter flights and, starting after August 31, 2001, aerial surveys at altitudes from 900 to 1500 ft (274 to 457 m). For a more detailed description of the seismic operation, please refer to WesternGeco (2001).

Comments and Responses

On June 14, 2001 (66 FR 32321), NMFS published a notice of receipt and a 30-day public comment period was provided on the application and proposed authorization. Comments were received from the Marine Mammal Commission (MMC) and LGL Ltd., environmental research associates (monitoring contractor for the seismic surveys) on behalf of Western Geco LLC.

Activity Concerns

Comment 1: The June 14, 2001, Federal Register notice implies that the 1210 in3 airgun array might be operated at two different pressures: ``249 dB re 1 micro Pa-m equals 29.4 bar-m zero-to-peak, or 253 dB re 1 micro Pa-m equals 45.9 bar-m peak-to-peak.'' LGL Ltd. commented that these four measurements are all equivalent to one another, and all would apply simultaneously. The same applies for the pressures quoted for the 640 in3 airgun array. In addition, LGL Ltd. noted that the ``-m'' in the unit ``dB re 1 micro Pa-m'' should be read as ``at 1 meter'', not ``per minute'' as stated in the notice.
Response: Thank you for providing this information. NMFS did not intend to imply that the airgun array(s) would operate at two different pressures. To clarify, NMFS has added equivalent language to the sentences referred to within this document. Also, NMFS has corrected the micro Pascal ``per minute'' reference to read micro Pascal ``at 1 meter''.
Comment 2: LGL Ltd. noted that the statement: ``the highest frequency in the airgun sounds will be 188 Hz'' is in error. Western's application states that the dominant frequency components will extend up to 188 Hz. The energy content decreases with increasing frequency, but there is some energy at frequencies above 188 Hz. The overall source level of the 1210 in\3\ array, as quoted in Western's application, included energy up to 375 Hz.

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Response: NMFS has made the appropriate changes in this document and has taken this information into account when making its determinations under the MMPA.

Subsistence Concerns

Comment 3: LGL Ltd. noted that a Conflict Avoidance Agreement for 2001 has been signed by WesternGeco, AEWC, and representatives of the Kaktovik and Nuiqsuit whaling captains.
Response: Thank you for this information.

Mitigation, Monitoring and Reporting Concerns

Comment 4: LGL Ltd. notes that at the peer/stakeholder workshop in Seattle on June 5-6, 2001, it was agreed that the number of marine mammal observers for the 2001 work aboard the Arctic Starwould be three (two biologists and one Inupiat), not four as the June 14, 2001, Federal Register notice stated. As in previous years, one marine mammal observer would be on watch at most times, though 30 minutes prior to and during airgun startups, and occasionally at other times, two marine mammal observers would be on watch.

Response: Thank you for this information. NMFS has made the appropriate changes in this document and has taken this information into account when making its determinations under the MMPA.

Comment 5: LGL Ltd. notes that at the peer/stakeholder workshop in Seattle on June 5-6, 2001, it was agreed that the number of marine mammal observers for the 2001 work aboard the Peregrine would be two (one biologist and one Inupiat, with no additional observers required as the June 14, 2001, Federal Register notice stated), provided that wheelhouse personnel watch for marine mammals at times when no marine mammal observer is on duty, and that shut down of airguns would be conducted in the same manner when a marine mammal is seen inside the safety radius and a marine mammal observer is not on duty. It was also agreed that when a shutdown is initiated by wheelhouse personnel in the absence of a marine mammal observer, the shutdown would be recorded but additional details concerning the marine mammal sighting probably would not be recorded. It was noted at the peer/stakeholder workshop that the Peregrine has space for only two marine mammal observers, that frequent boat-to-boat transfers of personnel are undesirable from a safety perspective, and that the Peregrine will operate in shallow waters (mainly a lagoon) where bowhead whales are highly unlikely to occur and where seal densities may be relatively low.

Response: Thank you for this information. NMFS concurs with this change in the monitoring requirements aboard the Peregrine, with one exception. When a shut down occurs and a marine mammal observer is not on duty, the wheelhouse personnel must notify one of the marine mammal observers so that they can record the information required by NMFS. This was agreed upon by NMFS and WesternGeco at the peer/stakeholder meeting on June 6, 2001 as part of WesternGeco's standard operating procedures. NMFS has made the appropriate changes in this document and has taken this information into account when making its determinations under the MMPA.

Comment 6: The MMC concurs with NMFS that the proposed activities in the Alaskan Beaufort Sea will result, at most, in a temporary modification of the behavior of certain species of cetaceans and pinnipeds. The MMC also concurs that the monitoring and mitigation measures proposed by WesternGeco appear to be adequate to ensure that the planned surveys will not result in the mortality or serious injury of any marine mammals or have unmitigable adverse effects on the availability of marine mammals for taking by Alaska Natives for subsistence uses. Therefore, the MMC recommends that the requested IHA be issued, provided that NMFS is satisfied that the monitoring and mitigation programs will be carried out as described in the application.

Response: Thank you for the comment. On June 5, 2001, NMFS convened a peer-review/stakeholders meeting in Seattle, WA to discuss the proposed monitoring and mitigation measures for this seismic survey program. A description of the monitoring and mitigation that will be required for this activity is described later in this document.

Although NMFS has no reason to believe that the monitoring and mitigation programs will not be carried out, a report on all activities under the IHA will be required to be submitted to NMFS within 90 days of completion of the planned survey. This report will be reviewed by NMFS to determine whether WesternGeco fully complied with the terms and conditions of the IHA, including the monitoring and mitigation requirements.

Comment 7: The MMC questions whether there is a sufficient basis for concluding that this activity, combined with past and possible future activities in this region, is unlikely to have non-negligible cumulative effects on any of the potentially affected marine mammal species or their availability to Alaska Natives for subsistence uses. Therefore, the MMC recommends (as in previous letters) that NMFS, in consultation with the applicant, the Alaska Department of Fish and Game, and the Native communities, determine the long-term monitoring that would be required to confirm that the proposed seismic surveys and possible future exploration and development activities do not cause changes in the seasonal distribution patterns, abundance, or productivity of marine mammal populations in the area. MMC recommends that such consultations address: (1) the possibility that the sum of exploration and development activities could have significant cumulative adverse effects on marine mammal behavior and distribution; (2) whether previous and proposed monitoring programs have provided and will continue to provide adequate baseline data for detecting possible future changes in the distribution, abundance, or productivity of the potentially affected marine mammal populations; (3) changes in the planned marine mammal and acoustic monitoring program that would be required to provide adequate baseline data; and, (4) whether the purposes of the MMPA and the Endangered Species Act might be met more cost-effectively by designing and implementing long-term monitoring programs to replace or augment the site-specific monitoring currently required.

Response: Thank you for the recommendation. Based on the best available scientific information, WesternGeco's proposed OBC seismic survey is unlikely to have more than minimal behavioral effects on marine mammal species in the area. If the survey period extends into the fall bowhead migration season, there may be some effect on bowhead whales migrating inshore. However, some of WesternGeco's seismic work will be conducted shoreward of the barrier islands, where noise from the survey would be unlikely to reach the main migration path for bowheads. In addition, the seismic arrays being used will never be fired simultaneously.

NMFS recognizes the need to address potential adverse cumulative impacts from oil and gas exploratory and development activities on both marine mammal stocks and subsistence needs. The 2001 scientific peer review workshop participants concluded that the current research and monitoring proposed by WesternGeco for seismic surveys, by BPX for oil development at Northstar, and by BP/EM/PAI for

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shallow hazard surveys (see 66 FR 32321, June 14, 2001, 65 FR 34014, May 25, 2000, and 66 FR 29287, May 30, 2001), coupled with existing projects to monitor bowhead population abundance (trends in abundance) should provide the information necessary to provide baseline data and determine overall cumulative impacts from noise on bowhead whales. Existing long-term monitoring projects that augment current site-specific monitoring required under MMPA authorizations, include: (1) the North Slope Borough spring bowhead census; (2) the Minerals Management Service's (MMS) autumn aerial survey; and, (3) an MMS-funded bowhead whale photo-identification project conducted in conjunction with bowhead whale feeding studies. Similar work is underway for ringed seals. Provided trends in bowhead (and other species') abundance continue to be positive and until new scientific information is made available, NMFS presumes industrial development on the North Slope is not adversely affecting the bowhead population.

Description of Habitat and Marine Mammals Affected by the Activity

A detailed description of the Beaufort Sea ecosystem and its associated marine mammals can be found in several documents (Corps of Engineers, 1999; NMFS, 1999; Minerals Management Service (MMS), 1992, 1996) and does not need to be repeated here.

Marine Mammals

The Beaufort/Chukchi Seas support a diverse assemblage of marine mammals, including bowhead whales (Balaena mysticetus), gray whales (Eschrichtius robustus), beluga whales(Delphinapterus leucas), ringed seals (Phoca hispida), spotted seals (Pusa largha) and bearded seals (Erignathus barbatus). Descriptions of the biology and distribution of these species and of others can be found in NMFS (1999), Western Geophysical (2000), WesternGeco (2001), the annual monitoring reports for seismic surveys in the Beaufort Sea (LGL Ltd. and Greeneridge Sciences Inc, 1997, 1998, 1999, 2000) and several other documents (Corps of Engineers, 1999; Lentfer, 1988; MMS, 1992, 1996; Ferrero et al., 2000). Please refer to those documents for information on these species.

Potential Effects of Seismic Surveys on Marine Mammals

Disturbance by seismic noise is the principal means of taking by this activity. Support vessels and aircraft may provide a potential secondary source of noise. The physical presence of vessels and aircraft could also lead to non-acoustic effects on marine mammals involving visual or other cues.

Underwater pulsed sounds generated by open water seismic operations may be detectable a substantial distance away from the activity. The effect of these pulsed sounds on living marine resources, particularly marine mammals in the area, will be dependent on the hearing sensitivity of the species, the behavior of the animal at the time the sound is detected, as well as the distance and level of the sound relative to ambient conditions. Any sound that is detectable is (at least in theory) capable of eliciting a disturbance or avoidance reaction by some marine mammals or of masking signals of comparable frequency that are generated by marine mammals (e.g., whale calls) (WesternGeco, 2001). An incidental harassment take is presumed to occur when marine mammals in the vicinity of the seismic source, the seismic vessel, other vessels, or aircraft show a disturbance or avoidance reaction to the generated sounds or to visual cues.

When the received levels of noise exceed some behavioral reaction threshold, cetaceans will show disturbance reactions. The levels, frequencies, and types of noise that will elicit a response vary between and within species, individuals, locations, and seasons. Behavioral changes may be subtle alterations in the surface, respiration, and dive cycles. More conspicuous responses include changes in activity or aerial displays, 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. Whales engaged in active behaviors, such as feeding, socializing, or mating, are less likely than resting animals to show overt behavioral reactions, unless the disturbance is directly threatening. Seismic pulses have been observed to cause strong avoidance reactions by many of the bowhead whales occurring within a distance of several kilometers, including changes in surfacing, respiration and dive cycles, and to sometimes cause avoidance or other changes in bowhead behavior at considerably greater distances (Richardson et al., 1995; Rexford, 1996; MMS, 1997; Miller et al., 1999). Airgun pulses may also disturb some other marine mammal species occurring in the area. Ringed seals within a few hundred meters of an airgun array showed variable reaction to the noise, with some moving somewhat farther away and other seals not moving far at all (Harris et al., 1997, 1998, in press; Lawson and Moulton, 1999; Moulton and Lawson, 2000). It is likely that avoidance distances around nearshore seismic operations of the type planned for 2001 may be less than those around some of the seismic operations that were done in the Beaufort Sea before 1996 for the following reasons: (1) The recent seismic operations have been in shallow water, (2) the recent seismic operations have been limited to a confined area at any one time, and (3) the recent seismic operations have employed smaller airgun arrays than those that were used in the past.

Although some limited masking of low-frequency sounds (e.g., bowhead and gray whale calls) is a possibility, the intermittent nature of seismic survey pulses used by WesternGeco (1 second in duration every 16 to 24 seconds), as well as the fact that airgun operations are expected to occur no more than 50 percent of the time, will limit the extent of masking. Bowhead whales are known to continue calling in the presence of seismic survey sounds, and their calls can be heard between seismic pulses (Greene et al., 1997, 1999; Richardson et al., 1986). Masking effects are expected to be absent in the case of beluga whales, given that sounds utilized by them are at much higher frequencies (in the 2 to 6 kilohertz (kHz) range) (Sjare and Smith, 1986) than airgun sounds from WesternGeco's seismic surveys (dominant frequency components will extend up to 188 hertz(Hz)) (WesternGeco, 2001).

Permanent hearing damage is not expected to occur during the project. There is no direct evidence that the hearing systems of marine mammals close to an airgun array would be at risk of temporary or permanent hearing impairment; however, depending on the species, the equipment being used, and the number of pulses to which the animal is exposed, temporary threshold shift (TTS) is a theoretical possibility for animals within a few hundred meters of the source (Richardson et al., 1995; Finneran et al., 2000).

Planned monitoring and mitigation measures, proposed by WesternGeco and described later in this document, are designed to avoid sudden onsets of seismic pulses at full power, to detect marine mammals occurring near the array, and to avoid exposing them to sound pulses that have any possibility of causing hearing impairment.

For a discussion on the anticipated effects of ships, boats, and aircraft on marine mammals and their food sources, and for a more complete review of the best available information

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available on the potential effects of seismic surveys to marine mammals in the Arctic, please refer to the application (WesternGeco, 2001) and the Federal Register notice of June 14, 2001 (66 FR 32321).

Numbers of Marine Mammals Expected to Be Taken

Based on an analysis provided in their application, WesternGeco estimates that the following numbers of marine mammals may be subject to Level B harassment, as defined in 50 CFR 216.3:

Species	Population Size	Harassment Takes in 2001	
		Possible	Probable
Bowhead	8,200	....	....
160 dB criterion	....	1,000	500
2 0km criterion	....	2,630	1,300
Gray whale	26,000	10	0
Beluga whale	39,258	250	150
Ringed seal\3\	1-1.5 million	400	200
Spotted seal\3\	>200,000	10	2
Bearded seal\3\	>300,000	50	15

1 The maximum number that might be taken if seismic surveys are operable during the September/October period and the bowhead migration passes unusually close to shore as in 1997.
2 The number that could be taken under the most likely operating conditions.
3 Some individual seals may be harassed more than once

At the 2001 open water peer-review workshop held in Seattle on June 5\th\ and 6\th\, the attendees agreed on support of the following statement based on methods and results reported in Miller et al. (1999): ``Monitoring studies of 3-D seismic exploration (6-18 airguns totaling 560-1500 in\3\) in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active seismic source, while deflection may begin at distances up to 35 km. Sound levels received by bowhead whales at 20 km ranged from 117-135 dB re 1 micro Pa rms and 107-126 dB re 1 micro Pa rms at 30 km. The received sound levels at 20-30 km are considerably lower levels than have previously been shown to elicit avoidance in bowhead or other baleen whales exposed to seismic pulses.'' NMFS adopts the Miller et al. research and the peer review workshop's statement as the best scientific information available on bowhead whale reactions to seismic sources. Given this information, NMFS utilized the 20 km criterion estimates of take for bowhead whales provided by WesternGeco in determining the number of harassment takes to be authorized under the IHA for the 2001 open water season.

Estimates of Marine Mammal Takes

Estimates of takes by harassment will be made through vessel and/or aerial surveys. Preliminarily, WesternGeco will estimate the number of (1) marine mammals observed within the area ensonified strongly by the OBC seismic vessel (see Mitigation section of this document for description of safety radii); (2) marine mammals observed showing apparent avoidance or disturbance reactions to seismic pulses (e.g., heading away from the seismic vessel in an atypical direction); (3) marine mammals estimated to be subject to take by type (1) or (2) when no monitoring observations were possible; and (4) bowhead whales whose migration routes come within 20 km (actual distance dependent on a combination of 1996-1998 and 2001 data) of the operating OBC seismic vessel, or would have if they had not been displaced farther offshore.

Effects of Seismic Noise and Other Activities on Subsistence Needs

The disturbance and potential displacement of marine mammals by sounds from seismic activities are the principle concerns related to subsistence use of the area. The harvest of marine mammals (mainly bowhead whales, but also ringed and bearded seals) is central to the culture and subsistence economies of the coastal North Slope communities. In particular, if migrating bowhead whales are displaced farther offshore by elevated noise levels, the harvest of these whales could be more difficult and dangerous for hunters. The harvest could also be affected if bowhead whales become more ``skittish'' when exposed to seismic noise.

The location of the proposed seismic activity is south of the center of the westward migration route of bowhead whales, but there is some limited overlap with the southern limit of the migration. Seismic monitoring results from 1996-1998 indicate that most bowhead whales avoid the area within about 20 km (12.4 mi) around the airgun array when it is operating, and some avoid the area within 30 km (18.6 mi). In addition, bowhead whales may be able to hear the sounds emitted by the seismic array out to a distance of 50 km (31.1 mi) or more, depending on the ambient noise level and the efficiency of sound propagation along the path between the seismic vessel and the whale (Miller et al., 1997).

Nuiqsut is the community closest to the area of the proposed activity. The communities of Barrow and Kaktovik also harvest resources that pass through the general area, but do not regularly hunt in the planned seismic exploration area. Subsistence hunters from all three communities conduct an annual hunt for migrating bowhead whales during the autumn months. In recent years, Nuiqsut whalers have typically taken two to four whales each year (WesternGeco, 2001). Nuiqsut whalers concentrate their efforts on areas north and east of Cross Island, generally in water depths greater than 20 m (65 ft). Cross Island, the principle field camp location for Nuiqsut whalers, is located within the general area of the proposed 2001 seismic area.

Whalers from the village of Kaktovik search for whales east, north, and west of the village. Kaktovik is located 72 km (45 mi) east of the easternmost end of WesternGeco's planned 2001 seismic exploration area.

Whalers from the village of Barrow search for bowhead whales >200 km (>125 mi) to the west of the planned seismic area (WesternGeco, 2001).

Nuiqsut hunters also hunt seals for subsistence purposes. Most seal hunting has been during the early summer in open water. Boat crews hunt ringed, spotted, and bearded seals. The most important sealing area for Nuiqsut

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hunters is off the Colville Delta, extending as far west as Fish Creek and as far east as Pingok Island. The planned seismic exploration during the summer has some potential to influence seal hunting activities by residents of Nuiqsut. During BP and Western Geophysical's 1996-2000 seismic programs, an operating airgun array apparently did not displace seals by more than a few hundred meters.

The possibility and timing of potential seismic operations in the Cross Island area and in Nuiqsut sealing areas required WesternGeco to provide NMFS with either (1) a Plan of Cooperation with the Alaska Eskimo Whaling Commission (AEWC) and the North Slope whaling communities, or (2) measures that have been or will be taken to avoid any unmitigable adverse impact on the availability of these animals for subsistence needs. The timing of seismic operations has been addressed in a Conflict Avoidance Agreement (CAA) between WesternGeco, the Nuiqsut and Kaktovik whalers, and the AEWC (WesternGeco, 2001). In addition, WesternGeco's application identifies, and the IHA has incorporated, mitigation and monitoring measures that will be taken to minimize any adverse effect on subsistence uses and improve the state of knowledge on the effects of seismic exploration on the accessibility of bowhead whales to hunters.

Anticipated Impact on Habitat

The proposed seismic activity is not expected to cause significant and permanent impacts on habitats used by marine mammals, or to the food sources they utilize. The main impact issue associated with the proposed activity will be temporarily elevated noise levels. For a more detailed analysis of anticipated impact on habitat refer to the application (WesternGeco, 2001) and the Federal Register notice of June 14, 2001 (66 FR 32321).

The 2001 OBC survey area may overlap with areas identified as ``Boulder Patch'' habitat. WesternGeco is required by the State of Alaska to consult with NMFS as to the location and resources of the Stephansson Sound Boulder Patches so that they may be avoided.

Mitigation

For the 2001 seismic operations, WesternGeco will reduce its primary airgun array from the 1,500 in3 used in 1998 to 1,210 in\3\. This reduction in volume will lower the source levels and result in lower received levels at each distance compared to Western Geophysical's 1998 project. The smaller volume 640 in3 airgun array consists of sixteen 40 in\3\ airguns in four 4-gun clusters. The airguns comprising this small volume array will be spread out horizontally, such that the energy from the array, like that from the 1,210 in\3\ array, will be directed downward insofar as possible. The distances within which received levels (see the proposed safety radii below) can exceed 190 dB and 180 dB re 1 micro-Pa have been measured at two airgun depths (2.3 and 5 m or 7.5 and 16.4 ft) and in two water depths (8 and 23 m or 26.2 and 75.5 ft) (Greene and McLennan, 2000), and are reduced relative to those around the 1998 array. The shallower depth at which the 640 in\3\ array will operate will tend to reduce the source level (and hence the 190 and 180 dB safety radii) even farther; however, as a precautionary approach, the 190 and 180 dB radii for the 1,210 in\3\ airgun operating at 2.3 m (7.5 ft) depth will be assumed to apply to the 640 in\3\ array operating at 1 m (3.3 ft) gun depth.

The safety radii for OBC seismic operations in 2001 are based on comprehensive measurements of the sounds recorded in the water near the OBC array in 1999 and analyzed by Greene and McLennan (2000).

Vessel-based observers will monitor marine mammal presence in the vicinity of the seismic arrays throughout the seismic program. To avoid the potential for injury, WesternGeco will immediately shut down the seismic source if seals and/or whales are sighted within the safety radii. The safety radii are as follows:

SOURCE (in\3\)	AIRGUN DEPTH (m/ft)	WATER DEPTH ft)
1210	2.3/7.5	10/32
1210	2.3/7.5	>10/>32
1210	5/16.4	10/32
1210	5/16.4	>10/>32
640	1/3.3	10/32

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640                                                   1/3.3       >10/>32
--------------------------------------------------------------------------
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In addition, WesternGeco will ramp-up the 1,210 in\3\ and 640 in\3\ seismic sources to operating levels at a rate no greater than 6 dB per minute. Under normal operational conditions (source vessel speed at least 4 knots), a ramp-up will be required after the array has been inactive for a period lasting 1 minute or longer. If the towing speed is reduced to 3 knots or less, a ramp-up will be required after the array has been inactive for a period lasting 2 minutes or longer. Ramp-up will begin with an air volume discharge not exceeding 80 in\3\ for the 1,210 in\3\, and 40 in\3\ for the 640 in\3\ array. Additional guns will be added at appropriate intervals so as to limit the rate of increase in source level to 6 dB per minute.

Monitoring

As part of its application, WesternGeco provided a monitoring plan for assessing impacts to marine mammals from seismic surveys in the Beaufort Sea. This monitoring plan is described in WesternGeco (2001) and in LGL, Ltd. and Greeneridge Sciences Inc. (2001).

The monitoring plan submitted to NMFS on April 16, 2001, was reviewed at a peer-review workshop held in Seattle, WA, on June 5-6, 2001. The monitoring plan, with minor modifications, was accepted by NMFS at this meeting. A copy of the monitoring plan is available upon request (see ADDRESSES).

WesternGeco plans to conduct the following monitoring:

Vessel-based Visual Monitoring

One or two marine mammal observers aboard the seismic source vessels will search for and observe marine mammals whenever seismic operations are in progress and for at least 30 minutes before the planned start of seismic transmissions. These observers will scan the area immediately around the vessels with reticle binoculars during the daytime. Laser rangefinding binoculars will be available to assist with distance estimation. If operations continue after mid-August, when the duration of

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darkness increases, image intensifiers and additional light sources will be used to illuminate the safety zone (see application for more detail).

A total of three observers (two trained biologists and one Inupiat observer/communicator) will be based aboard the seismic source vessel Arctic Star. Two observers must be on active watch 30 minutes prior to and during the start of seismic transmissions and a minimum of one observer needs to be on active watch aboard the Arctic Star whenever the seismic sources are operating during daylight hours.

A total of two observers will be based aboard the seismic source vessel Peregrine. A minimum of one observer must be on active watch 30 minutes prior to and during the start of seismic transmissions and a minimum of one observer must be on active watch aboard the Peregrine for a total of 16 hours during any given 24 hour period when seismic operations are taking place. In addition, wheelhouse staff aboard the Peregrine will assist in maintaining a watch for marine mammals. During the hours when a marine mammal observer is not on duty, wheelhouse personnel must actively watch for marine mammals, follow all shut-down procedures if a marine mammal is sighted within the designated safety zones, and notify the marine mammal observer(s) any time a shut-down occurs.

Vessel-based monitoring will include recording information on seismic operations, vessel activities, marine mammals sighted, and other relevant activity in a standardized format.

Aerial Surveys

If OBC seismic work continues after August 31, 2001, aerial surveys by WesternGeco's marine mammal contractor, LGL Ltd., will occur from the date on which OBC seismic operations commence until 1 day after the OBC seismic operations end. If OBC seismic work is suspended during the bowhead subsistence hunting season, but resumes later in the autumn, aerial surveys will commence (or resume) when OBC seismic work resumes. WesternGeco will continue aerial surveys until 1 day after OBC seismic work ends. It should be noted that the proposed duration for aerial surveys would be a reduction from previous years. WesternGeco believes this reduction is appropriate because some of the main questions about disturbance to bowhead whales from a nearshore seismic operation have been answered through the 1996-1998 monitoring projects. In addition, the MMS expects to conduct its broad-scale aerial survey work from approximately August 31 until the end of the bowhead migration in October. WesternGeco believes that this combined aerial survey data will provide sufficient information to estimate the numbers of bowhead whales taken by harassment.

The primary objective of WesternGeco's aerial surveys will be to document the occurrence, distribution, and movements of bowhead whales, and (secondarily) beluga and gray whales in and near the area where they might be affected by the seismic pulses. These observations will be used to estimate the level of harassment takes and to assess the possibility that seismic operations affect the accessibility of bowhead whales for subsistence hunting. Pinnipeds will be recorded when seen, although survey altitude will be too high for systematic surveys of these species. Sonobuoys will be dropped to document seismic and ambient noise at offshore locations, including locations near whales.

WesternGeco will fly at 300 m (1,000 ft) in areas where no whaling is underway, with a minimum altitude of no less than 275 m (900 ft) under low cloud conditions. In addition, and subject to the terms of the 2001 CAA with subsistence communities, surveys will be flown at 457 m (1500 ft) altitude over areas where whaling is occurring and will avoid direct overflights of whaleboats and Cross Island.

The daily aerial surveys are designed to cover a grid of 18 north-south lines spaced 8 km (5 mi) apart and extending seaward to about the 100 m (328 ft) depth contour (typically about 65 km (40.4 mi) offshore). This grid will extend from about 65 km (40.3 mi) east to 65 km (40.3 mi) west of the area in which seismic operations are underway on that date. This survey design will provide extended coverage to determine the eastward and westward extent of the offshore displacement of whales by seismic operations. Because of the inshore nature of the 2001 seismic surveys, few whales are expected to occur within 20 km (12.4 mi) of the operations; therefore, no ``intensive'' grid surveys are planned.

Detailed information on the aerial survey program can be found in WesternGeco (2001) and in LGL Ltd. and Greeneridge Sciences Inc. (2001), which are incorporated in this document by citation.

Acoustical Measurements

The acoustic measurement program for 2001 is designed to provide, in conjunction with existing results from previous years (see LGL and

Greeneridge Sciences Inc., 1997, 1998, 1999), the specific acoustic data needed to document the seismic sounds to which marine mammals will be exposed in 2001. This measurement program will only be operable if seismic operations continue after August 31, 2001. Proposed emphasis is on situations and locations not studied in detail during previous operations.

WesternGeco has two basic objectives for collecting acoustic measurements, one physical and one biological. The physical acoustics objective is to determine the characteristics of airgun array pulses as received in the bowhead migration corridor at varying distances offshore and to the east of the area of seismic exploration in 2001 and in 1996- 98 plus 2001 combined. Pulse characteristics to be determined are received levels and pulse durations versus range offshore and to the east, spectral properties, and signal-to-ambient ratios. The biological objective is to determine whether there are differences in the pattern of bowhead call detection rates near, offshore of, and east of the seismic exploration area at times with and without active seismic operations based on 2001 data and combined 1996-98 and 2001 data. If there are differences, then WesternGeco will use the combined acoustic and aerial survey data to evaluate whether the noise-related differences in call detection rate are attributable to differences in calling behavior, whale distribution, or a combination of the two.

In 2001, the acoustic measurement program is planned to include (1) deployment in late August/September of autonomous seafloor acoustic recorders (ASARs) to provide continuous acoustic data for extended periods, and (2) use of air-dropped sonobuoys in September/October. WesternGeco will use these methods only if OBC surveys occur in September/October.

For a more detailed description of planned monitoring activities, please refer to the application and the Technical Monitoring Plan (WesternGeco, 2001; LGL Ltd. and Greeneridge Sciences Inc., 2001) and the Federal Register notice of June 14, 2001 (66 FR 32321).

Reporting

WesternGeco will provide an initial report on 2001 activities to NMFS within 90 days after the end of the seismic program. This report will summarize dates and locations of seismic operations, marine mammal sightings (dates, times, locations, behaviors, associated seismic survey activities), estimates of the amount and nature of all takes by harassment or in other ways, and any apparent effects on

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accessibility of marine mammals to subsistence users.

A final technical report will be provided by WesternGeco within 20 working days of receipt of the document from the contractor, but no later than April 30, 2002. The final technical report will contain a description of the methods, results, and interpretation of all monitoring tasks.

Consultation

Under section 7 of the Endangered Species Act (ESA), NMFS completed consultation with MMS on oil and gas exploration and associated activities in the Alaskan Beaufort Sea on May 25, 2001. This consultation includes a review of seismic and related noise sources used by the oil and gas industry. The finding of that consultation was that oil and gas activities in the Alaskan Beaufort Sea, and the issuance by NMFS of a small take authorization for oil and gas activities, are not likely to jeopardize the continued existence of the bowhead whale. In formulating this opinion, NMFS used the best available information, including information provided by MMS, recent research on the effects of oil and gas activities on the bowhead whale, and the traditional knowledge of Native hunters and the Inupiat along Alaska's North Slope. A copy of the Biological Opinion issued as a result of this consultation is available upon request (see ADDRESSES).

National Environmental Policy Act (NEPA)

In conjunction with the 1996 notice of proposed authorization (61 FR 26501, May 28, 1996) for open water seismic operations in the Beaufort Sea, NMFS released an Environmental Assessment (EA) that addressed the impacts on the human environment from issuance of the authorization and the alternatives to the proposed action. No comments were received on that document and, on July 18, 1996, NMFS concluded that neither implementation of the proposed authorization for the harassment of small numbers of several species of marine mammals incidental to conducting seismic surveys during the open water season in the U.S. Beaufort Sea nor the alternatives to that action would significantly affect the quality of the human environment. As a result, the preparation of an environmental impact statement on this action is not required by section 102 (2) of NEPA or its implementing regulations.

In 1999, NMFS determined that a new EA was warranted. This determination was based on (1) the proposed construction of the Northstar project by BP, Alaska, (2) the collection of data from 1996 through 1998 on Beaufort Sea marine mammals and the impacts of seismic activities on these mammals, and (3) the analysis of scientific data indicating that bowhead whales avoid nearshore seismic operations by a distance of approximately 20 km (12.4 mi). Accordingly, a review of the impacts expected from the issuance of an IHA have been assessed in the EA, in the Federal Register notice of June 14, 2001 (66 FR 32321), and in this document. NMFS has determined that there will be no more than a negligible impact on marine mammals from the issuance of the IHA and that there will not be any unmitigable impacts to subsistence communities, provided the mitigation measures required under the authorization are implemented. As a result, NMFS determined, as in 1999, that neither implementation of the authorization for the harassment of small numbers of several species of marine mammals incidental to conducting seismic surveys during the open water season in the U.S. Beaufort Sea nor the alternatives to that action would significantly affect the quality of the human environment. Since this proposed action falls into a category of actions that do not individually or cumulatively have a significant impact on the human environment, as determined through the 1999 EA, this action is categorically excluded from further NEPA analysis (NOAA NAO 216-6). A copy of the 1999 EA is available upon request (see ADDRESSES).

Coastal Zone Management Act Consistency

The State of Alaska, Department of Natural Resources, Division of Oil and Gas issued a proposed Alaska Coastal Management Program consistency determination on June 21, 2001, for WesternGeco's planned 3-D seismic surveys on state tide and submerged lands in the Beaufort Sea during the open water season of 2001. Based on the State's review, performed under 6 AAC 50, the State concurred that the project is consistent with the ACMP as long as: (1) Operations beyond September 1 will be considered on a case-by-case basis if the Director, Division of Oil and Gas, in consultation with NMFS, determines that: (a) a suitable whale monitoring program will be conducted and appropriate measures to minimize conflict with the Nuiqsuit subsistence whale harvests will be taken; or (b) the Village of Nuiqsuit has completed its whale hunt for 2001; or (c) NMFS has issued an IHA; (2) all operations must be conducted in a manner that will assure minimum conflict with other users of the area, including coordination with local whaling crews as needed to avoid conflicts with the subsistence whale hunt; (3) seismic activities shall avoid or minimize interference with traditional food gathering and access to subsistence resources; and (4) permittee will consult with NMFS' Alaskan Offices as to the location and resources of the Stephansson Sound Boulder Patches and any operational changes made in response to this consultation will be disclosed in the completion report.

Determinations

Based on the evidence provided in the application, the EA, the Federal Register notice (66 FR 32321), and this document, and taking into consideration the comments submitted on the application and proposed authorization notice, NMFS has determined that there will be no more than a negligible impact on marine mammals from the issuance of the harassment authorization to WesternGeco, LLC and that there will not be any unmitigable adverse impacts to subsistence communities. NMFS has determined that the short-term impact of conducting OBC seismic operations in the Alaskan Beaufort Sea will result, at worst, in a temporary modification in behavior by certain species of pinnipeds and cetaceans. Behavioral modifications may be made by these species to avoid noise from seismic operations; however, this behavioral change is expected to have a negligible impact on marine mammal species and stocks mentioned here. Due to the distribution and abundance of marine mammals during the projected period of activity and the location of the seismic operations in waters generally too shallow and distant from the edge of the pack ice for most marine mammals of concern, the number of potential harassment takings is estimated to be small.

Since (1) the number of potential harassment takings of bowhead whales, gray whales, beluga whales, ringed seals, spotted seals, and bearded seals is estimated to be small; (2) no take by injury and/or death is anticipated; (3) the potential for temporary or permanent hearing impairment is low and will be avoided through the incorporation of the mitigation measures mentioned in this document and required under the IHA; and (4) no rookeries, mating grounds, year-round areas of concentrated feeding, or other areas of special significance for marine mammals occur within or near the planned area of operations during the season of operations, NMFS has determined that the requirements of section 101 (a)(5)(D) of the MMPA have

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been met and the authorization can be issued.

Appropriate mitigation measures to avoid an unmitigable adverse impact on the availability of bowhead whales for subsistence needs have been the subject of a CAA between WesternGeco, the AEWC, and Nuiqsut and Kaktovik whalers. This agreement consists of three main components: (1) Communications, (2) conflict avoidance, and (3) dispute resolution, and has been concluded for the 2001 open-water seismic season.

WesternGeco estimates that 2,630 bowheads could potentially be exposed to its OBC seismic survey activities and, more probably, a total of less than 1,300 bowheads may be harassed based on the number of bowheads that might potentially be within 20 km of the airgun arrays. NMFS concurs and is therefore authorizing a take for bowhead whales by Level B harassment of 1,965 animals (based on the average of 2,630 and 1,300 animals). NMFS believes that no bowheads will be killed or seriously injured by WesternGeco's activity and accordingly has not authorized takings for injury or mortality.

Open-water seismic exploration in the Alaskan Beaufort Sea does have some potential to influence seal hunting activities by residents of Nuiqsut. However, because the main summer sealing by the village of Nuiqsut is conducted off the Colville Delta, west of the proposed survey area, and the zone of influence by seismic sources on seals is expected to be fairly small (less than a few hundred meters), NMFS believes that WesternGeco's OBC seismic survey will not have an unmitigable adverse impact on the availability of seals for subsistence uses.

Authorization

Accordingly, NMFS has issued an IHA to WesternGeco, LLC for the ocean bottom cable seismic survey operations described in this notice during the 2001 open water season in the Alaskan Beaufort Sea provided the mitigation, monitoring, and reporting requirements described in this document and in the IHA are undertaken.

Dated: August 1, 2001.
Donald Knowles,
Director, Office of Protected Resources, National Marine Fisheries Service.

[FR Doc. **01-20281 Filed** 8-10-01; 8:45 am]
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OPTIONAL FORM 99 (7-90)

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To John Goll	From Don
Dept./Agency	Phone #
Fax # FYI	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

JUL 20 1999

JUL 29 1999 RECEIVED

Ms. Cynthia Quarterman
Director
Minerals Management Service
U.S. Department of the Interior
Washington, D.C. 20240

Dear Ms. Quarterman:

Enclosed is an amended Incidental Take Statement for endangered whales that should become a part of the Arctic Regional Biological Opinion that was issued to the Minerals Management Service on November 23, 1988.

At the time of issuance of the 1988 Biological Opinion, the taking of endangered whales incidental to Outer Continental Shelf leasing and exploration activities was not authorized by the National Marine Fisheries Service (NMFS) under section 7 of the Endangered Species Act because this incidental take had not been authorized under section 101(a)(5) of the Marine Mammal Protection Act (MMPA). However, subsequently, NMFS published final regulations on July 18, 1990, under section 101(a)(5), authorizing a take of marine mammals incidental to oil and gas exploration activities in the Beaufort and Chukchi Seas for the five year period expiring on August 17, 1995. NMFS issued an Incidental Take Statement under the Arctic Regional Biological Opinion for that 5-year period.

On April 30, 1994, the President signed Public Law 103-238, The MMPA Amendments of 1994. One part of this law added a new subsection 101(a)(5)(D) to the MMPA to establish an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment for a period of up to one year. For oil and gas exploration work, this 1-year authorization has replaced the 5-year regulated authorization.

On March 24, 1999, NMFS received an application from Western Geophysical requesting an authorization for the harassment of small numbers of several species of marine mammals incidental to conducting seismic surveys during the open water season in the Beaufort Sea between Harrison Bay and Flaxman Island, AK. Weather permitting, the survey is expected to take place from middle- to late-July and to extend until approximately September 10, but no later than October 20, 1999. After a 30-day comment period on the application, NMFS concluded that the taking will not result in more than the incidental harassment (as defined by the MMPA Amendments of 1994) of small numbers of certain species of marine mammals, would have only a negligible impact on these stocks, will not have an unmitigable adverse impact on the availability of these stocks for subsistence uses, and would result in the least practicable impact on the stocks. As a result, NMFS has determined that the requirements of section 101(a)(5)(D) have been met and an incidental harassment authorization has been issued to Western Geophysical. The effective dates of this Authorization will also be the effective dates of the Incidental Take Statement.

If you have any questions regarding the statement, please contact Donna Wieting, Chief, Marine Mammal Conservation Division, Office of Protected Resources, at 301-713-2322.

Sincerely,

Art Jeffers
Acting Director
Office of Protected Resources

Enclosure

Incidental Take Statement
Pursuant to Section 7(b)(4) of the Endangered Species Act

Section 7(b)(4) of the Endangered Species Act of 1973 (ESA) requires that when a proposed Federal agency action is found to be consistent with section 7(a)(2) of the ESA, and the proposed action may incidentally take individuals of listed species, the National Marine Fisheries Service (NMFS) will issue a statement that specifies the impact (amount or extent) of such incidental taking. Furthermore, NMFS will provide reasonable and prudent measures that are necessary to minimize such impacts. Incidental taking by the Federal agency or applicant that complies with the reasonable and prudent measures of this statement is authorized and exempt from the taking prohibitions of the ESA.

Available information indicates that incidental acoustic harassment of small numbers of bowhead whales may occur during Western Geophysical's seismic exploration activities within the Beaufort Sea, Alaska. The noise from the activity may temporarily modify this species' behavior. Based on the density of whale abundance that could be subject to acoustic harassment in the project area, the auditory disturbance threshold for whales when exposed to sound, and the intensity and frequency of the sound source, NMFS anticipates that fewer than 750 bowhead whales will be incidentally harassed between the effective date of this authorization and November 1, 1999. Therefore, this Statement authorizes the following level of incidental harassment of endangered whales by Western Geophysical:

Species	Number of animals harassed
Bowhead whale	750

Reinitiation of consultation is required if: (1) new information reveals effects of the action that may affect listed species in a manner or, to an extent, not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (3) it is estimated that the annual harassment levels are met or exceeded for any of these species of whales.

Reasonable and Prudent Measures

Compliance with the Incidental Harassment Authorization (attached) issued under section 101(a)(5)(D) and 50 CFR 216.107.

The following reasonable and prudent measures must be implemented by Western Geophysical to allow its seismic survey work in the Western Beaufort Sea to occur. These measures are necessary to monitor and minimize impacts on listed marine mammals.

(1). Ramp-up airguns slowly over a period of several minutes, to operating levels: (a) At the commencement of seismic operations, (b) Prior to any array calibrations or testing, and (c) Anytime after the array has been powered down, by firing the smallest gun first and then adding additional guns in sequence until the full array is firing.

(2) Immediately power down the seismic array whenever any bowhead enters, or is about to enter the area delineated by the 180 dB isopleth:

(3) Except in emergency situations or when conducting marine mammal surveys, aircraft (including helicopters) supplying the seismic vessels should maintain an altitude of at least 1,000 ft (305 m) until within 0.5 nm (926 m) of the seismic vessel.

(4) Western Geophysical must designate biologically-trained, on-site individual(s), approved in advance by the National Marine Fisheries Service, to record the effects of seismic surveys and the resulting noise on marine mammals.

(5) Once monitoring begins, the lead contractor for the holder of this Authorization must consult weekly by telephone with Brad Smith, or his designee, at the Western Alaska Field Office, Alaska Region, NMFS (907-271-5006), providing a status report on the appropriate reporting items, unless other arrangements for monitoring are agreed in writing.

(6) The National Marine Fisheries Service must be informed immediately of any changes or deletions to any portions of the technical monitoring plan submitted on March 19, 1999.

(7) Monitoring is to be conducted by a minimum of 3 biological observers onboard the active seismic vessel. A minimum of one observer needs to be on active watch whenever the seismic array is operating during all daylight hours and two observers whenever the seismic array is being powered up to (a) ensure that no marine mammals enter their respective safety zones whenever the seismic array is on, and (b) to record marine mammal activity.

(8) At all times, but specifically during routine non-daylight surveys when the observer need only be on standby, the crew must be instructed to keep watch for marine mammals. If any are sighted, the watch-stander must immediately notify the biological observer on standby. If a marine mammal is within, or

closely approaching, its designated safety zone, the source must be immediately powered down.

(9) Observations on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic array is to be turned on and/or ramped-up.

(10) Monitoring will consist of (a) noting the species, group size, age/size/sex categories (if determinable), the general activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, and apparent reaction of all marine mammals seen to the seismic vessel and/or its airgun array; (b) the location, heading, speed and activity of the vessel (shooting or not), along with ice cover and sea state, at (i) any time a marine mammal is sighted, (ii) at the start and end of each watch, and (iii) during a watch (whenever there is a change in one or more variable); and, (c) the name of each and every vessel that is visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time, bearing, distance, heading, speed and activity of the other vessel(s).

(11) All biological observers must have 7X50 reticulated binoculars for use when necessary.

(12) Western Geophysical must conduct aerial surveys of the seismic area and nearby waters on a daily basis, weather permitting, from September 1, 1999 for a period not less than 10 days.

(13) Using standard aerial survey procedures for marine mammal surveys, monitoring is to be conducted by 2 primary biological observer(s) and a third observer for part-time observations and data logging.

(14) Aerial monitoring will consist of (a) noting the marine mammal species, number, age/size/sex class (if determinable), general activity, heading (if consistent), swimming speed category (if travelling), sighting cue, ice conditions, and inclinometer reading.

(15) In order to assess the effects of seismic noise on marine mammals in Arctic waters, Western Geophysical is required to conduct observations or measurements, or both, as specified in the Technical Monitoring Plan, necessary to determine the acoustic properties of the seismic source and the impacts of seismic activities on marine mammals. These may include aerial observations, and acoustic recordings of marine mammal vocalizations.

(16) A report on the 1999 open water season must be submitted to the Western Alaska Field Office and the Office of Protected Resources, within 90 days after completion of the work

described in this authorization.

(17) The Plan of Cooperation outlining the steps that will be taken to cooperate and communicate with the native communities to ensure the availability of marine mammals for subsistence uses, must be implemented.

United States Department of the Interior
MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
949 East 36th Avenue, Suite 308
Anchorage, Alaska 99508-4363

JUN 14 1999

Mr. Bret Schafer
Western Geophysical Company
351 East International Airport Road
Anchorage, Alaska 99518

Dear Mr. Schäfer:

Your application dated April 27, 1999, requests a Federal permit to conduct geophysical operations on certain Outer Continental Shelf (OCS) lands. The activity is in the Beaufort Sea area as shown on the map accompanying your application. Western Geophysical Company (WGC) will conduct the subject operations using the vessels described in the Operation Plan and attached Vessel List. Operations are proposed to begin on or after July 1, 1999, and will be completed on or before November 30, 1999. The proposed program is a marine seismic acquisition using air guns as an energy source.

OCS Permit 99-02 is hereby granted to conduct geophysical exploration operations on the OCS in the area and manner described in the application. All operations are subject to the enclosed stipulations and approved Permit for Geophysical Exploration for Mineral Resources on the OCS.

The information contained in the following paragraphs should be evaluated before initiating operations and appropriate action taken:

Endangered bowhead whales may occur in the Beaufort Sea during operations. Bowhead whales pass through the area on their fall migration back to the Bering Sea. They begin to leave Canadian Beaufort Sea waters in August and September and travel west through the southern Beaufort Sea. Bowhead whales are known to occur in shallow coastal waters all the way out to the icepack. Other marine mammals that may appear in the project vicinity include beluga whales, spotted, bearded, and ringed seals, and walrus. Gray whales also appear seasonally in the western Beaufort Sea in small numbers.

The Endangered Species Act (ESA) states that there shall be no activity conducted which might jeopardize the continued existence of an endangered species or result in the destruction or adverse change of the habitat of such species. In addition, the Marine Mammal Protection Act (MMPA) provides that there shall be no unauthorized take of marine mammals.

"Take" means to harass, hunt, capture, collect, kill, or attempt to harass, hurt, capture, collect, or kill any marine mammals. Whenever whales or marine mammals are encountered in the project vicinity, WGC should exercise precautions to assure that activities are not in violation of the provisions of the MMPA.

The Minerals Management Service (MMS) will continue regional, systematic aerial survey investigations in the Beaufort Sea to meet informational needs identified under the ESA section 7 consultation and other interagency bowhead whale research coordination. Information on locations, number of sightings, and preliminary behavioral information obtained from these studies will be conveyed to the National Marine Fisheries Service (NMFS). The information will be evaluated and may result in modifications of stipulations applied to this permit to protect these endangered species.

The NMFS regulations will allow incidental taking by harassment of bowhead, gray, and beluga whales, and bearded, ringed, and spotted seals. The operator's actions under this permit will be somewhat guided by an Incidental Harassment Authorization (IHA) and supporting regulations.

Your application states that WGC has requested an IHA from NMFS. If WGC intends to conduct operations under the IHA, we will require a copy of the IHA prior to initiation of operations. The Communication and Avoidance Agreement (CAA) between WGC and the North Slope communities is in place to resolve subsistence-related concerns. The procedures outlined in this agreement represent a good faith effort on the part of WGC to avoid conflict with whaling activities which may be conducted during a portion of the time proposed for this seismic operation. Please notify this office of any changes in the CAA.

If the appropriate letter of authorization is not obtained from NMFS, then the stipulations in the following paragraphs apply.

All vessels operating high-energy sound sources must maintain a minimum spacing of 15 miles between vessels. We request notification by means of the weekly report whenever you must shut down operations in order to maintain this spacing.

The permittee must have one person looking for whales, assisted by the use of standard field binoculars (7 X 35 mm or higher power), whenever the seismic sound source is in operation. No seismic energy source may be fired if a bowhead whale is within the lookout's range of vision. This restriction normally applies out to 3 miles from the vessel.

For the purposes of this permit, it is assumed that the whale migration has started when whales are sighted in the operating vicinity of a vessel or are presumed to be in the area based on aerial survey data.

The following condition applies to operations prior to the bowhead whale migration. If the sound source is being used and visibility is reduced to less than 3 miles, the survey may continue unless the sound source is interrupted for 2 hours or longer. During fog, darkness, or weather conditions, which limit visibility to less than 3 miles, the permittee should not initiate seismic operations or resume seismic operations after interruptions of 2 hours or longer.

After the beginning of whale migration, seismic vessels can operate their high energy sound sources only when visibility exceeds 3 miles. During periods of fog, darkness, or weather conditions which limit visibility to less than 3 miles, the seismic sound sources must be shut down. Operations cannot be initiated or resumed until an area with a radius of 5 miles from the vessel is clear of whales. This may require the use of an aircraft.

Whaling activities within the area of the proposed survey are concentrated around Cross Island and the villages of Kaktovik. It is recommended that the operator shoot any program near these locations prior to the whaling season. For up-to-date information on whaling activities or questions concerning the relation between seismic activities and the subsistence hunt, contact the NMFS Regional Office at (907) 586-7725.

Western Geophysical Company must exercise extra precautions if operating in the following areas. A boulder and cobble habitat occurs inside the barrier islands extending south and east of Cross Island to the easterly portion of Reindeer Island and south to Foggy Island Bay. This habitat supports a unique kelp and invertebrate community known as the "boulder patch community." This area could be critically altered by cables dragged across the sea bottom. We require that you advise us in writing if you initiate operations in this area.

If no adverse effect on whales is detected or if the effect can be avoided by limited shutdown as described earlier, then seismic activities will be allowed to continue until expiration of the permit, voluntary termination, or freeze-up, whichever comes first. If disruption of the bowhead whale migration appears to be unavoidable, then MMS will take corrective action to prevent the disturbance.

Further information on the identification and occurrence of endangered whales or marine mammals in the proposed area of operations and the provisions and penalties of the ESA and the MMPA are available. This information may be obtained from the

U.S. Fish and Wildlife Service
Alaska Region
1011 E. Tudor Road
Anchorage, Alaska 99503
Telephone: (907) 786-3467

and from the

National Marine Fisheries Service
Federal Building, Room C-554
Anchorage, Alaska 99513
Telephone: (907) 271-5006

This permit is effective from the date of approval until November 30, 1999, or the completion of the survey, whichever occurs earlier. Please be advised that this office requests a weekly report of daily operations. We will require a completion report as prescribed in section III B of this permit within 30 days following cessation of field operations. Also, it should be noted that a navigation tape will be required as part of the completion report.

Sincerely,

Larry W. Cooke
Acting Regional Supervisor
Resource Evaluation

3 Enclosures

STIPULATIONS

In the performance of any operations under the Permit and Agreement for Outer Continental Shelf Exploration, the Permittee shall comply with the following Stipulations:

1. As part of the requirements of 30 CFR 251.7-3, the Permittee shall submit to the Regional Supervisor, Resource Evaluation (hereinafter referred to as the Supervisor) within 30 days after the completion of the survey authorized under this Permit and Agreement a map at the same scale as that used ordinarily for such maps and showing the coordinates of latitude and longitude. In addition, each Permittee shall submit one (1) one-half inch, nine-track, final edited navigation tape of all locations in latitude and longitude degrees. The tape is to be in an ASCII or EBCDIC 1600 BPI format with fixed record length and fixed block size. Record length, block size, density and whether the tape is ASCII or EBCDIC must be on a label affixed to the tape. The label must also specify the geodetic reference system (NAD27 or NAD83) used. A printed tape listing and format statement are to be included with the tape.

2. As part of the requirements of 30 CFR 251.3-5, if any operation under this Permit and Agreement is to be conducted in a leased area, the Permittee shall take all necessary precautions to avoid interference with operations on the lease and damage to existing structures and facilities. The lessee (or operator) of the leased area will be notified by letter before the Permittee enters the leased area or commences operations, and a copy of the letter will be sent to the Supervisor executing this Permit and Agreement.

3. (a) Solid or liquid explosives shall not be used except pursuant to written authorization from the Supervisor. Requests for the use of such explosives must be made in writing, giving the size of charges to be used, the depth at which they are to be suspended or buried, and the specific precautionary methods proposed for the protection of fish, oysters, shrimp, and other aquatic life, wildlife, or other natural resources.

(b) The following provisions are made applicable when geophysical exploration on the Outer Continental Shelf using explosives is approved:

(i) Each explosive charge will be permanently identified by markings so that unexploded charges may be positively traced to the Permittee and to the specific field party of the Permittee responsible for the explosive charge.

(ii) The placing of explosive charges on the seafloor is prohibited. No explosive charges shall be detonated nearer to the seafloor than five (5) feet.

(iii) No explosives shall be discharged within one thousand (1000) feet of any boat not involved in the survey.

4. Any serious accident, personal injury, or loss of property shall be immediately reported to the Supervisor.

5. All pipes, buoys, and other markers used in connection with work shall be properly flagged and lighted according to the navigation rules of the U.S. Corps of Engineers and the U.S. Coast Guard.

6. If the Permittee discovers any archaeological resource during geological and geophysical activities, the Permittee shall report the discovery immediately to the Supervisor. The Permittee shall make every reasonable effort to preserve the archaeological resource until the Supervisor has told the Permittee how to protect it.

7. In addition to the general provisions above, the following special provisions shall apply:

(a) This permit is applicable only to that portion of the program involving Federal OCS lands seaward of the submerged lands of the State of Alaska.

(b) The Permittee shall, on request of the Supervisor, furnish quarters and transportation for a Federal representative(s) or other designated observer to inspect operations.

(c) Operations shall be conducted in a manner to assure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions or unreasonably interfere with other uses of the area. Any difficulty encountered with other users of the area or any conditions which cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Supervisor. Serious or emergency conditions shall be reported without delay.

(d) A final summary report (one copy) shall be submitted to this office within 30 days of completion or cessation of operations.

This report shall include:

(i) Program commencement date.

(ii) Program completion date.

(iii) Field effort in crew weeks (actual work time based on 168-hour weeks).

(iv) Line miles of surveys completed.

(v) Summary of incidents or accidents from paragraph 4.

(vi) Date or reasonable estimation of date when data will be available for inspection or selection.

(e) The Permittee shall notify the Commander, U.S. Coast Guard and the Commander, 3rd Fleet as to the approximate time and place the work is to be conducted and to keep them informed:

Commander, U.S. Coast Guard
17th Coast Guard District
Aids to Navigation Branch
P.O. Box 25517
Juneau, AK 99801
(907)586-7365

COMTHIRD
Pearl Harbor, HI
96860
(808)472-8242

8. Information to the Permittee

(a) Operations authorized under permit are subject to the Marine Mammal Protection Act of 1972 as amended (16 U.S.C. 1361 et seq), the Endangered Species Act as amended (16 U.S.C. 1531 et seq), regulations found in 50 CFR Part 18 (U.S. Fish and Wildlife Service), and 50 CFR Part 228 (National Marine Fisheries Service). Special attention should be given to the prohibition of the "taking" of marine mammals. "Taking" means to harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, collect, or kill any marine mammal. National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (F&WS) regulations allow, under certain conditions, the incidental taking by harassment of specific marine mammals. Such a taking of marine mammals is controlled through Letters of Authorization issued by NMFS or F&WS. Permittees are advised to consult the appropriate agencies regarding these laws and regulations. Further information may be obtained from

Regional Director
U.S. Fish and Wildlife Service
Alaska Region
1011 East Tudor Road
Anchorage, Alaska 99503
telephone (907) 786-3542

National Marine Fisheries Service
222 West 7th Avenue, Box 43
Anchorage, Alaska 99513
telephone (907) 271-5006

(b) It is recommended that you contact the appropriate Regional Supervisor, Commercial Fish Division, Alaska Fish and Game Department, or the National Marine Fisheries Service for information on the fisheries and fishing activities in the proposed area of operations in order to minimize potential conflict between your activities and fishing activities. We are attaching a list of the Fish and Game offices with addresses and telephone numbers and a map showing the boundaries of the fishing districts for your convenience.

THE FOLLOWING DOCUMENT PROVIDES INFORMATION TO THE PERMITTEE ON THE ENDANGERED SPECIES ACT OF 1973, AS IT MIGHT APPLY WHEN CONDUCTING FIELD OPERATIONS.

The Endangered Species Act prohibits harassment of endangered and threatened species whether the harassment occurs through an intentional or negligent act or omission. Harassment refers to conduct of activities that disrupt an animal's normal behavior or cause a significant change in the activity of the affected animal. In many cases the effect of harassment is readily detectible: a whale may rapidly dive or flee from an intruder to avoid the source of disturbance. Other instances of harassment may be less noticeable to an observer but will still have a significant effect on endangered whales.

The Permittee must be prepared to take all reasonable and necessary measures to avoid harassing or unnecessarily disturbing endangered whales. In this regard, the Permittee should be particularly alert to the effects of boat and airplane or helicopter traffic on whales.

In order to ensure that the Permittee may derive maximum benefits from their operations at a minimum cost to the health and well being of endangered whales, the following guidelines are offered to help avoid potential harassment of endangered whales:

(1) (a) Vessels and aircraft should avoid concentrations or groups of whales. Operators should, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas.

(b) When weather conditions do not allow a 1,000-foot flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.

(2) When a vessel is operated near a concentration of whales, the operator must take every precaution to avoid harassment of these animals. Therefore, vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.

(3) Vessel operators should avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

(4) Small boats should not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.

When any Permittee becomes aware of the potentially harassing effects of operations on endangered whales, or when any Permittee is unsure of the best course of action to avoid harassment of endangered whales, every measure to avoid further harassment should be taken until the National Marine Fisheries Service is consulted for instructions or directions. However, human safety will take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of endangered whales.

Permittees are advised that harassment of endangered whales may be reported to the National Marine Fisheries Service. For further information contact the National Marine Fisheries Service, Federal Building, Room C-554, Anchorage, Alaska, 99513, telephone (907) 271-5006.

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
949 East 36th Avenue, Suite 308
Anchorage, Alaska 99508-4363

AUG 10 2000

Memorandum

To: Rosa Meehan, PhD, Chief, Marine Mammals Management

From: Regional Supervisor, Resource Evaluation

Subject: Marine Mammals on the Outer Continental Shelf

Thank you very much for your information. We will add polar bears to the list of species that may be encountered by marine seismic survey crews during the summer open water season. If you do not object, we will continue to advise seismic operators about the possibility of encountering walrus. Even though it is rare, both seismic operators and drilling operators have encountered walrus in the western Beaufort Sea.

We have revised the contact number appearing in the permit to reflect the new number you provided.

Thanks again for your assistance.

bcc: OCS Permit 00-02
RE Chron
RD Chron
Hoffman
GBSHEARER:vh:08/09/00
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	Initial & Date
RE/RE	[signature] 8/10/00
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