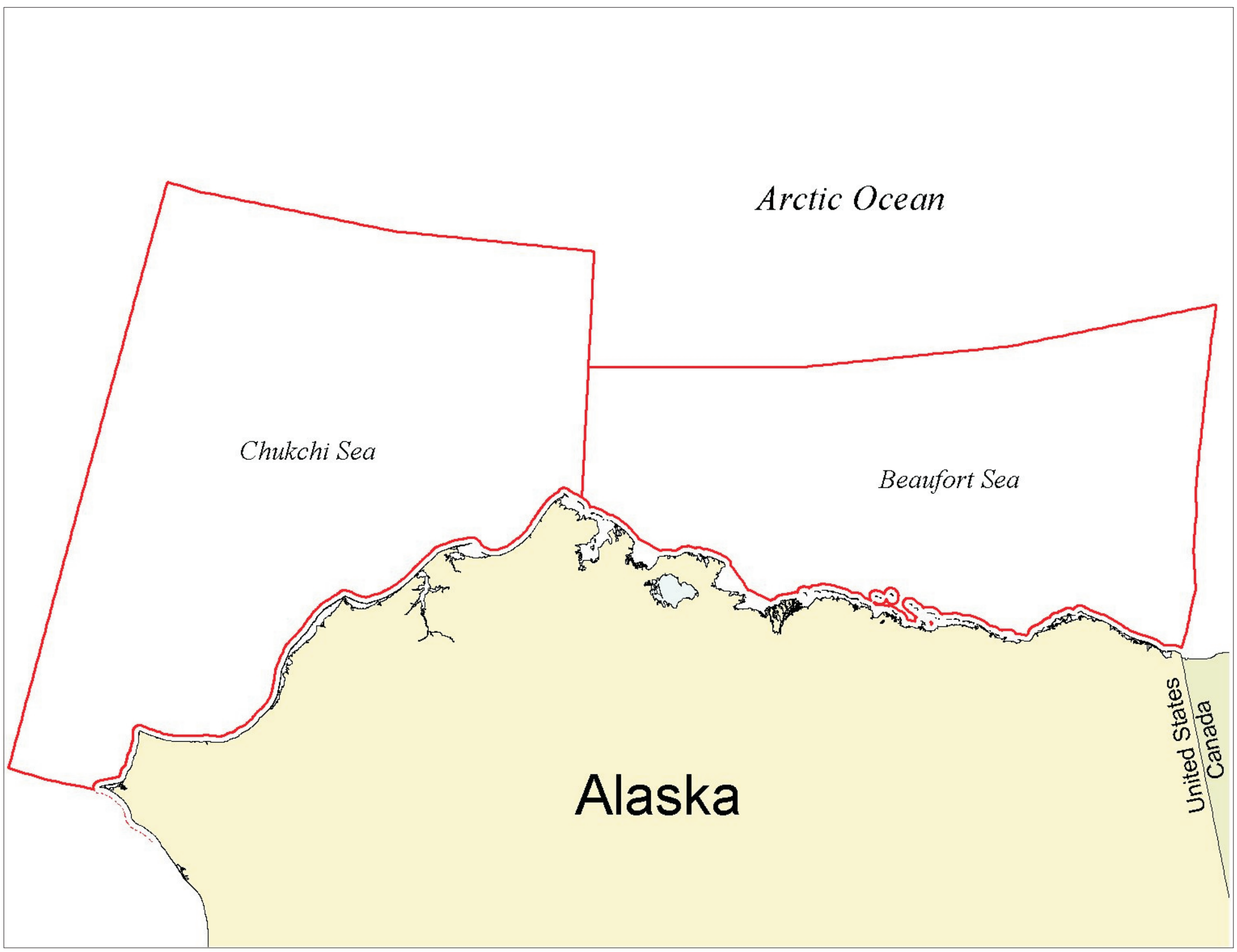
Alaska Outer Continental Shelf

OCS EIS/EA
MMS 2007-001

Seismic Surveys in the Beaufort and Chukchi Seas, Alaska

Draft Programmatic
Environmental Impact Statement



Authors

MMS U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region

NOAA U. S. Department of Commerce
National Oceanic and
Atmospheric Administration
National Marine Fisheries Service

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February 2007

The Department of the Interior Mission
As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U. S. administration.

The Minerals Management Service Mission
As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilites, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS Royalty Management Program meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U. S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of : (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protecion.

The National Marine Fisheries Service Mission
NOAA Fisheries Service is dedicated to protecting and preserving our nation's living marine resources and their habitat through scientific research, management and enforcement. NOAA Fisheries Service provides effective stewardship of these resources for the benefit of the nation, supporting coastal communities that depend upon them, and helping to provide safe and healthy seafood to consumers and recreational opportunities for the American public.

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List of Acronyms, Initialisms, Abbreviations, and Symbols

AAC	Alaska Administrative Code
ACMP	Alaska Coastal Management Program
ACQCR	Air Quality Control Regions
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AGL	above ground level (altitude)
AMAP	Arctic Monitoring and Assessment Program
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ASL	above sea level (altitude)
bbl	barrel(s)
BCB Seas	Bering-Chukchi-Beaufort Seas stock of bowhead whales
BE	Biological Evaluation
BLM	Bureau of Land Management
BO	Biological Opinion
BWASP	Bowhead Whale Aerial Survey Program
CDFO	Canadian Department of Fisheries and Oceans
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeter(s)
cm/s	centimeters per second
CV	coefficient of variation
dB	decibel(s)
dB re 1 µPa rms	decibels re 1 microPascal root-mean-square
dB re 1 µPa at 1 m	decibels re 1 microPascal at 1 meter
DEW	Defensive Early Warning (system)
DMT	DeLong Mountain Terminal
EEZ	exclusive economic zone
EFH	essential fish habitat
ESA	Endangered Species Act
FMP	fisheries management plan
ft	feet
FR	*Federal Register*
FWS	Fish and Wildlife Service
G&G	geophysical and geological (permit)
gal	gallon(s)
$6/m^2$	grams per square meter(s)
Hz	Hertz
IHA	Incidental Harassment Authority
in	inch(es)
in^3	cubic inch(es)
ITM	Information Transfer Meeting
IWC	International Whaling Commission
kHz	kiloHertz
kW	kilowatt(s)
km	kilometer(s)
kn	knot(s)
L	liter(s)
LME	large marine ecosystem
LOA	Letter of Authorization
m	meter(s)
m/s^3	meters per second
mi	mile(s)

mi^2	square mile(s)
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOU	Memorandum of Understanding
MSFCM	Magnuson-Stevens Fishery Conservation Management Act
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
nmi	nautical mile(s)
NOAA	National Oceanographic and Atmospheric Administration
NRC	National Research Council
NRDC	National Resource Defense Council
NSB	North Slope Borough
OBC	ocean-bottom cable (surveys)
OCS	outer continental shelf
PEA	Programmatic Environmental Assessment
ppb	parts per billion
P.L.	Public Law
ppm	parts per million
PSD	Prevention of Significant Deterioration
psi	pounds per square inch
PTE	potential to emit
rms	root-mean-square
ROI	rate of increase
RS/FO	Regional Supervisor/Field Operations
RUSCALA	Russian-American Long-Term Census of the Arctic
TAPS	Trans-Alaska Pipeline System
U.S.C.	United States Code
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
yd	yard(s)
Y-K Delta	Yukon-Kuskokwim Delta
2D	two-dimensional (seismic surveys)
3D	three-dimensional (seismic surveys)
<	less than
>	greater than
%	percent
~	about
±	plus/minus
µg/L	micrograms per liter

I. INTRODUCTION

Pursuant to the National Environmental Policy Act (NEPA), the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) and the Department of the Interior, Minerals Management Service (MMS) have prepared a draft Programmatic Environmental Impact Statement (PEIS) to describe and analyze the potential significant environmental impacts related to reasonably foreseeable proposed geophysical exploration and scientific research using seismic surveys in waters of the Arctic Alaska Outer Continental Shelf (OCS). Specifically, the draft PEIS will assess the environmental impacts of deep-penetration two-dimensional (2D) and three-dimensional (3D) streamer and ocean bottom cable surveys (hereafter referred to as 2D/3D seismic surveys), and high-resolution surveys, among other issues. NMFS and MMS also intend to rely on the PEIS for future permitting and compliance processes under the Marine Mammal Protection Act (MMPA), Endangered Species Act (ESA), the Outer Continental Shelf Lands Act (OCS Lands Act), and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

This Draft PEIS addresses a group of similar or related actions as a whole (seismic surveys in the Arctic Ocean) rather than one at a time in a separate environmental analysis document, and it is an effective means for addressing broad programmatic and cumulative issues and impacts. The "foreseeable level of activity" is based on MMS discussions with the oil and gas industry, the number of active leases in the Beaufort Sea, proposed Chukchi Sea Lease Sale 193, and the evaluation of potential oil and gas resources. With the renewed interest in oil and gas exploration on the OCS portions of the Chukchi and Beaufort seas and the short open-water season, geophysical seismic surveys may be conducted concurrently in the Chukchi Sea and Beaufort Sea OCS Planning Areas.

While this draft PEIS focuses on issues and species under the jurisdiction of MMS and NMFS, a thorough analysis is provided on potential impacts to all species and resources in the affected environment regardless of jurisdiction and/or management authority. In addition, Sections II (Description of the Alternatives) and IV (Description of Mitigation and Monitoring Measures and Discussion of their Effectiveness) contain mitigation and monitoring measures specific to the Pacific walrus and ESA-listed birds, species that are under the jurisdiction of the U.S. Fish and Wildlife Service (FWS). These measures were developed in close coordination between MMS and FWS and appeared as conditions in MMS Geological & Geophysical (G&G) permits during the 2006 Arctic open water season. As MMS is considering these conditions for inclusion within any issued MMS G&G permits in 2007 and beyond, the conditions are also contained within this analysis. Their inclusion, however, does not preclude the FWS from requiring additional measures through any authorizations (e.g. incidental harassment authorizations) they may issue separately under authorities such as the MMPA and/or ESA.

I.A. Background.

I.A.1. Regulatory Framework.

I.A.1.a. NMFS Statutory and Regulatory Mandates. Under the MMPA (16 U.S.C. § 1371; 50 C.F.R. Subpart I), the taking of marine mammals without a permit or exemption from NMFS is prohibited. The term "take" under the MMPA means "to harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." NMFS has further defined takes by "harassment" into two types: (1) Level A Harassment as "any act of pursuit, torment, or annoyance, which has the potential to injure a marine mammal or marine mammal stock in the wild" and (2) Level B Harassment as "any act of pursuit, torment, or annoyance, which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild." To date, NMFS' policy has been to use the 180-decibel (dB) root-mean-squared (rms) isopleth for cetaceans and 190-dB rms isopleth for pinnipeds to indicate where Level A harassment from acoustic sources begins. In addition, NMFS uses the 160-dB rms isopleth to indicate where Level B harassment begins for acoustic sources, including impulse sounds, such as used for seismic surveying.

In order to obtain an exemption from the MMPA's prohibition on taking marine mammals, a citizen of the United States who engages in a specified activity (other than commercial fishing) within a specified geographic region must obtain an incidental take authorization (ITA) under the MMPA. An ITA shall be granted if NMFS finds that the taking of small numbers of marine mammals of a species or stock by such citizen will have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. NMFS may also prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stock and its habitat (i.e., mitigation, monitoring and reporting of such takings). ITAs may be issued as either (1) Letters of Authorization (LOAs) or (2) Incidental Harassment Authorizations (IHAs), the latter applicable when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Application instructions for marine mammal incidental take authorizations, whether an LOA or an IHA, can be found at the following URL: http://www.nmfs.noaa.gov/pr/permits/incidental.htm. ITA applications currently under public review (including Arctic activities) can also be found at this site.

In order to issue an incidental take authorization, NMFS must find that the takings would be small in number, have no more than a "negligible impact" on marine mammal species or stocks, and not have an "unmitigable adverse impact" on subsistence uses of these species. Through these authorizations, NMFS must also identify:

- Permissible methods of taking pursuant to the activity and the specified geographical region of taking;
- The means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for "subsistence" uses; and
- Requirements for monitoring and reporting, including requirements for the independent peer-review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

I.A.1.b. MMS Statutory and Regulatory Mandates. Under the OCS Lands Act, MMS must ensure that the seismic-survey data and information collected by industry and government are obtained in a technically safe and environmentally sound manner. The MMS regulations (30 C.F.R. Part 251) specifically state that geological and geophysical activities cannot:

- interfere with or endanger operations under any lease or right-of-way easement, right-of-use, scientific notice, or permit issued or maintained pursuant to the OCS Lands Act;
- cause harm or damage to aquatic life, property, or to the marine, coastal, or human environments;
- cause undue pollution;
- create hazardous or unsafe conditions;
- unreasonably interfere with or harm other uses of the area;
- disturb archaeological resources; or
- cause hazardous or unsafe conditions.

Pursuant to 30 C.F.R. § 251.4, an MMS G&G permit must be obtained from MMS to conduct geological or geophysical exploration for oil, gas, and sulphur resources. Separate permits must be obtained for either geological or geophysical explorations for mineral resources. Under 30 C.F.R. Part 250 regulations, G&G activities may occur without a permit, provided such activities are ancillary and conducted pursuant to a lease issued or maintained under the OCS Lands Act. The 2D/3D seismic surveys usually occur over unleased OCS lands and are conducted by potential lessees to collect information in preparation for bidding in a lease sale. The upcoming lease sale may be in an area where there are no current leases or where there are both current leases and unleased blocks with additional sales planned (such as in the Beaufort Sea Planning Area).

The 2D/3D seismic surveys may be proposed over areas of: (1) leased blocks by the lessee or operator to gather information to identify the best sites on their leases to consider for exploration/delineation drilling (on lease surveys are covered by 30 C.F.R. § 250.207); or (2) on- and off-lease to provide seismic-survey information between their leases and other wells, so the geologic information from wells can be "extrapolated" to their leases with the seismic-survey information (covered by 30 C.F.R. § 251.4).

High-resolution seismic surveys (often referred to as site clearance or geohazards surveys) and on-lease 2D/3D seismic surveys are ancillary activities authorized by the lease and are conducted under regulations (30 C.F.R. § 250.207). These seismic surveys are done by the lessee or operator on a lease or unit (several leases managed as a group to produce common reservoirs) to collect required site-specific information (on potential geo-hazards or sensitive seafloor resources) in support of the preparation of an Exploration Plan (EP) or a Development and Production Plan (DPP). To support the preparation of Right-of-Way Pipeline applications, high-resolution surveys may also be required to be run along proposed pipeline routes (both on lease and off lease) to identify potential geo-hazards and sensitive seafloor resources. This activity would also be considered an ancillary activity under the 30 C.F.R. Part 250 regulations. The MMS Alaska Region requires lessees to submit a notice of planned ancillary activities at least 30 days prior to start of the activity. If MMS determines that these activities do not meet the performance standards established by 30 C.F.R. § 250.202(a), (b), (d) and (e), the Regional Supervisor will notify the lessees that the ancillary activities do not comply with those standards. In such a case, the Regional Supervisor will require the lessees to submit an EP or DPP and the lessees may not start ancillary activities until the Regional Supervisor approves the EP or DPP.

In addition to assessing and mitigating for potential environmental impacts in advance of survey operations, MMS also reviews the acquired seismic-survey information and determines where resources of concern (e.g., archaeological or sensitive benthic resources) could be adversely affected so that appropriate measures can be implemented to reduce the potential for adverse impacts. Where this potential exists, operators/lessees are required to proceed in one of the following three ways:

1. employ specific operational procedures to protect the resources of concern;
2. adjust the location of the proposed activity(ies) to a distance necessary to prevent disturbance of the resource(s) of concern; or
3. perform additional investigations to establish that the potential resources of concern do not exist at the proposed site or will not be adversely affected by the proposed activity.

I.A.1.c. NMFS and MMS Shared Mandates. Section 7 (16 U.S.C. § 1536) of the ESA states that all Federal agencies shall, in consultation with and with the assistance of the Secretary of the Interior/Commerce (Secretary), ensure that any actions authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species, or result in the destruction or adverse modification of habitat of such species, which is determined by the Secretary to be critical. Section 9 (16 U.S.C. § 1538) of the ESA identifies prohibited acts related to endangered species and prohibits all persons, including all Federal, State, and local governments, from taking listed species of fish and wildlife, except as specified under provisions for exemptions (16 U.S.C. §§ 1535(g)(2) and 1539). A summary of NMFS' and MMS' ESA consultations with the NMFS Office of Protected Resources, Endangered Species Division and the FWS in regards to the Proposed Action is provided in Section IV.

The 1996 reauthorization of the MSFCMA amendments requires each Federal agency to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency may adversely affect essential fish habitat (EFH) identified under the MSFCMA. A summary of NMFS' and MMS' EFH consultation with the NMFS Office of Habitat Conservation in regards to the Proposed Action is provided in Section IV.

I.A.2. Historical Overview.

MMS-permitted seismic surveys have been conducted in the Federal waters of the Beaufort and Chukchi seas since the 1960's with a peak in the 1980's. In 1982 and 1983, MMS issued 23 and 24 permits, respectively, to conduct seismic surveys in the Beaufort Sea (11 marine and 12 over-ice 2D surveys in 1982 and 1, 3D over-ice survey; 14, 2D over-ice surveys; and, 9, 2D marine surveys in 1983). In comparison, there have been fewer surveys conducted in the Chukchi Sea (relatively few in the 1970's with an increase during the 1980's). For the Chukchi, 1986 saw the most permits issued in any one year (6 marine and 1 over-ice, the only over-ice ever permitted in the Chukchi). Prior to the 2006 open water season, more than 100,000 line-miles of 2D and 3D seismic surveys have been collected in the Beaufort Sea Planning Area and approximately 80,000 line-miles of 2D seismic surveys in the Chukchi Sea Planning Area. The vast majority of these surveys used the less detailed 2D methodology to explore for oil and gas deposits.

Section III.C.1 provides more information and discussion about the history of seismic surveys in the Beaufort and Chukchi seas. Figures III.C-1, III.C-2, and III.C-3 illustrate cumulatively, the geographic extent of OCS-permitted seismic surveys conducted in the Beaufort and Chukchi seas beginning in the 1970s and through 2004. The MMS Study "MMS 2002-017 Evaluation of Sub-Sea Physical Environmental Data for the Beaufort Sea OCS and Incorporated into Geographic Information System (GIS) Database" documents site clearance activities in the Beaufort Sea including the timing, scope and results of the surveys. Since the publication of MMS 2002-017 only the OCS Y-1577 McCovey high-resolution survey was conducted. The McCovey high-resolution survey work was accomplished both over ice and during the open water period prior to rig placement. The Chukchi Sea high-resolution surveys were conducted prior to exploration drilling activities. Five exploratory wells were drilled in the Chukchi Sale Area each requiring high-resolution surveys. Two additional leases had high-resolution surveys conducted but exploration drilling was not attempted. All the Chukchi Sea high-resolution surveys were conducted during open water periods.

Although seismic survey activity in both seas declined significantly after the 1980's (see section III.C.1), the 2006 open water season resulted in the issuance of four permits, including three in the Chukchi and one in the U.S. portion of the Beaufort. This renewed interest by industry was primarily due to upcoming MMS lease sales in both seas. MMS anticipates it will receive additional permit applications for surveys in these areas over the coming years (see Section I.B.).

For the 2006 permit applications MMS developed a programmatic environmental assessment (PEA) with NMFS as a cooperating agency (MMS, 2006). NMFS adopted the PEA to meet its NEPA requirements for issuing MMPA authorizations. The Proposed Action under the PEA included the issuance of up to four seismic-survey-related geophysical exploration permits in both the Chukchi and Beaufort seas during 2006. An electronic version of the final PEA can be found on-line at:
http://www.mms.gov/alaska/ref/pea_be.htm.

For future seismic operations in the Beaufort and Chukchi Sea Planning Areas, NMFS and MMS determined that an EIS rather than an Environmental Assessment would be prepared for the following reasons:

- Both agencies had received preliminary information from industry that suggested an additional increase in seismic survey applications beyond the 2006 levels. Given that the scope of the proposed action had increased, both agencies felt it was appropriate to analyze potential effects under an EIS.
- Understanding that survey activity could be expected to continue beyond 2007, both agencies believed that a longer timeframe needed to be analyzed in order to most effectively and fully evaluate the potential for cumulative impacts.
- In 2006, ConocoPhillips Alaska, Inc. filed a lawsuit challenging the legality of a required 120 dB safety zone for certain groupings of bowhead whales. This measure was incorporated into ConocoPhillips IHA to support NMFS' Finding of No Significant Impact. The District Court granted plaintiffs motion to stay this measure stating that plaintiffs raised a "serious question" as to the propriety of the 120 dB monitoring safety zone. Given the District Court's preliminary ruling on this issue and the overall level of uncertainty surrounding the environmental effects of seismic surveys on bowhead whale populations in Arctic waters, NMFS believes it is necessary to address these issues in the context of an EIS, as opposed to an EA.

I.B. Purpose and Need

The Proposed Action includes seismic surveying during the open water season in the Beaufort and Chukchi Sea Planning Areas (see Map 1) resulting from the annual issuance of up to six (6) MMS seismic survey-related geophysical exploration permits or ancillary activity notices in the Chukchi Sea and six (6) seismic survey-related geophysical exploration permits or ancillary activity notices in the Beaufort Sea. Surveys would likely operate concurrently in both planning areas. The Proposed Action also includes an evaluation of high-resolution surveys, which usually occur on-lease and are also analyzed under MMS' lease sale NEPA documents.

The Draft PEIS serves several purposes. First, in order to fulfill its statutory mandates, MMS requires the collection of geological and geophysical seismic-survey information to: (a) ensure safe operations; (b) support environmental impact analyses; (c) protect benthic resources through avoidance measures; (d) ensure fair market value for leases; (e) make royalty-relief determinations; (f) conserve oil and gas resources; and (g) perform other statutory responsibilities. Geophysical seismic surveys provide information that is used by industry and the government to make informed decisions, evaluate the potential for offshore oil and gas resources, and determine the presence of geologic hazards. Seismic survey information reduces the drilling of unnecessary exploration wells. The MMS has a mandate to ensure that the seismic survey data and information collected by industry are obtained in a technically safe and environmentally sound manner.

Next, NMFS is required to prepare an environmental analysis to support the issuance of ITAs under Section 101(a)(5) of the MMPA. The environmental analysis will support future NMFS determinations in the event seismic survey permitees covered under any MMS G&G permits or ancillary activities authorized under the Proposed Action request ITAs. The environmental analysis will assist NMFS in making the requisite MMPA determinations, i.e., the takings would be small in number, have no more than a "negligible impact" on marine mammal species or stocks, and not have an "unmitigable adverse impact" on subsistence uses of these species.

Finally, the environmental analysis will also assist NMFS and MMS in carrying out other statutory responsibilities relating to the agencies' role in authorizing seismic survey activities or incidental take of marine mammals (e.g., assessing environmental impacts on listed species under the ESA (Section 7 consultation) and effects of the proposed action on EFH under the MSFCMA (EFH consultation)).

I.C. Scope, Objectives, and Assumptions.

The scope of the action involves two parts: (1) continue permitting or authorizing geophysical and scientific research seismic surveys that will provide the oil and gas industry and MMS with accurate data on the location, extent, and properties of hydrocarbon resources, as well as information on shallow geological hazards and seafloor geotechnical properties; and (2) to support MMPA authorizations for the incidental taking of marine mammals by seismic survey activities under the Proposed Action. Therefore, the objectives of the Draft PEIS are to:

1. Provide a broadly scoped programmatic NEPA document that assesses a reasonably foreseeable level of geophysical and scientific research and seismic survey activity in waters of the Beaufort and Chukchi Sea Planning Areas, from which other future NEPA documents that evaluate more specific marine seismic-survey plans can be tiered.
2. Provide environmental information that can be used to evaluate whether to grant MMS G&G permit applications and NMFS incidental take authorizations under the MMPA.
3. Characterize OCS seismic activities that available information indicates are likely to occur in the Chukchi and Beaufort seas.
4. Identify and analyze any direct, indirect and cumulative impacts that may result from the proposed action, including any impacts resulting from proposed mitigation measures.

5. Describe the Proposed Action alternatives, including the proposed mitigation measures, which are designed to help prevent or reduce any potential significant adverse impacts.

NMFS and MMS assume (either under G&G permits or as ancillary on-lease activities) that up to six (6) MMS 2D/3D seismic surveys in the Chukchi Sea and six (6) MMS 2D/3D seismic surveys in the Beaufort Sea are likely to occur annually during the open water season. Surveys would likely operate concurrently in both planning areas. For analysis purposes, it is also assumed that one seismic sound source vessel will operate per survey (G&G permit or ancillary activity) (i.e., a maximum of six 2D/3D source vessels operating in the Chukchi Sea Planning Area and six 2D/3D source vessels operating in the Beaufort Sea Planning Area). An exception to the one source vessel per survey assumption could occur if multiple source vessels are used due to equipment limitations (see Section I.E. for a description of such operations). The estimate of the number of surveys was derived from a review of past activity and by expressions of interest by the industry. NMFS and MMS also assume that MMPA authorizations will be sought and where approved by NMFS or the FWS, obtained by the operators in order for these seismic survey activities to commence.

NMFS and MMS assume that high-resolution surveys will occur annually in both planning areas during the open water season. These surveys usually occur on-lease and are also analyzed under MMS' lease sale NEPA documents. The surveys use smaller and fewer air guns and cover a more defined area (see description under I.E.3.). Each high-resolution survey takes five to seven days to complete, so a single vessel can conduct multiple surveys during the open water season. The amount of total surveys depends largely on the amount of ice present. Based on recent activity and upcoming lease sales, NMFS and MMS assume that high-resolution surveys could occur annually on up to 30 potential drill or platform sites in the Beaufort Planning Area and on 12 such sites in the Chukchi Planning Area.

Marine-streamer seismic surveys require essentially ice-free conditions to maneuver effectively the source array(s) and receiver streamer(s). Therefore, ice coverage determines when the "open-water" seismic survey season begins and ends. The amount of ice remaining in an area each year is influenced by a variety of oceanographic and weather conditions, such as currents, seafloor topography, ice conditions, temperature, and wind. The size of the ice-free area necessary for seismic surveys is dependant on the size of the area to be surveyed and the turning radius of the seismic survey vessel, which in turn depends on the overall length of the vessel plus the streamers. For example, the open water season might begin as early as late May for a high-resolution survey using a small vessel towing one streamer or as late as August for a large 3D seismic survey vessel towing using multiple streamers. However, because of environmental concerns (Section III.F), no seismic surveying would be allowed in the spring lead system of the Chukchi Sea before July 1, unless approved by MMS in consultation with NMFS.

For analysis purposes, it is also assumed that one source vessel will operate per survey (G&G permit or ancillary activity) (i.e., a maximum of six source vessels operating in the Chukchi Sea Planning Area and six source vessels operating in the Beaufort Sea Planning Area). Additional vessels may be present to support the source vessel, but these support vessels will not operate a seismic source.

Approximately four refueling operations per marine seismic-survey operation are expected to occur during an open water seismic season covered under the scope of this PEIS. This number does not include refueling of support vessels. The incidents involving the release of oil and fuel from vessels during refueling would be small, on the order of less than 5 gallons (gal) per refueling event—in total, approximately 240 gal of fuel might be spilled during the open water seismic seasons covered under the scope of this PEIS. The 240 gal estimate is likely conservative since the 2006 open water seismic survey season did not result in any reported spillages. Refueling operations in the Beaufort Sea likely would occur at Prudhoe Bay's West Dock facility or at sea with the use of fuel supply vessels, and refueling operations in the Chukchi Sea would occur at sea (in State and/or Federal waters) with the use of fuel supply vessels.

It is also assumed that marine resources could be exposed to accidentally spilled lubricating oil or diesel fuel from a vessel associated with active seismic-survey operations. A torn or damaged streamer also might leak into the marine environment. The liquid used to fill and provide streamer buoyancy usually is liquid paraffin that is biodegradable and evaporates very quickly. Solid/gel streamers, which will not leak if damaged, also are available for use.

MMS believes the risk of fuel spills resulting from vessels colliding with each other or with ice is low because: (1) seismic-survey operations must maintain a distance (usually about 15 miles [mi]) from each other to ensure not interfering with each others' data collection; and (2) vessels are likely to be shared between the two planning areas thus reducing the numbers of vessels present; and (3) seismic surveys would be conducted in open water only, as the presence of ice interferes with vessel maneuverability and acoustic equipment. Table I.C-1 summarizes other assumptions used to identify and analyze the impacts associated with conducting seismic surveys in the Chukchi and Beaufort Sea Planning Areas.

Given that 2D/3D seismic surveys have the potential to take marine mammals by harassment, both agencies believe that MMS permittees need an MMPA incidental take authorization in order to obtain a legal exemption from the MMPA take prohibition while conducting such surveys. This may include obtaining an authorization from the FWS (for the Pacific walrus and polar bears) and one from NMFS (for cetaceans and pinnipeds other than the Pacific walrus). A determination whether taking will occur while conducting a certain activity is the responsibility of the permittee in consultation with NMFS or FWS.

Also, the ESA requires that NMFS cannot complete an Incidental Take Statement (ITS) under section 7 of the ESA in regard to harassment of endangered or threatened marine mammal species (e.g., bowhead, fin, and humpback whales) before the appropriate MMPA authorization is obtained. Because an ITS is issued under the ESA only after NMFS has issued an MMPA authorization, any seismic-survey permits to be issued by the MMS Alaska OCS Region or on-lease ancillary activities involving 2D/3D seismic surveys authorized by the MMS will state that seismic surveys shall not commence until such time that FWS and NMFS issue MMPA authorizations and, where needed, ESA ITSs.

NMFS and MMS assume that requirements for a plan of cooperation with the affected Alaskan Native communities will be met. NMFS and MMS also assume that a Conflict Avoidance Agreement (CAA), or similar document, will be agreed to by the applicant and affected Alaska Native groups to lessen the potential for negative impacts to subsistence-harvest activities. This plan of cooperation will then be reviewed by NMFS to determine whether the activity can meet the MMPA requirement for no "unmitigable adverse impact" on subsistence. If a plan of cooperation is not agreed upon, then NMFS may consider implementation of additional mitigation and monitoring measures within the MMPA authorization. These measures could include time or area closures similar to those imposed during the 2006 open water season or other management controls to limit or curtail operations based on results from site specific monitoring programs. Identification and implementation of these provisions will be coordinated between the MMS and NMFS.

Seismic surveys may be described by the location of the receivers (e.g., marine streamer surveys, vertical cable surveys, ocean-bottom cable surveys, and vertical seismic profiling). The same acoustic source may be used for all of these receiver configurations. Impacts associated with these seismic survey receivers was not identified as an issue of concern during preparation of the 2006 PEA for seismic surveys in the Arctic OCS, during scoping or public hearings for NEPA processes for proposed OCS lease sales in the Beaufort and Chukchi Seas, or during scoping for this PEIS. As the potential environmental effects associated with the different receiver configurations are expected to be similar and limited, the impacts specific to different receiver configurations do not need to be individually addressed in this PEIS. The potential impacts are generally addressed in the analysis of multiple-use and seafloor impacts and the MMS has standard requirements to mitigate potential impacts to the seafloor on site-specific basis.

This Draft PEIS will also not assess potential oil and gas activities (e.g., exploration drilling, etc.) in Federal waters that already have been evaluated in Beaufort Sea sale-related environmental assessment documents or in the Chukchi Sea Lease Sale 193 EIS (see http://www.mms.gov/alaska/ref/eis_ea.htm). This draft PEIS' cumulative activities scenario (Sec. III.C) and cumulative impact analysis (Sec. III.H) focus on oil- and gas-related and non-oil- and gas-related noise-generating events/activities in both Federal and State of Alaska (within 3 mi of shore) waters that are reasonably foreseeable during the period of the

Proposed Action. Environmental impacts resulting from community and commercial development, military activities, and arctic warming also are considered.

Aside from the analysis within this PEIS, each G&G permit application/ancillary notice or application for MMPA authorization will receive an additional review to determine if the proposed seismic survey is within the scope of the activities addressed and evaluated within the PEIS. Those seismic surveys within the scope of the final PEIS may be permitted, subject to compliance with applicable law. Further NEPA analysis will be conducted for any permit applications and/or ancillary notices that fall outside the scope of the Proposed Action within the Final PEIS.

I.D. Issues and Concerns.

Issues and concerns associated with seismic-survey operations in the marine environment have been documented by the scientific community, in government publications, and at scientific symposia. In addition, public testimony and traditional knowledge from Alaskan Natives have provided valuable information about seismic-survey operations.

Based on the information obtained from the aforementioned sources, the following more prominent issues and concerns have been identified by NMFS and MMS:

- Protection of subsistence resources and the Inupiat culture and way of life.
- Risks of oil spills and their potential impacts on area fish and wildlife resources.
- Disturbance to bowhead whale migration patterns.
- Impacts of seismic operations on marine fish reproduction, growth, and development.
- Harassment and potential harm of wildlife, including marine mammals and marine birds, by vessel operations and movements.
- Impacts on water and air quality.
- Changes in the socioeconomic environment.
- Impacts to threatened and endangered species.
- Impacts to marine mammals.
- Incorporation of traditional knowledge in the decision-making process.
- Effectiveness and feasibility of marine mammal monitoring and other mitigation and monitoring measures.

In accordance with Council on Environmental Quality (CEQ) regulations, this Draft PEIS will focus on those activities and resources for which significant impacts exist and identify and describe potential mitigation measures to avoid and/or minimize those impacts.

I.E. Overview of Seismic Surveys.

Seismic surveys are most often characterized by the type of data being collected (2D, 3D, high-resolution). Seismic surveys may be described in very general terms by when the surveys occur (pre-lease, post-lease) because the timing can indicate the type of data likely to be collected. Surveys may be described by the acoustic sound source (air gun, water gun, sparker, pinger, etc) or by the purpose for which the data is being collected (speculative shoot, exclusive shoot, site clearance).

Seismic surveys may also be described by the location of the receivers. The last two types (vertical seismic profiling and vertical cable surveys) have rarely or never been used in the Alaskan OCS to date and, therefore, will not be considered (unless otherwise proposed as a form of technology) in the analysis under this PEIS. In addition, vertical cable surveys and vertical seismic profiling usually use standard seismic sources and do not need to be discussed separately from standard seismic surveys.

- Marine streamer surveys (deep penetration): Receivers are located in long hydrophone cables towed behind the source vessel or separate streamer vessels.

- Marine streamer surveys (shallow penetration): Receivers are located on short hydrophone cables towed behind the source vessel.
- Ocean-bottom cable surveys: Receivers are located on hydrophone cables that are laid in a grid pattern on the seafloor.
- Vertical seismic profiling. Receiver(s) are located within a well bore (downhole). Alternatively, the sound source may be located within the well bore with the receivers located in any of the configurations above.
- Vertical cable surveys: Receivers are located in hydrophone cables that are attached to the seafloor and extend vertically in the water column.

I.E.1. Marine-Streamer 3D and 2D Surveys. Airguns are the acoustic source for 2D and 3D seismic surveys. Their individual size can range from tens to several hundred 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 for 2D/3D seismic surveys are expected to range from 1,800-4,000 in^3 but may range up to 6,000 in^3. These arrays emit pulsed rather than continuous sounds. While most of the energy is directed downward and the short duration of each pulse limits the total energy, the sound can propagate horizontally for several kilometers (Greene and Richardson, 1988; Hall et al., 1994).

Marine-streamer 3D seismic surveys vary markedly depending on client specifications, subsurface geology, water depth, and geological target reservoir. Figure I.E-1 illustrates a typical marine seismic survey using streamers. The vessels conducting these surveys generally are 70-120 meters (m) long. A 3D source array typically consists of two to three subarrays of six to nine airguns each, but may vary as newer technology is developed. Vessels tow one to three source arrays to generate the acoustic energy, depending on the technical survey design specifications required for the geologic target. Most operations use a single-source vessel; however, in a few instances, more than one source vessel will be used. The overall energy output for the permitted activity will be the same, but the firing of the source arrays on the individual vessels will be alternated. The sound-source level (zero-to-peak) associated with 3D seismic surveys ranges between 233 and 240 decibels re 1 microPascal at 1 meter (dB re 1 µPa at 1 m) but can exceed this depending on the configuration of the array. The arrays usually are 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 kilometers (km) long and spread out over a width of 400-900 m. Streamers are passive listening equipment consisting of multiple hydrophone elements.

An exception to the one sound-source vessel per survey assumption could occur if multiple source vessels are used due to equipment limitations. For example, an OBC survey could have two source vessels alternating shots due to deck load restrictions on the source vessels; the resulting amount of sound introduced into the environment would be the same. This method was used in a 2005 3D seismic survey in Cook Inlet. Neither of the small sound-source boats used could carry air compressors large enough to recharge the airgun arrays fast enough to conduct the survey. Two vessels with smaller air compressors capable of recharging the airgun arrays in time to shoot every other shotpoint were used. The two vessels were sailed along the same course in close proximity and alternated shooting.

Vessel transit speeds are highly variable, ranging from 8-20 knots (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 3D surveys are acquired at typical vessel speeds of approximately 4.5 kn (8.3 km/hour). A source array is activated approximately every 10-15 seconds, depending on vessel speed. The timing between activations varies between surveys to achieve the desired spacing required to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m. Depending on the shotpoint interval, airguns are fired between 20 and 70 times per mile. The above description is for a generalized 3D survey. Individual survey parameters may vary from the description.

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 track line may take several hours, depending on 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 track line. Seismic vessels operate day and night and a survey may continue for days, weeks, or months, depending on 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. "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%" (Fontana, 2003, pers. commun.). The marine surveys in the Chukchi Sea in 2006 were able to acquire 10-13 square miles of data per 24 hour operational period using a 6 streamer vessel. This assumes no shutdowns due to weather, marine mammals, and equipment maintenance. This equates to acquiring between 600-1100 square miles per vessel during a typical seismic operational season from July to November. Using the maximum acquisition number, this equates to data being acquired over approximately two percent of either the Beaufort of Chukchi areas per vessel.

Adjacent transit lines for a modern 3D survey generally are 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 between outermost streamers. Biodegradable liquid paraffin is used to fill the streamer and provide buoyancy. Solid/gel streams also are available for use. 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 an offset racetrack pattern, whereby the next acquisition line is several kilometers away from and traversed in the opposite direction of the track line just completed.

Marine-streamer 2D surveys use similar geophysical-survey techniques as 3D 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 compared to 3D surveys, and they are conducted over wide areas or on a regional basis to identify potential prospective areas.

The 2D seismic-survey vessels generally are smaller than modern 3D-survey vessels, although larger 3D-survey vessels are able to conduct 2D surveys. The source array typically consists of three or more subarrays of 6-8 airgun sources each, but may vary as newer technology is developed. The sound-source level (zero-to-peak) associated with a 2D marine seismic survey is the same as 3D marine seismic surveys (233-240 dB re 1 µPa at 1 m) but can exceed this depending on the configuration of the array 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 spread widely apart compared to 3D surveys, which acquire data in a closely packed rectangular area. Therefore, considerably less source effort (less acoustic energy) is required to cover a given area of the subsurface compared to 3D surveys. Seismic vessels acquiring 2D data are able to shoot at 4-5 miles per hour and are able to acquire between 85-110 line-miles per day depending on the distance between line changes. Vessels acquiring 2D data can acquire 5,000-8,000 line-miles per vessel during a typical open water seismic operational season in Arctic waters.

A guard or chase 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. Crew changes, refueling, and resupply for the seismic vessels are generally on a four to six week schedule. Helicopters also may be used, when available, for vessel support and crew changes. During the 2006 open water season, helicopters were not used due to safety concerns. All crew changes and resupply were done using support vessels.

Marine-streamer 2D and 3D surveys in the Beaufort and Chukchi seas require an essentially ice-free operational environment because of having to maneuver the long streamers and airgun arrays. Thus, the timing and areas of the surveys will be dictated by ice conditions but may also be adjusted based on mitigation requirements in MMS permits or authorization of ancillary activities or MMPA authorizations. The data-acquisition season in the Chukchi Sea could start as soon as ice conditions permit (as early as June), and end when ice conditions prevent further operations to be conducted (sometime in November). The Beaufort Sea data-acquisition season, because of a later ice-free season, likely would begin in late

July/early August and end in early October. Even during this time period, there is no assurance that any given location will be ice-free. The Beaufort Sea season is additionally constrained by the need to get the vessel out of the area before ice conditions trap the vessel in the area.

I.E.2. Ocean-Bottom-Cable Seismic Surveys. Ocean-bottom-cable (OBC) seismic 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 seismic 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 one or two smaller utility boats). Most operations use a single source vessel. In a few instances, however, more than one source vessel will be used. The overall energy output for the permitted activity will be the same, but the firing of the source arrays on the individual vessels will be alternated. These vessels generally, but not necessarily, are smaller than those used in streamer operations, and the utility boats can be very small, in the range of 10-15 m.

An OBC operation begins by laying cables off the back of the layout boat. Cable length typically is 4-6 km but can be up to 12 km. Groups of seismic-survey 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 seismic 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. The source array may be a single or dual array of multiple airguns, which is similar to the 3D marine seismic survey. The sound-source level (zero-to-peak) associated with an OBC seismic survey is the same as the 2D and 3D marine seismic surveys (233-240 dB re 1 μPa at 1 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 track line is completed, the source ship takes about 10-15 minutes to turn around and pass over the next cable. When a cable is no longer needed to record seismic-survey 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 on operation conditions. Normally, a cable is left in place for about 24 hours.

An OBC seismic survey typically covers a smaller area (approximately 10 by 20 mi) and may spend days in an area. In contrast, 3D streamer seismic surveys cover a much larger area (thousands of square miles) and only stay in a particular area for hours.

While OBC seismic surveys might occur in the Beaufort Sea, they are not anticipated to occur in the Chukchi OCS because of its greater water depths and the greater efficiency of streamer operations in deep water. 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.

I.E.3. High-Resolution Surveys. A high-resolution seismic survey is the preferred method used by the oil and gas industry to provide required information to MMS about the site of 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 (e.g., proposed platform locations and pipeline routes); and detect geohazards, archaeological resources, and certain types of benthic communities.

A typical operation consists of a vessel towing an acoustic source (airgun) about 25 m behind the ship and a 600-m streamer cable with a tail buoy. The source array usually is a single array composed of one or more airguns. A high-resolution survey usually has a single airgun (for two dimensional data) or a tri-cluster of airguns (for three dimensional data). The ships travel at 3-3.5 kn (5.6-6.5 km/hour), and the source is activated every 7-8 seconds (or about every 12.5 m). All involved ships are designed to reduce self-noise, as the higher frequencies used in high-resolution work are easily masked by the vessel noise if special attention is not paid to keeping the ships quiet.

Typical surveys cover one lease block at a time. The MMS regulations require information be gathered on a 300- by 900-m grid, which amounts to about 129 line-kilometers of data per lease block. If there is a high probability of archeological resources, the north-south lines are 50 m apart and the 900 m remains the same. Including line turns, the time to survey a lease block is approximately 36 hours. Airgun volumes for high-resolution surveys typically are 90-150 in^3, and the output of a 90-in^3 airgun ranges from 229-233 dB re 1µPa at 1 m. Airgun pressures typically are 2,000 psi (pounds per square inch), although they can be used at 3,000 psi for more output.

II. DESCRIPTION OF THE ALTERNATIVES

The Proposed Action (Alternative 2) is for MMS and NMFS to issue authorizations for seismic surveying (2D/3D and high-resolution) in the Beaufort and Chukchi Sea Planning Areas (see Map 1) resulting from the annual issuance of up to six (6) MMS 2D/3D seismic survey-related geophysical exploration permits or ancillary activity notices in the Chukchi Sea and six (6) 2D/3D seismic survey-related geophysical exploration permits or ancillary activity notices in the Beaufort Sea and for the taking of marine mammals incidental to these activities. Surveys would likely operate concurrently in both planning areas. It also includes high-resolution surveys, which usually occur on leased blocks and are analyzed under MMS' lease sale NEPA documents. The Proposed Action also includes the issuance of NMFS-related authorizations under Section 101(a)(5) of the MMPA for the incidental taking of marine mammals.

Through the scoping process, a range of alternatives has been identified that consider issues of concern (see Sec. I.D) and the need to protect the fish and wildlife resources of the Beaufort and Chukchi Seas Planning Areas and associated subsistence-harvest activities.

II.A. Range of Alternatives.

The alternatives that follow were developed taking into consideration the Proposed Action's purpose and need, as described in Section I (Introduction) and the potential impacts identified through the scoping process. The primary impacts of the Proposed Action are associated with the generation of acoustic sounds from seismic-survey operations, seismic-vessel movements and traffic, air traffic associated with supporting seismic-survey operations, and cumulative impacts. The sound generated by a seismic-survey operation and related activities has the potential to adversely impact marine mammals and other marine resources and for some resources could result in significant impacts (as defined in Section III.E) if not properly mitigated.

A more detailed description of the range of proposed alternatives is contained later in this chapter. Section III (Affected Environment and Impact Analysis) includes a more thorough discussions of the potential effects from the Proposed Action and describes and analyzes the impacts associated with each alternative described below. Similarly, the mitigation and monitoring measures that may be required will be addressed in Section IV. All alternatives require the seismic-survey operator to successfully perform and demonstrate the efficacy of mitigation measures.

Alternative 1. No seismic surveys would be approved (No Action).

Alternative 2. Seismic surveys would be approved as proposed with existing Alaska OCS G&G exploration stipulations and guidelines (Proposed Action).

Alternative 3. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 120-decibel (dB) safety zone for marine mammals.

Alternative 4. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 160-dB safety zone for marine mammals.

Alternative 5. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including 160-dB and 120-dB safety zones for marine mammals.

Alternative 6. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180-dB exclusion zone for cetaceans and the Pacific walrus and a 190-dB exclusion zone for seals.

Alternative 7. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180-dB exclusion zone for cetaceans and the Pacific walrus, 190-dB exclusion zone for seals and 120/160-dB safety zones for marine mammals.

Alternative 8. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180-dB exclusion zone for cetaceans and the Pacific walrus, 190-dB exclusion zone for seals, 160-dB monitored safety zone for feeding bowhead and gray whales, and requirements for specific temporal/spatial/operational restrictions to further reduce impacts to feeding/socializing/migrating aggregations of bowhead and gray whales and bowhead cow/calf pairs.

Alternative 9. Seismic survey activities would be limited to one geophysical exploration seismic survey permit or authorized ancillary activity annually in each planning area and would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180-dB exclusion zone for cetaceans and the Pacific walrus and a 190-dB exclusion zone for seals.

Alternatives 2-9 incorporate existing MMS G&G exploration stipulations and guidelines (see below). In addition, **Alternatives 3-9** also emphasize the inclusion of a specified exclusion/safety zone for marine mammals and additional protective mitigation measures for marine animals (see below). All of these measures and stipulations may be included as MMS permit stipulations and/or within NMFS' MMPA authorizations.

MMS Existing Alaska OCS Geological and Geophysical Exploration Stipulations and Guidelines Incorporated into Alternatives 2-9

- No solid or liquid explosives shall be used without specific approval.
- Operations shall be conducted in a manner to ensure 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 uses of the area or any conditions that 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 Regional Supervisor/Resource Evaluation. Serious or emergency conditions shall be reported without delay.
- Operators must maintain a minimum spacing of 15 miles between the seismic-source vessels for separate operations. The MMS must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permit applicants shall use the lowest sound levels feasible to accomplish their data-collection needs.
- 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.
- 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.
- 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.
- 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.

- 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 NMFS 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.

Proposed Mitigation and Monitoring Requirements Specific to Marine Mammals for Alternatives 3-9 (for inclusion in MMPA authorizations and/or as conditions in MMS G&G permits). The measures outlined below are based on: (1) measures in the July 1999, August 2001 and June-July 2006 MMPA authorizations from NMFS related to MMS-issued G&G permits in the Beaufort and Chukchi Sea Planning areas; (2) protective measures in MMS' most recent G&G permits; (3) Open Water meetings in 1999, 2001 and 2006; (4) the NMFS' Biological Opinion on Arctic Region OCS activities dated June 16, 2006 (NMFS, 2006); and (5) the analysis contained within the PEA for 2006 Arctic open water season seismic surveys (MMS, 2006a).

- **Implementation and Monitoring of the Specified Exclusion and/or Safety Zone –** An exclusion and/or safety zone(s) has been specified for each alternative. The zone is set from the seismic-survey-sound source and shall be free of marine mammals before the survey can begin and must remain free of marine mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from potential Level A harassment (injury). NMFS has set the 180-dB (Level A Harassment-injury) for cetaceans and the 190-dB (Level A Harassment-injury) for seals and sea lions. FWS has set the 180-dB (Level A Harassment-injury) for Pacific walrus. The purpose of the safety zones (e.g., 120-dB and 160-dB) is to provide additional protection for bowhead whale cow/calf pairs and aggregations of bowhead and gray whales engaged in biologically significant behaviors.

  Individuals (marine mammal biologists or trained observers approved by NMFS) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free zone and monitor for avoidance or take behaviors. Visual observers monitor the zone to ensure that marine mammals do not enter the zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the monitoring programs and observers.

- **Shut Down** – The survey shall be suspended until the exclusion/safety zone is free of marine mammals. All observers shall have the authority to, and shall instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the zone. If the airgun array is completely shut-down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.

- **Ramp Up** – Ramp up is the gradual introduction of sound from airguns to deter marine mammals from potentially damaging sound intensities and from approaching the specified zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated at night or when monitoring the zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the zone before the airgun array is again ramped up to full output.

- **Field Verification** – Before conducting the survey, the operator shall verify the radii of the exclusion/safety zones within real-time conditions in the field. This provides for more accurate radii rather than relying on modeling techniques before entering the field. Field-verification techniques must use valid techniques for determining propagation loss. The methodology chosen must be approved in advance by NMFS. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the zones by applying a sound-propagation series.

- **Monitoring of the Seismic-Survey Area –** Aerial-monitoring surveys or an equivalent monitoring program acceptable to the NMFS may be required through the MMPA authorization process. Field verification of the effectiveness of any monitoring techniques may be required by NMFS.

- **Reporting Requirements** – Reporting requirements provide the regulating agencies with specific information on the monitoring techniques to be implemented and how any observed impacts to marine mammals will be recorded. In addition, operators must report immediately any shut downs due to a marine mammal entering the exclusion/safety zones and provide the regulating agencies with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the zones.

- **Temporal/Spatial Restriction** – Seismic surveys must not occur in the Chukchi Sea spring lead system before July 1, unless authorized under the MMPA by NMFS, to provide bowhead cow/calf pairs additional protection.

Additional Proposed Mitigation Measures for MMS G&G Permits. The following measures are specific to Alternatives 3-9. They were included as conditions within the MMS G&G permits for the 2006 Arctic open water season and are considered for inclusion in MMS G&G permits issued under this Proposed Action. Several of these measures concern FWS species and were developed in close coordination between MMS and the FWS for MMS-authorized surveys as described under the Proposed Action. In addition, several of these measures were included in the FWS biological opinion issued to MMS (FWS, 2006) covering 2006 seismic surveys in the Beaufort and Chukchi Sea Planning Areas.

- No seismic activity, including re-supply vessels and other related traffic, will be permitted within the Ledyard Bay spectacled eider critical habitat area following July 1 of each year, unless human health or safety dictates otherwise.

- Seismic survey support aircraft must avoid overflights across the Ledyard Bay spectacled eider critical habitat area below an altitude of 1,500 feet (450 m) after July 1 of each year, unless human health or safety dictates otherwise.

- Survey operations shall use the lowest sound levels feasible to accomplish their data-collection needs.

- Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters as much as possible.

- Seismic operations shall be shut down if walruses are sighted within the 180-dB (Level A harassment-harm) acoustical safety/exclusion zone.

- Seismic-survey and associated support vessels shall observe a 0.5-mile (~800 m) safety radius around Pacific walrus groups hauled out onto land or ice.

- Aircraft shall be required to maintain a 1,000 ft minimum altitude within 0.5 mile (~800 m) of hauled-out Pacific walruses.

- Seismic-survey operators shall notify MMS and NMFS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals.

- To avoid significant additive and synergistic effects from simultaneous seismic-survey operations that might hinder the migration of bowhead whales, NMFS and MMS will review the seismic-survey plans and may require special restrictions, such as additional temporal or spatial separations.

- Seismic cables and airgun arrays must not be towed in the vicinity of fragile biocenoses, unless MMS determines the proposed operations can be conducted without damage to the fragile biocenoses. Seismic-survey and support vessels shall not anchor in the vicinity of fragile biocenoses (e.g., the Boulder Patch, kelp beds) as identified by MMS or may be discovered by the operator during the course of their operations, unless there is an emergency situation involving human safety and there are no other feasible sites in which to anchor at the time. Permittees must report to MMS any damage to fragile biocenoses as a result of their operations.

- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m-bathymetric contour. High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting seismic surveys; however, navigation lights, deck lights, and interior lights could remain on for safety.

- All bird-vessel collisions shall be documented. Reporting information will include, but not be limited to, species identification, date/time, location, weather, and operational status of the survey vessel when the strike occurred. If eiders or murrelets that are injured or killed through collisions with vessels are recoverable, seismic-survey personnel should recover them and immediately contact the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska, at 907-456-0499 for instructions on the handling and disposal of the injured or dead bird(s).

For all measures, an inability or unwillingness to effectively perform any mitigation measure may result in MMS suspending the seismic-survey operator's authorization and/or NMFS suspending its MMPA authorization until such time that the protective measures can be successfully performed and documented.

II.A.1. Alternative 1. No seismic surveys would be approved (No Action). No seismic surveys would be approved for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data-processing technology to reanalyze existing geophysical exploration seismic data and/or using survey techniques other than seismic. The environmental assessment of alternative geophysical-survey techniques is not part of this PEIS.

IIA.2. Alternative 2. Seismic surveys would be approved as proposed with existing Alaska OCS G&G exploration stipulations and guidelines (Proposed Action).

Seismic surveys would be approved as proposed with stipulations related to G&G exploration activities on the OCS. MMS regulations would then require that geophysical operations be conducted in a manner to ensure that they will not cause pollution or undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. The stipulations also notify the permittee that operations under the permit are subject to the MMPA and ESA, and advise the permittee to contact the NMFS and/or FWS to discuss their proposed activities.

II.A.3. Alternative 3. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 120-dB safety zone. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including a required 120-dB safety zone for marine mammals during all seismic survey operations in both planning areas. The 120-dB isopleth is the approximate zone where Richardson et al. (1999) found at 20 kilometers (km) from the seismic source almost total bowhead whale exclusion. Sound levels received by bowhead whales at 20 km ranged from 117-135 dB re 1 µPascal root-mean-square (dB re 1µPa rms) and 107-126 dB re1µPa rms at 30 km. The 2001 Open Water Meeting participants concluded that bowhead whales in the Beaufort Sea exhibit responses when exposed to these levels (NMFS, 2001).

II.A.4. Alternative 4. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 160-dB safety zone. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including a required 160-dB safety zone for marine mammals during all seismic survey operations in both planning areas. This alternative is identical to Alternative 3, except this alternative specifies a 160-dB safety zone instead of a 120-dB safety zone. The intent is to reduce impacts to marine mammals (principally gray and bowhead whales) to the lowest level practicable to lessen the potential for disruption of feeding and socializing, behavior patterns important for reproduction and survival. The 160-dB is where Malme et al. (1984) found migrating gray whales avoided seismic noise along the California coast, and it is used by NMFS to indicate where Level B harassment begins for impulse sounds, such as seismic.

II.A.5. Alternative 5. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including 160-dB and 120-dB safety zones. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including 120-dB and 160-dB safety zones. The intent of this alternative is the same as Alternatives 3 and 4 and provides combined special protection for: (1) bowhead whale calves; (2) reproductive-aged female bowhead whales; (3) aggregations of bowhead and gray whales; and (4) fall subsistence hunting of bowhead whales in the Beaufort Sea. All seismic survey operations would implement a 160-dB safety zone for all marine mammals in both planning areas. However, the safety zone would be expanded to 120-dB and monitored according to the following conditions:

- A 120-dB safety zone for bowhead whales in the Beaufort Sea will be established and monitored when four or more fall-migrating bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program within the area to be seismically surveyed during the next 24 hours. No seismic surveying shall occur within the 120-dB safety zone around the area where the whales were observed, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.

- Based on the 120-dB safety zone, an aerial monitoring zone for bowhead whales in the Chukchi Sea will be established and monitored: (1) when four or more fall-migrating bowhead whale cow/calf pairs are observed at the surface during the vessel research-monitoring program; (2) when Barrow whalers notify NMFS or MMS that bowhead whale cow/calf pairs are passing Barrow; or (3) on September 25, whichever is earliest. Once notified by NMFS or MMS, a daily aerial survey will occur (weather permitting) within the area to be seismically surveyed during the next 24 hours. Whenever four or more migrating bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program, no seismic surveying shall occur within the 120-dB safety zone around the area where the whales were observed by aircraft, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.

- The threshold of four or more fall-migrating bowhead whale cow/calf pairs was set based on the following: (a) cow/calf pairs are identified in Section III.F.3.f(1) as the most vulnerable portion of the population and disruption of their biologically significant behaviors or their avoidance of important habitats is more likely to lead to population level impacts; (b) mitigation measures for this portion of the population should be cautiously developed to ensure that takings are at the lowest practicable level (as required by MMPA Section 101(a)(5)(D)(ii)) and that significance is not met (as defined in Section III.E); (c) bowhead whale cow/calf pairs migrate in groupings or pulses and the observed presence of cow/calf pairs by aerial and vessel surveys generally indicates that additional cow/calf pairs are present but unseen; (d) using professional judgment, NMFS and MMS have determined that the presence of four or more cow/calf pairs (as observed during aerial or vessel surveys) indicates that enough cow/calf pairs are likely present (but some unseen) in the area in numbers equal to or greater than 12 animals; and (e) the potential for significance to occur (as defined in Section III.E) therefore increases when four or more bowhead whale cow/calf pairs are observed.

- Dedicated aerial and/or vessel surveys, if determined by NMFS to be appropriate and necessary would be conducted in the Beaufort and Chukchi seas during the fall bowhead whale-migration period to detect bowhead whale cow/calf pairs and to detect aggregations of feeding bowhead whales. The protocols for these aerial and vessel monitoring programs would be specified in the MMPA authorizations granted by NMFS.

- Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, would be provided to NMFS as required in MMPA authorizations and will form the basis for NMFS determining whether additional mitigation measures, if any, could be required over a given time period.

II.A.6. Alternative 6. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine mammals, including a 180/190 dB exclusion zone. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including a 180-dB exclusion zone for cetaceans and the Pacific walrus and a 190-dB exclusion zone for seals during all seismic survey operations in both planning areas. This alternative establishes an exclusion zone set at the levels NMFS has determined as Level A Harassment (potential to injure) for species under its jurisdiction (180 dB for cetaceans and 190 dB for seals and sea lions). The 180-dB and 190-dB exclusion zones evolved when two expert panels (HESS, 1998; Gentry, 1999; NMFS, 1999) determined that at an unknown higher sound pressure level (SPL), cetaceans and seals/sea lions, respectively, potentially could incur permanent hearing impairment (Level A harassment). These levels are used by NMFS to indicate where Level A harassment (injury) potentially begins. The FWS has set a 180-dB level to indicate where Level A harassment (injury) potentially begins for the Pacific walrus (USDOI, FWS, 2005).

II.A.7. Alternative 7. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180/190-dB exclusion zone and 160-dB and 120-dB safety zones for marine mammals. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including a 180/190-dB exclusion zone and 120/160-dB safety zones for marine mammals. This alternative is a combination of Alternatives 3, 4, 5 and 6 and establishes exclusion/safety zones of: (1) 120-dB for aggregations of four or more bowhead whale cow/calf pairs; (2) 160-dB for groups of 12 or more gray and bowhead whales; (3) 180-dB for all other cetaceans and the Pacific walrus; and (4) 190 dB for all seals. These zones are based on findings from Richardson et al. (1999), Malme et al. (1984), HESS (1998), NMFS (1999), and USDOI, FWS (2005). Under this alternative, all seismic survey operations would implement a 180-dB or 190-dB exclusion zone. However, dedicated aerial and/or vessel surveys programs would be required in both planning areas to monitor a 120-dB and 160-dB safety zones in order to detect the presence of bowhead whale cow/calf pairs (120-dB zone) and aggregations of feeding bowhead and gray whales (160-dB zone). Detection of these species and age/sex classes will trigger expansion of the 180/190-dB exclusion zone to a 160-dB (as described below) or 120-dB safety zone (as described in Alternative 5). The protocols for these aerial and vessel monitoring programs would be specified in the MMPA authorizations granted by NMFS. Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, would be provided to NMFS as required in MMPA authorizations and will form the basis for NMFS determining whether additional mitigation measures, if any, could be required over a given time period.

- An aerial or vessel monitoring program based on a 160-dB safety zone will be established and monitored during all seismic surveys sufficient to detect the presence of an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a nonmigratory, significant biological behavior [e.g., feeding, socializing]). Should 12 or more bowhead or gray whales occur within the 160-dB safety zone around the seismic activity, the seismic operation will shut down immediately or not commence until two consecutive surveys (aerial or vessel) indicate the 12 or more bowhead or gray whales are no longer present within the 160-dB safety zone surrounding seismic-survey operations.

- The threshold of 12 is based on the following premises: (a) whales aggregate in order to communicate and perform "*biologically significant*" behaviors (as defined by NRC (2005:3)), such as feeding, resting, socializing, mating, calving; (b) aggregations of animals can also indicate an area of preferred habitat and locations where biologically significant behaviors are likely occurring; (c) disruptions of these biologically significant behaviors and important habitats has a greater potential to lead to population level effects (i.e., result in limiting reproductive potential or recruiting success, impeding important mother/calf bonding); (d) protective measures should be designed to reduce the potential for disruption of biologically significant behaviors or help ensure whales do not avoid important key habitat areas (and thus potentially negate a negligible impact finding under the MMPA); (e) criteria defined in Section III.E for bowhead and gray whales sets significance at the effective loss of animals to move the stock below its Optimum Sustainable Population (in consideration of PBR, subsistence quota, and commercial fishery interactions); and (f) standard scientific acceptance that the presence of observed whales (i.e., at the surface) during aerial and vessel surveys indicates that additional whales are also present in the area but non-detectable (i.e., below the surface).

  Specifically for bowhead whales, Section III.E defines significance at a level that may affect the survival and reproduction of 12 or more bowhead whales (of an affected species and/or stock) annually. Although NMFS and MMS do not expect the seismic surveys to result in direct serious injury or death of bowhead whales, Level B harassment (behavioral disturbance) may occur and affect biologically significant behaviors and/or deter whales from important habitats. Significance could then be reached if these behavioral disturbances resulted in indirect removal of animals from the stock, limiting reproductive potential or recruiting success, impeding important mother/calf bonding, etc. As analyzed in Section III.F.3.f., females (and calves) are more susceptible to this type of disturbance than males. Theoretically, NMFS and MMS would define an aggregation as 12 or more females or calves in order to protect the more vulnerable portion of the population and not reach significance (which would then may negate a negligible impact determination under the MMPA). However, vessel and aerial surveys are not able to distinguish between males and females and therefore the level of 12 is set at individual whales, regardless of their sex or age.

  For gray whales, the significance criteria defined in Section III.E is "an adverse impact that results in an abundance decline and/or change in distribution requiring three or more generations (or having an impact lasting 10 or more years) for the indicated population to recover to its former status." Several studies have shown that gray whales are subject to behavioral disturbance from the presence of anthropogenic noise at received levels of impulses at 160-170 dB re: 1 µPa rms (see Section III.F.4.b(2) for further discussion). In addition, gray whales are believed to congregate in larger groups along offshore shoals in the northern Bering and Chukchi Seas for feeding during the summer months. As these groupings may indicate that these areas are important feeding grounds for the gray whale population as it expands its range and avoidance of these areas due to seismic activity may result in greater than normal effects to this population, additional protection of these aggregations/areas is warranted at this time. Again, females and calves would be the most vulnerable portion of the population and NMFS and MMS would theoretically set an aggregation at 12 or more females or calves. However, vessel or aerial surveys are not able to distinguish between male and female whales and also may not be able to discern between gray and bowhead whales (particularly when whales are engaged in active behaviors or infrequent surfacing), so an aggregation is therefore defined at 12 individual whales regardless of their sex, age, or species.

- Dedicated aerial, vessel and/or acoustic surveys, if determined by NMFS to be appropriate and necessary would be conducted in the Beaufort and Chukchi seas during the fall bowhead whale migration period to detect bowhead whale cow/calf pairs and to detect aggregations of feeding bowhead whales. The protocols for these aerial and vessel monitoring programs would be specified in the MMPA authorizations granted by NMFS.

- Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, would be provided to NMFS as required in MMPA authorizations and will form the basis for NMFS determining whether additional mitigation measures, if any, could be required over a given time period.

II.A.8. Alternative 8. Seismic surveys would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including 180/190-dB exclusion and 160-dB safety zones for marine mammals and requirements for specific temporal/spatial/operational restrictions to further reduce potential impacts to feeding/socializing/migrating aggregations of bowhead and gray whales and bowhead cow/calf pairs. Seismic surveys would be approved in the Beaufort and Chukchi seas, incorporate standard G&G stipulations, and require additional protective measures for marine mammals, including 180/190-dB exclusion and 160-dB safety zones and requirements for specific temporal/spatial/operational restrictions to further reduce potential impacts to feeding/ socializing/migrating aggregations of bowhead and gray whales and bowhead cow/calf pairs. These restrictions would be shaped by the outcome of the public review process for this PEIS, the MMPA authorization process, and whether industry and Alaska Native groups reach a CAA or similar plan of cooperation. These restrictions would aim to lessen the potential for impacts to bowhead whale cow/calf pairs, the most vulnerable portion of the populations, and aggregations of bowhead and gray whales engaged in critical natural behaviors (e.g., feeding, socializing). Restrictions may be similar to those imposed under the MMPA authorizations during the 2006 open water season as well as those included in the 2006 CAA between industry and several Alaska Native groups.

Using the 2006 CAA as an example for analysis purposes, restrictions may include, but are not limited to:

- Area specific closures to seismic in the Beaufort Sea from late August through late October when migrating bowhead whale cow/calf pairs are present, including:
    - Kaktovik: No geophysical activity from the Canadian border to the Canning River (~146 deg. 4 min. W) from 25 August to 20 September.
    - Nuiqsut: No geophysical activity from the Canning River (~146 deg. 4 min. W) to Point Storkersen (~148 deg. 45 min. W) from 25 August to 25 September.
    - Barrow: No geophysical activity from Pitt Point on the east side of Smith Bay (~152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from 10 September to 25 October.

Using the 2006 MMPA authorizations, restrictions may include, but are not limited to:

- General area closure to seismic in the Chukchi Sea after September 25 to protect migrating bowhead whale cow/calf pairs until monitoring programs accepted by NMFS show that the majority of bowheads have migrated out of the operations area.
- Limit vessel activity to no more than four 2D/3D seismic vessels operating simultaneously within each planning area. (This alternative also provides for the same level of activity analyzed under the 2006 Arctic Seismic PEA (MMS, 2006), which resulted in a Finding of No Significant Impact.)

II.A.9. Alternative 9. Seismic survey activities would be limited to one geophysical exploration seismic survey permit or authorized ancillary activity annually in each planning area and would be approved with existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including 180/190-dB exclusion zones for marine mammals. The permitted survey or authorized ancillary activity would incorporate existing Alaska OCS G&G exploration stipulations and guidelines and additional protective measures for marine animals, including a 180/190-dB exclusion zone for marine mammals. This approach for reducing the level of activity would be selected by NMFS and MMS on an annual basis.

II.B. Evaluation of Alternatives.

For an alternative to be considered further in this PEIS, it must be reasonable and adequately support and accomplish the purpose and need as previously identified and discussed in Section I (Introduction). In addition, the alternative must be non-speculative and bounded by some notion of feasibility.

II.B.1. Alternatives Excluded from Further Evaluation.

Alternative 2 (Proposed Action) would result in the permitting of seismic surveys for geophysical exploration activities as proposed with existing Alaska OCS G&G exploration stipulations and guidelines. This alternative does not incorporate mitigation and monitoring measures found in Alternatives 3-9 (i.e., set exclusion/safety zone, field verification, ramp-up, etc.). It also would not address any additional mitigation that might be needed to reduce the level of any impacts to other types of marine life (i.e., fish, fragile biocenosis, birds). This would be contrary to the mandates under the OCS Lands Act which requires operations to be conducted in an environmentally sound manner. This alternative is therefore not feasible or acceptable and is not considered further in this analysis.

Alternative 9 (seismic survey activities would be limited to one geophysical exploration seismic survey permit or authorized ancillary activity annually in each planning area) also is not considered further for the reasons discussed below.

The 2006 Arctic Seismic PEA analyzed potential impacts of up to four permitted seismic surveys and related source vessels per planning area. The PEA resulted in a FONSI. The scenario and analyses in the PEA were by necessity and definition programmatic and regional in nature. Such a programmatic, regional scenario does not support analyses that quantify and identify differences in the potential impacts between one, two, three, or four permits. The PEA stated that the potential impacts from seismic surveys are more directly related to where, when, how long, and how close together seismic surveys are conducted than to the absolute number of surveys. As the programmatic analyses do not differentiate the level of potential impacts between one and four seismic surveys, an analysis of this alterative would not differ substantively from the analysis in the PEA. The potential impacts of one seismic survey can be assumed to be a proportion of impacts that might occur under four surveys. As the PEA on four surveys resulted in a FONSI, the one annual survey under this alternative can be assumed to have no significant impacts.

Limiting the number of seismic surveys would not meet the purpose and need under the Proposed Action. Geophysical seismic surveys provide information that is used by industry and government to make informed decisions, evaluate the potential for offshore oil and gas resources, and determine the presence of geologic hazards. As OCS lease sales are scheduled in a 5-Year leasing program per the OCS Lands Act, limiting the amount of seismic survey information that could be collected and available at the time leasing decisions are being made does not support informed decision-making.

Limiting the number of permitted or authorized seismic surveys would not necessarily reduce impacts. The number of permits or authorized ancillary activities does not correspond to the level of activity proposed or conducted. A single permit could be for tens or hundreds of square miles of 2D/3D seismic surveying. Authorization of ancillary activities could be for a site-clearance program of one lease or multiple leases.

Although for purposes of analysis this EIS assumes that one seismic survey source vessel would be associated with one permit or one authorized ancillary activity, there is no such restriction in the MMS implementing regulations at 30 CFR 250 and 251. A permittee or lease operator could propose the use of multiple source vessels for multiple surveys under one permit application or one ancillary activity notification. For example, in 2006 WesternGeco performed the seismic survey work under Shell's two permits (Chukchi and Beaufort Seas) and ConocoPhillips' permit (Chukchi Sea). WesternGeco could have applied for one permit to perform all of this work (plus more).

Under the assumption of one seismic source vessel per permit or ancillary activity, limiting the number of permits or authorized ancillary activities allowed annually could be interpreted as a limit on the number of seismic source vessels. Limiting the number of seismic source vessels would not necessarily reduce the level of impact. As documented in the analyses for Alternatives 3-8, the potential impacts from seismic surveys are more directly related to where, when, how long, and how close together seismic surveys are conducted than to the absolute number of seismic source vessels.

The MMS implementing regulations at 251.5(b) state "If MMS disapproves your application, the Regional Director will state the reasons for the denial and will advise you of the changes needed to obtain approval." If an application for seismic survey were to be denied under Alternative 9 because it exceeds a limit on the number of permits, there would be no changes that could be made by the applicant to obtain approval.

Under the terms of an OCS lease, the lessee must make progress on exploration and development of the lease to hold that lease beyond the initial lease term. Ancillary activities are those activities conducted on lease to obtain data and information to meet MMS rules and regulations to explore and develop a lease or unit. If a limit is placed on the number of ancillary activities authorized for a planning area in a given year, MMS could preclude the lessee from complying with MMS rules and regulations to proceed in a timely manner.

II.B.2. Alternatives Considered in More Detail. Alternative 1 (No Action - No seismic-survey permits issued for geophysical exploration activities) eliminates any potential impacts of seismic surveys on the environment, but it does not provide the means for the oil and gas industry to obtain the information it needs to evaluate the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Without the geophysical data, MMS is hampered in its ability to ensure fair market value for leases, make royalty-relief determinations, conserve oil and gas resources, and perform other statutory responsibilities. The alternative is not efficient, because it does not accommodate cost-effective technologies. It is not acceptable because, while being socially and logistically feasible, there are engineering, economical, and possibly environmental limitations of alternative sources of information. The alternative will be evaluated further, because it is required by CEQ [40 CFR Ch. V, §1502.14 (d)] and will provide a benchmark for decisionmakers to compare the magnitude of environmental effects of the Proposed Action.

Alternatives 3, 4, 5, 6, 7 and 8 are considered in more detail in the PEIS because each, to varying degrees, is effective, efficient, and acceptable and, therefore, feasible. The following text provides a comparative ranking and discussion of each alternative, relative to their effectiveness, efficiency, and acceptability.

The most sensitive social issue associated with conducting marine seismic surveys is the potential impact on subsistence-harvest activities and the Inupiat lifestyle and culture. Subsistence harvesting bowhead whales and other marine mammals is essential to most Inupiat communities on the North Slope. Impacts from seismic surveys on marine mammals and other harvested marine life can in turn potentially affect the availability of marine animals for subsistence harvest activities or force hunters to move to new and/or more challenging areas.

The potential for impacts to marine mammals (and thus potentially their availability for subsistence purposes) across Alternatives 3 though 8 is largely dependent on the specified exclusion/safety zone and additional measures put in place to mitigate against and monitor for impacts to subsistence harvesting activities. Alternatives 3, 4, 5, 7 and 8 have larger safety zones (i.e., include a 120-dB and/or 160-dB safety zone) that should theoretically provide greater protection to marine mammals. Of these, Alternative

3 (120-dB safety zone) provides the largest safety zone and would therefore be considered the most protective of all the alternatives while Alternative 6 (180/190-dB exclusion zone only) would be considered the least protective. Alternative 8 also includes additional temporal/spatial/operational restrictions geared toward the protection of bowhead whales that would be designed to be considered equal to or greater than that afforded by Alternatives 4, 5, 6 and 7.

The remaining alternatives 3 through 8 would all require that applications for MMPA authorizations be approved before the start of seismic survey activity. An MMPA authorization must include a determination that the activity will not result in an "unmitigable adverse impact" on subsistence uses of marine mammals. This determination is generally based on a plan of cooperation (e.g., a CAA or similar document) agreed upon by the applicant(s) and affected Alaska Native Groups. If a plan of cooperation is not agreed upon, then NMFS may consider implementation of additional mitigation and monitoring measures within the MMPA authorization to ensure there are no unmitigable adverse impacts to subsistence uses of marine mammals. Given that Alternative 1 results in no seismic surveying and Alternatives 3 though 8 all require an MMPA authorization (and subsistence determination), then the remaining alternatives are all similar in regards to avoiding unmitigable adverse impacts on subsistence. The difference then is in the degree of protection of marine mammals provided within each alternative with the more protective alternatives (i.e., those with large safety zones or implementation of spatial/temporal/operational restrictions) further reducing any potential for negative effects to subsistence harvest activities.

II.B.2.a. Effectiveness Evaluation. With the exception of Alternative 1 (No Action), the remaining alternatives to varying degrees allow the oil and gas industry to obtain the information it needs to evaluate effectively the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. However, remaining alternatives with more mitigation may require more time and resources to collect seismic survey data.

The no-action alternative eliminates any possibility of adverse impacts due to seismic-survey operations. The physical environmental impacts associated with other field methodologies and techniques the oil and gas industry may or may not use are outside the scope of this draft PEIS. Obtaining better 3D seismic data now could lessen the number of exploration wells (and associated environmental impacts) needed in the future.

The remaining alternatives (3 through 8) are environmentally sound as they all contain protective measures to mitigate possible impacts on marine life. Theoretically, alternatives with larger safety zones and required temporal/spatial/operational restrictions would provide greater levels of protection for marine mammals from potential harm and harassment. However, the more complicated marine mammal-monitoring requirements associated with some of these measures may make it more difficult or costly to collect the needed seismic data. In some instances, some areas may not be surveyed or surveys will be delayed to future seasons due to time constraints, weather restraints and/or closures. For this reason, Alternative 3 (with its 120-dB safety zone) is ranked highest for environmental protection but lowest for the cost-effectiveness of obtaining data. The remaining alternatives are ranked based on the size of the exclusion/safety zone and/or temporal/spatial/operational restrictions and associated monitoring requirements with Alternative 6 representing the remaining alternative with the least amount of environmental protection.

II.B.2.b. Efficiency Evaluation. The most variable cost associated with conducting an environmentally sound seismic-survey program is associated with monitoring and maintaining the marine mammal exclusion/safety zone. There may also be costs associated with time area closures potentially imposed under several of the alternatives with a greater degree of these restrictions contained in Alternative 8. The costs associated with the no-action alternative are related primarily with having to use other developing technologies to reanalyze existing seismic data and/or use other field methods to physically obtain the information. A cost-benefit analysis of having to implement this alternative, as opposed to conducting seismic surveys, has not been made; however, based on MMS professional judgment, seismic surveys likely would be determined to be the most cost-effective means to collect high-quality geophysical information to assist in determining the locations of potential oil and gas deposits.

Effectively monitoring larger safety zones probably has higher associated costs than effectively monitoring smaller safety zones because, as the safety zone enlarges, more human resources and monitoring equipment are necessary. For example, because the outer perimeter of the 120-dB safety zone could range between 20 and 30 km or more from the sound-source vessel, aircraft and/or other acoustic-monitoring equipment would be required to survey and monitor those areas outside the effective monitoring range of vessel-based monitors. The costs associated with conducting aerial monitoring and marine mammal surveys understandably are higher than conducting vessel-based monitoring. Although several companies are considering the use of unmanned aircraft for monitoring purposes, this technology is still in the developmental stage and its effectiveness and cost saving measures are still unknown. For the aforementioned reasons, Alternative 6, with its 180/190-dB exclusion zone would be expected to have the least associated cost. The incremental cost increase to effectively monitor a 160-dB safety zone may not be much more than the cost associated with the 180/190-dB exclusion zone, unless aerial surveys are required in which case, the costs would substantially rise. Costs to implement the temporal/spatial/operational restrictions in Alternative 8 would also be considered less as operators would not be permitted to operate in areas where more costly mitigation and monitoring (e.g., 120-dB safety zone) would be required.

II.B.2.c. Acceptability Evaluation. Alternatives 1, 3, 4, 5, 6, 7 and 8 and the associated environmental protection measures identified in the NEPA process intend to comply with applicable State and Federal laws, including the ESA and the MMPA. This is especially true if a seismic-survey operator obtains an MMPA authorization before beginning seismic operations. NMFS also requires an MMPA authorization be in place before an ESA ITS is issued for marine mammals. In addition, ESA Section 7 consultations are ongoing with the Alaska regional offices of NMFS and the FWS. Consultation with the NMFS Office of Habitat Conservation regarding the potential impacts of the Proposed Action on EFH is ongoing, and the evaluation of impacts to EFH is contained in the draft PEIS. Other applicable Federal laws and Executive Orders (EO's) considered in this draft PEIS include: the Clean Air Act, Clean Water Act, Coastal Zone Management Act, Migratory Bird Treaty Act, NEPA, National Historic Preservation Act, EO 13175 - Consultation and Coordination with Indian Tribal Government, and EO 12898 - Environmental Justice in Minority and Low-income Populations.

All the alternatives to be considered further provide marine mammals a high level of protection from injury or mortality (all at least impose a 180/190 dB exclusion zone or larger safety zone) and also provide varying levels of protection from potential harassment. The potential for impacts to subsistence-harvest activities correlates with the degree of protection from harassment or harm contained within each remaining alternative. If no seismic surveys were conducted (the no-action alternative), no additional impacts to subsistence would occur. However, the no-action alternative does not preclude impacts on subsistence from the other field methods (e.g., electromagnetic, aeromagnetic, and gravity surveys) that might be used in attempts to collect the desired oil- and gas-resource information. Presumably, the seismic-survey alternatives that have larger safety zones provide the most protection for marine mammals. Alternative 3, which theoretically would have the largest safety zone is ranked alongside the no-action alternative as potentially having the highest level of subsistence-resource/marine mammal protection. However, because bowhead whales apparently show some avoidance in areas of seismic sounds at levels lower than 120 dB (Richardson et al., 1999), the largest safety zone considered, impacts to subsistence still might occur under all identified alternatives. However, Alternative 8 includes additional temporal/spatial/operational restrictions (see description of Alternative 8 above) which provide closures in specific areas of marine mammal presence (often associated with areas of subsistence activities) and would therefore eliminate the potential for impacts to subsistence activities.

With the exception of the no-action alternative, all the alternatives considered further have environmental protection measures that include exclusion/safety zones for marine mammals. While the 120-dB safety zone may provide marine mammals with the highest level of protection from potential behavioral harassment and injury, it may be expensive and difficult to manage because of its anticipated large size and potential use of aerial (whether through manned or unmanned aircraft) or vessel-based surveys and/or other acoustic monitoring technology (i.e., passive acoustic monitoring). Implementing the smallest 180/190-dB exclusion zones likely would be more manageable and less costly than the larger safety zones but would not provide additional protection from behavioral disturbance. Implementing Alternative 8, which includes a 160-dB safety zone, 180/190-dB exclusion zones and area closures, would reduce costs associated with monitoring as surveys would not be permitted in areas of higher bowhead and other marine mammal presence. Implementing a smaller safety zone with no other mitigation measures would not completely protect marine mammals from potential Level B behavioral harassment. The feasibility (implementable in an environmental sense) of the no-action alternative is uncertain, because which alternate field techniques would be proposed for use to replace seismic surveys is unknown. No environmental impacts in the Chukchi and Beaufort seas are associated with reanalyzing historical seismic data. Other than costs, all the remaining alternatives would result in varying degrees of environmental benefits in the form of reducing the level of seismic exposure on marine mammals. If costs become a limiting factor, then the environmental benefits associated with larger safety zones may not be realized as it may be impracticable for operators to conduct aerial or vessel-based surveys and monitoring or employ other acoustic-monitoring technology.

The implementation of safety/exclusion zones for marine mammals also provides protection to other wildlife occurring within these zones. Additional mitigation measures for fish and birds (e.g., Ledyard Bay restrictions, no towing of cables and arrays near fragile biocenoses) also afford increased protection. As these requirements are included in alternatives 3-8, all of these would provide additional protection to fish, birds, benthic habitat and coastal communities. The main difference across these alternatives would then be a greater level of protection for these resources through alternatives with larger safety zones. Alternative 8 may also provide a higher level of protection through its establishment of closure areas assuming closure areas are selected that do not move seismic activity from areas of less marine life density to areas of higher density.

There are fewer technical issues and costs associated with effectively monitoring smaller safety zones than larger zones. Generally, and with some exceptions due to weather and other disruptive oceanic conditions, exclusion/safety zones associated with the 160-dB and 180/190-dB isopleths can be effectively monitored with vessel-based monitors. Logistical complications and engineering limitations make effective monitoring of the 120-dB safety zone (in Alternatives 3, 5 and 7) more challenging although several companies are now investigating the use of unmanned aircraft. This is because continuous aerial or vessel-based monitoring, possibly with additional acoustic monitoring, may be required to monitor the outer perimeters of the safety zone that are not accessible to seismic-vessel-based observers.

Determination of the Selected Alternative will be based on all the factors and issues raised and discussed in this section, the detailed analysis of impacts provided in Section III (Existing Environmental and Impact Analysis), and comments received during the public review of the draft PEIS.

II.B.3 Summary of the Alternatives' Environmental Impacts

The following summarizes the detailed impact analyses found in Section III (Existing Environment and Impact Analysis), and is limited to those resources determined (see Section III.D, Preliminary Screening of Seismic-Survey Activities and Potential Impacts) to be at most risk for being adversely impacted by seismic survey operations

II.B.3.a Fish/Fishery Resources and Essential Fish Habitat. Overall, the Proposed Action and Alternatives 3 through 8 potentially could adversely impact essential fish habitat (EFH) and fish/fishery resources. Many fish species are likely to hear airgun sounds as far as 2.7-63 km (1.6-39 mi) from their source, depending on water depth. Fish responses to seismic sources are species specific and may differ according to the species' lifestage. Immediate mortality and physiological damage to eggs, larvae, and fry, adult and juvenile marine fishes is unlikely to occur, unless the fish are present within 5 m of the sound source (although more likely 1 m). The potential for physical damage is related to the characteristics of the sound wave, the species involved, lifestage, distance from the airgun array, configuration of array, and the environmental conditions. Damage to tissue may not be immediately apparent.

Behavioral changes to marine fish and invertebrates may include balance problems (but recovery within minutes); disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses. Some fishes may be displaced from suitable habitat for hours to weeks. Thresholds for typical behavioral effects to fish from airgun sources occur within the 160-dB to 200-dB range. Potential impacts from vessel noise, anchor or cable deployment, and recovery of fuel spills is regarded as a negligible adverse but not significant impact to fish/fishery resources and EFH. Commercial fisheries in the region are not expected to be impacted, but there is a potential for impacts to migration, spawning or subsistence fishing.

A review of the available science and management literature shows that at present, there are no empirical data to document potential impacts reaching a population-level effect nor have the experiments conducted to date contained adequate controls in place to allow us to predict the nature of a change or that any change would occur. The information that does exist has not demonstrated that seismic surveys would result in significant impacts to marine fish or related issues (e.g., impacts to migration/spawning, rare species, subsistence fishing).

Based on the review of available scientific and fishery management literature, the Proposed Action and Alternatives 3 through 8 could result in adverse but not significant impacts to fish/fishery resources, EFH, and commercial/recreational fisheries.

II.B.3.b Marine Birds. Potential negative effects of the proposed seismic-survey activities on coastal and marine birds can be summarized in categories of:

- Disturbance from the physical presence of vessels;
- Disturbance from noise by vessels, seismic airguns, and support aircraft;
- Collision with vessels or aircraft; and
- Direct and indirect results of petroleum product spills from vessels.

It would be difficult to quantify effects in terms of the number of marine birds potentially affected or areas of habitat potentially modified or lost, because the area of the proposed seismic surveys is very large and specific knowledge of marine bird distribution and density within the survey area is limited.

Seismic-vessel activity is expected to have only temporary and localized disturbance effects on relatively small numbers of certain marine bird species that are distributed in low density over a large action area. Similarly, disturbance to pelagic species are expected to be minimal, because they are expected to move away from the slow-moving seismic vessel well in advance of the towed seismic- airgun array. Any displacement to these birds is expected to be dynamic and temporary.

It is possible, during the course of normal feeding or escape behavior that some birds could be near enough to an airgun to be injured by a pulse. The threshold for physiological damage, namely to the auditory system, for marine birds is unknown. Although MMS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all.

Aircraft operating at low altitudes may disturb birds that are in the path of the aircraft. There is an energetic cost to repeatedly moving away from aircraft disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability.

Many seabirds can be attracted to lights and vessels in nearshore waters. A marine bird striking a vessel could be injured or killed. Potential mortality from being attracted to and colliding with seismic-survey vessels is more likely to occur inside the 20-m isobath, where the majority of seabirds and waterfowl are believed to migrate. An unknown number of seabirds and waterfowl are expected to occasionally be attracted to the lights of seismic vessels during the survey period, but implementation of mitigation measures would reduce the risk that birds fly into survey vessels. Similar measures outside the 20-m isobath could reduce impacts to more pelagic species. No birds were reported to have collided with seismic survey vessels during the 2006 season when these mitigation measures were in effect.

Coastal and marine birds could be affected by a survey-vessel accident resulting in a petroleum spill. However, the potential for a spill is low, given that the vessels will be operating at least 3 mi from shore and away from obstructions.

In the Chukchi Sea, spectacled eiders (a threatened species) molt in Ledyard Bay, an area designated as critical habitat. Males and/or females are present in this area from early July through the middle of October or possibly later. Repeated disturbance of flightless eiders could move molting eiders near their energetic threshold and result in lower than desired fitness for winter survival in the Bering Sea. Implementation of mitigation measures would prevent or minimize vessel and aircraft-related disturbances to spectacled eiders molting in the Ledyard Bay. Alternative 1 (No Action) would have the least potential negative effect on spectacled eiders. Alternatives 3-8 would have the same relative amount of potential effects on spectacled eiders.

Alternative 1 (No Action) would have the least potential negative effect on Steller's eiders A threatened species) and Kittlitz'z murrelets (a candidate species). Alternatives 3-8 would have the same relative amount of potential effects on both threatened species. With the implementation of measures to mitigate impacts, none of the alternatives are likely to adversely both species in the project area.

II.B.3.c Threatened and Endangered Marine Mammals. Available information indicates that bowhead whales are responsive, in some cases highly responsive, to anthropogenic noise in their environment. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source, and the reasons for this variability are not fully understood. In other species of mammals, including cetaceans, females with young are more responsive to noise and human disturbance than other segments of the population (McCauley et al., 2000).

Data are sufficient to conclude that all responses to future noise and disturbance are 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 levels and the exact characteristics of that activity (e.g., airgun source levels, array configuration and placement in the water column; context (e.g., feeding versus migrating whales); the animal's motivation to be in an area; and options for alternative routes, places to feed. 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 within a relatively large distance than some other species, because they are hunted annually; some individual may have been exposed to both commercial and subsistence hunting over the course of many years and, thus, many individuals may have a strong negative association with human noise (i.e., sensitization). Bowhead whales that may be exposed to 2D/3D seismic surveys most likely would exhibit avoidance of such operations, and in so doing, avoid the potential for any harm to their hearing from the noise. However, data indicate that fall migrating bowheads can 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 20-30 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 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. 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 (e.g., between hunting areas) bowheads have during their autumn migration and other use of the Beaufort Sea.

If seismic operations overlap in time, the zone of seismic exclusion or influence across both planning areas 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 could result in avoidance of feeding areas, resting (including nursing) areas, or calving areas by large numbers of females with calves or females over a period of many weeks. This can be especially important if cow/calf pairs are not able to readily use other similar areas without a costly expenditure of energy. Avoidance of critical areas by bowheads, particularly females with calves, potentially could lead to population-level consequences. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by cow/calf pairs.

We acknowledge that we are not certain what the potential effects could be on calf survival or growth and female reproduction could be if multiple seismic surveys and other noise sources occurred within an area that was frequently used for feeding by large numbers of bowhead whales. If seismic surveys were not mitigated, or are insufficiently mitigated, effects that are biologically significant could result if seismic surveys cause avoidance of feeding areas, resting areas, or calving areas by females with calves, females, or aggregations of whales that likely contain reproductive-aged females over a period of many weeks. The impact likely would be related to the importance of the food source to the component of the population that would have used it, had not the disturbance caused them to avoid or leave 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 (e.g., between hunting areas) bowheads 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 detectable, long-term population-level 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, it is important to note that sublethal impacts on health (such as reduced hearing or increased stress) could not be detected in this population. Effects on reproduction or survival would not be detectable, unless the level of effects was great enough to be detected given the error around population estimation. The rates of population increase do not indicate any sublethal effects (if they occurred) resulted in a detectable effect on this population's recovery.

NMFS and MMS believe that 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 adverse effects can be reduced through careful shaping of the action through the implementation of sufficient monitoring coupled with adaptive management (where the mitigations measures required are dependent on what is discovered during monitoring).

In the Beaufort Sea, depending on the restrictions agreed to in a Plan of Cooperation or similar agreement (e.g., CAA), it is likely that 2D/3D seismic surveys will be conditioned to protect subsistence harvests. For example, seismic surveys in the central Beaufort Sea conducted during the open water season could be limited to areas west of Cross Island after September 1 under the provisions of a CAA between the operator and subsistence whalers. This would greatly reduce impacts on bowhead whales for the period of the restriction. Similar agreements between the operator and subsistence whalers are likely to be established for any seismic surveys proposed near Kaktovik and Barrow.

We acknowledge a greater level of 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 Sea during the late autumn, careful monitoring and mitigation will be necessary to avoid impacting large numbers of individuals. We propose marine mammal monitoring to address this uncertainty (see Section IV). Coupled with adaptive management that implements mitigation packages dependent on what is encountered during monitoring will ensure to the greatest extent practicable that impacts to bowhead and other species will not be more than negligible.

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

Icebreaker response distances vary. Predictions from some models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km or greater, even much greater, 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.

Under the Proposed Action, 2D and 3D seismic survey vessels will be attended by support vessels. 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. Operations with icebreakers attending could cause a greater zone of avoidance than seismic vessels without icebreakers, especially if active ice management is occurring. The predicted distances at which bowheads would be expected to avoid icebreakers are highly variable, but range up to 95 km, with reaction distances predicted (Richardson et al., 1995b) to commonly be on the order of 10-50 km.

Seismic surveys also may result 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 sometimes are conspicuous if the aircraft is below 300 m (984 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 related to seismic surveys occur, depending on the location, bowheads in some areas may be repeatedly exposed to aircraft noise. Potential effects could be nearly eliminated by the mitigation in Section IV that specifies that flight altitude must be high enough to avoid disturbance. If seismic-survey and aircraft-traffic 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.

Available information does not indicate any long-term population-level 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, it is important to note that sublethal impacts on health (such as reduced hearing or increased stress) or low-level effects on reproduction and survival were not scientifically detectable in this population. Data are insufficient to determine the extent of behavioral, including habitat use, effects that may have occurred during this time period. Data do indicate that this population continued to recover during the 1980’s but are insufficient to determine if the rate of recovery was affected by seismic surveys. There has been no documented evidence that noise from previous OCS operations has hindered the overall migration of bowhead whales. Because bowheads respond behaviorally to loud noise by swimming away from certain sounds, 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.

Overall, as up to six surveys may occur in each planning area yearly and individual bowheads could be exposed to 2D, 3D and high resolution surveys as they move through each planning area (potentially up to 12 surveys). We cannot however, conclude with certainty that there would not be exclusion or avoidance of bowhead whales from important feeding, resting or migratory areas. In addition, we cannot say with certainty that these exclusions, if they occur, would not result in significant impacts, as defined under the NEPA significance criteria (Section III.E), and/or affect their survival. With this in mind, we have identified mitigation that reduces the potential for these type of effects (exclusion or avoidance of these areas) to occur and applied these to all Alternatives 3-8 (see Sections II and IV). The alternatives, to varying degrees, also contain additional measures to reduce the potential for these types of effects (i.e., large exclusion zones, time/area closures). Also, any MMPA authorizations would, among other things, need to meet a determination that the survey(s) would only result in a negligible impact to whales. This provides an additional level to help avoid effects of exclusion and avoidance. So, although the potential for significant impacts, as defined under the NEPA significance criteria (Section III.E), exists considering the higher level of activity, especially concurrent surveys, and the potential for repeated exposures during critical behaviors, required mitigation and monitoring measures would be implemented to reduce the potential for significant effects to occur.

II.B.3.d Other Marine Mammals. Potential effects from seismic survey activities on non-threatened and non-endangered marine mammals include tolerance (that is the capacity of the individuals to endure or become less responsive to the repeated exposure), masking of natural sounds, behavioral disturbance, auditory impacts (e.g., temporary and permanent threshold shifts), and other physiological effects. Seismic surveys, either alone or in combination with other factors, could also have subtle, chronic effects such as: excluding marine mammals from important habitats (e.g., feeding and resting) at significant times, interfering with their migrations and movements, contributing to habitat degradation, disrupting biologically significant behaviors, and increasing levels of stress. No documented instances of deaths, physical injuries, or auditory (temporary or permanent threshold shifts or other physiological) effects on marine mammals from seismic surveys have been reported although again these may be difficult to document.

Overall, the potential for seismic survey activities to harass and injure non-threatened and non-endangered marine mammals is lessened through the implementation of appropriate protective measures as outlined in Section IV as well any imposed during the MMPA authorization process. These protective measures are designed to avoid Level A Harassment (potential to injure). Additional mitigation measures outlined in Section IV are designed to reduce uncertainty and further reduce the potential for harassment to occur at or below Level B Harassment (disturbance). In addition, these measures are meant to even further limit the potential for short-term harassment of marine mammals and thus avoiding the potential for long-term, population level effects.

Pinnipeds (Ringed, Spotted, Ribbon, and Bearded Seal and Pacific Walrus). Alternatives 3-5, when properly monitored, would provide exclusion zones which are sufficient for pinnipeds. The exclusion zone would be the smallest for Alternative 6 (180/190 dB) and could be monitored visually by vessel-based observers. Conversely, Alternative 3 would provide the largest safety zone (120 dB). Increased disturbance from vessel and aircraft activity could consequently cause pinnipeds to leave haul-out locations and enter the water, though the response is highly variable. This could have a greater impact if flushing of haul out sites occurs when pups are present, as they can be more easily injured and separated from their mothers. Use of the 160 dB safety zone in Alternative 4 and in Alternative 5 would provide an intermediate-sized safety zone. Alternatives 3 through 8 also require trained observers to visually monitor the safety and exclusion zones, regardless of its size, and to be able to call for a shut-down if marine mammals enter the zone. The ability of observers to effectively monitor the zone, and be able to call for a shut-down if marine mammals enter the zone is critical to the success of the protective measures described in Alternatives 3 through 8, though it is often difficult to observe all marine mammals, especially pinnipeds, within the zone.

Therefore, the potential for any injuries to pinnipeds from the proposed activity and Alternatives 3 through 8 is very limited, with Alternative 6 providing a slightly greater potential for Level A Harassment as its specified exclusion zone of 190 dB most closely approaches the lower limits of levels set by NMFS for

Level A Harassment. Conversely, Alternative 8 includes required spatial/temporal/operational restrictions that may be equal to or exceed the protection provided by the 120-dB safety zone.

Cetaceans (Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale). NMFS' current threshold for Level A Harassment (potential to injure) of cetaceans is 180 dB. The mitigation measures outlined in Section IV, and which apply to Alternatives 3 through 8, are set to avoid any takes of marine mammals by Level A Harassment. In addition, the MMPA authorization required under Alternatives 3 through 8 would not authorize any Level A takes of marine mammals. Based on the above, the fact that no injuries to marine mammals have been documented from seismic survey activities (although again difficult to document), and that protective measures outlined in Section IV are in place, NMFS and MMS believes the potential for any injuries to cetaceans from the proposed activity and Alternatives 3 through 8 is very limited, with Alternative 6 providing a slightly greater potential for Level A Harassment as its specified exclusion zone of 180 dB most closely approaches the lower limits of levels set by NMFS for Level A Harassment.

In comparing Alternatives 3 through 8, looking purely at the size of the safety or exclusion zone and assuming the monitoring requirements will be effective, there are differences in the level of potential behavioral impact across these alternatives. The most protective (i.e., resulting in the least potential for takes by Level B Harassment and avoidance of Level A Harassment) would be Alternative 3 as this provides the largest exclusion zone (120 dB). Given the bowhead whale is the only cetacean in the Proposed Action area to show avoidance near the 120 dB received sound levels from impulse sounds and all other cetaceans in the Proposed Action area have generally demonstrated avoidance at higher received sound levels (i.e., 160 to 180 dB), Alternative 3 would result in the least impact to cetaceans and other marine mammals in the Proposed Action area.

After Alternative 3, Alternative 5 would provide the next most protective level for cetaceans. In this alternative, the safety zone would be set at 160 dB unless a certain number of bowhead whales (individuals, reproductive-age females, calves) were present, as determined by MMS and NMFS, where the zone would be changed to 120 dB. The combination of the two zones under this alternative would provide all cetaceans with additional protective measures but still would provide a zone at 160 dB (the level set by NMFS beyond which Level B Harassment is more likely to occur) at all remaining times. Therefore, Alternative 5 provides the next most protective alternative for marine mammals.

Alternative 4 follows Alternatives 3 and 5, respectively, in the degree of potential impacts to cetaceans. This alternative sets the safety zone at 160 dB the level set by NMFS beyond which Level B Harassment is more likely to occur. Therefore, the greatest potential for Level B Harassment exists for Alternative 6 where the zone for cetaceans is set at 180 dB, which exceeds NMFS' 160 dB determination for Level B Harassment (disturbance) and most closely approaches the NMFS determination for Level A Harassment (injury).

Depending on the temporal/spatial/operational restrictions imposed, Alternative 8 might exceed the level of protection afforded in Alternatives 3-7. For example, closure of an operational area to surveys during bowhead whale migration would also protect other marine mammals found within this area. Also, avoiding impacts to important feeding areas would provide considerable benefits to cetaceans that are sensitive to human disturbance. However, a closure may result in greater impacts to non-listed marine mammals if the closure area pushes seismic survey activity into an area of higher non-ESA marine mammal concentration, especially if this area is important for feeding, resting, caring for young or migrating.

The above assessment of the degree of impacts of Alternatives 3 through 8 is based solely on the protection afforded by the various safety and exclusion zones and restrictions and assumes effective monitoring of those zones will occur. This evaluation must therefore also consider any differences in the ability of industry under Alternatives 3 through 8 to monitor their zones. From this standpoint, the larger zones to monitor would be under Alternative 3, 5, and 7, respectively, with the smaller zones being Alternatives 4, 6, and 8, respectively. Larger zones would require implementation of additional monitoring techniques beyond boat-based visual monitoring, such as aerial surveys and passive acoustic monitoring, where the smaller zones would rely mainly on boat-based visual monitoring. If these methods of additional monitoring are not effective, then additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis).

While the additional techniques required for Alternatives 3, 5, and 7 would be costly and a larger zone in theory would provide a much larger, and possibly more difficult, area to monitor, this does not necessarily mean these larger zones are less effective in limiting impacts to cetaceans for the following reasons: (1) each zone in Alternatives 3 through 8 would require boat-based visual monitoring (i.e., all observers are scanning areas from the vessel as far as visually possible with appropriate equipment); (2) larger zones in Alternatives 3, 5, and 7 would by definition require greater distance of operating seismic vessels from cetaceans than Alternatives 4, 6, and 8 with even smaller zones; (3) the aerial survey and passive acoustic monitoring required in Alternatives 3, 5, and 7 (and not in Alternatives 4, 6, and 8) would provide additional coverage further away from the seismic source; and (4) additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis) should monitoring measures prove ineffective.

With the mitigation measures outlined in Section IV and those required under the MMPA authorization process, all aircraft overflights would be required to fly at or above 1,000 ft in order to minimize the potential for behavioral impacts to marine mammals and adversely affect subsistence hunting. Therefore, the use of aerial surveys is not expected to significantly increase the potential for harassment of cetaceans under alternatives imposing a 120-dB safety zone.

The difference then within Alternatives 3 through 8 remains with the amount of protection afforded to marine mammals through the mitigation included within each alternative. Again, alternatives with larger safety zones (i.e., Alternatives 3, 4, 5 and 7) would provide a greater level of protection than the 180/190-dB exclusion zone specified in Alternative 6. In addition, Alternative 8 includes a larger safety zone of 160-dB and also adds temporal/spatial/operational restrictions that would close areas or reduce activity in areas of higher bowhead whale presence and subsequently provide additional protection to other marine mammals in these areas.

Marine Fissipeds (Polar Bear). Polar bears are managed by the FWS, and they recently implemented a safety radius for polar bears of 190 dB. Because any polar bears encountered will most likely be on the ice, air gun effects on them are expected to be minor. If polar bears are encountered in the water, received sound levels would be substantially reduced due to the pressure release effects near the water surface. The most likely impacts to polar bears from seismic surveys and associated activities would be disturbance and possible impacts to bears' food resources. Any impacts of seismic activity to polar bear food resources will probably be minor, local and brief in nature. Bearded and ringed seals are the primary prey of polar bears in the action area, and abundance and availability of these seals are not expected to be significantly altered by the proposed seismic surveys and associated activities.

Alternative 6 provides the smallest exclusion zone (180/190 dB) and could be visually monitored by vessel-based observers. As the zones grow in size, it becomes less likely that the zone can be effectively monitored by vessel-based observers and aircraft-based observers will need to be added (i.e., when 120-dB level is used in Alternatives 3 and 5). Vessel activity should cause only a brief disturbance, with bears resuming normal activities after the vessel passes. Aircraft activity may be more problematic as polar bears often run away from aircraft passing at low altitude (e.g., altitude < 200 m and lateral distance < 400 m) (Richardson et al. 1995a). The inclusion of aircraft-based observers has the potential to disturb more polar bears than vessel-based observers alone if the aerial observations are flown at a sufficiently low altitude. However, protective measures as outlined in Section IV should limit this impact. Use of the 160-dB exclusion zone in Alternative 4 and in Alternative 5 will provide an intermediate-sized safety zone. The ability of observers to effectively monitor the exclusion zone, and be able to call for a shut-down if polar bears enter the safety zone is critical to the success of the protective measures described in Alternatives 3 through 8.

The difference then within Alternatives 3 through 8 remains with the amount of protection afforded to marine mammals through the mitigation included within each alternative. Again, alternatives with larger safety zones (i.e., Alternatives 3, 4, 5 and 7) would provide a greater level of protection than the 180/190-dB exclusion zone specified in Alternative 6. In addition, Alternative 8 includes a larger safety zone of 160-dB and also adds temporal/spatial/operational restrictions that would close areas or reduce activity in areas of higher bowhead whale presence and subsequently provide additional protection to other marine mammals in these areas.

II.B.3.e Subsistence-Harvest Patterns. The greatest potential disruption of the subsistence whale hunt would be expected in the traditional bowhead whale-hunting areas for Kaktovik, Nuiqsut, and Barrow, where multiple seismic-survey operations could deflect whales away from traditional hunting areas. Conflict avoidance agreements between the AEWC and oil operators conducting one or perhaps two seismic-survey operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities, but the magnitude of six concurrent seismic surveys would test the ability of survey operators and whalers to coordinate their efforts to prevent disruptions to the hunt.

Because the spring subsistence-whale hunt in the communities of Point Hope, Wainwright, and Barrow would be concluding by the time seismic activities begin in the Chukchi Sea region, adverse noise effects on the spring whale harvest are not anticipated. However, Barrow's fall bowhead whale hunt could be particularly vulnerable. Noise effects from multiple seismic surveys to the west in the Chukchi Sea and to the east in the Beaufort Sea potentially could cause migrating whales to deflect farther out to sea, forcing whalers to travel farther—increasing the effort and danger of the hunt—and increasing the likelihood of whale-meat spoilage, as the whales would have be towed from greater distances. Barrow's fall hunt is particularly important, as it is the time when the Barrow whaling effort can "make up" for any whales not taken by other Chukchi Sea and Beaufort Sea whaling communities. These communities give their remaining whale strikes to Barrow, hoping that Barrow whaling crews will successfully harvest a whale and then share the meat back with the donating community. This practice puts a greater emphasis on the Barrow fall hunt. Additionally, a changing spring-lead condition—ice becoming thinner in recent years due to arctic warming—have made the spring hunt more problematic and makes the fall hunt even more pivotal in the annual whale harvest for all communities in the region. Thus, any disruption of the Barrow bowhead whale harvest could have significant effects on regional subsistence resources and harvest practices.

Under Alternative 1 (No Action) the MMS would not approve seismic-survey-permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic-survey methodologies. Because no seismic activity would occur, no impacts to subsistence resources and practices would be expected.

Alternatives 3 through 8 would all have similar impacts on subsistence harvests. These alternatives would permit seismic surveys in the Beaufort and Chukchi seas and incorporate standard G&G-permit stipulations and additional protective measures to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. Theoretically, the larger the safety/exclusion zone, coupled with shut-down procedures, the greater protection is afforded marine mammals from potential harassment and injury. The more marine mammals are protected, the more subsistence-harvest activities are protected.

Alternative 3 with its 120-dB safety zone would provide the greatest protection for all species of whales, bowhead cow/calf pairs, and other marine mammals and would be the preferred alternative for maximum protection of biological resources. However, Alternative 8 with its 180/190-dB exclusion zone for marine mammals, its 160-dB monitored safety zone for feeding whales and the implementation of specific temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (e.g. CAA) negotiation process and mitigate the stress on the AEWC and Whaling Captains' Associations who are generally forced to advocate for such provisions very late in the permitting process.

II.B.3.f Sociocultural Systems. The primary aspects of the sociocultural systems covered in this analysis are: (1) social organization; (2) cultural values; and (3) subsistence and social health. For purposes of analysis, it is assumed that effects on social organization and cultural values could be brought about at the community level by increased effects on subsistence-harvest patterns that could be associated with seismic-survey activity. Potential effects are evaluated relative to the tendency of introduced social forces to support or disrupt existing systems of organization, relative to how rapidly they occur and their duration (Langdon, 1996; USDOI, MMS, 2003a).

Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope might result from seismic-exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of people and equipment for seismic exploration. However, the possible long-term deflection of whale migratory routes or increased skittishness of whales due to seismic-survey activities in the Beaufort and Chukchi seas might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude discussed in the scenario for this draft PEIS has not been approached since the 1980's.

The more predominant issue associated with potential impacts on sociocultural systems is the potential disruption of seismic survey noise on subsistence-harvest patterns particularly on the bowhead whale, which is a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Displacement of ongoing sociocultural systems by seriously curtailing community activities and traditional practices for harvesting, sharing, and processing subsistence resources might occur.

Under Alternative 1 (No Action), the MMS would not approve seismic-survey permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data-processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic. Because no seismic-survey activity would occur, no impacts to subsistence resources and practices and consequent impacts on sociocultural systems would be expected.

Seismic surveys for geophysical exploration activities in alternatives 3 through 8 would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures, including specified isopleth-safety/exclusion zones ranging from a 120 dB safety zone to a 180/190 dB exclusion zone. Safety zones imply monitoring within the specified zone and exclusion zones imply a shutdown of seismic activity within the specified zones. Additional protective measures (beyond the existing Alaska OCS exploration stipulations and guidelines) have been identified and incorporated into these alternatives to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted.

Alternative 8 with its temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (which could be in the form of a CAA) negotiation process and reduce stress on local community organizations that normally negotiate such agreements. The more marine mammals are protected, the more subsistence-harvest activities are protected. If impacts on subsistence resources are mitigated, than consequent sociocultural impacts would be reduced.

II.B.3.g Environmental Justice. Alaskan Inupiat Natives, a recognized minority, are the predominant residents of the communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, Point Hope, and Kivalina, the areas potentially most affected by activities assessed in this draft PEIS. Effects on Inupiat Natives might occur because of their reliance on subsistence foods, and noise from seismic survey activities may affect subsistence resources and harvest practices. "Significant" effects on environmental justice is defined as: disproportionately high adverse impacts to low-income and minority populations. Potential significant impacts to subsistence resources and harvests and consequent impacts to sociocultural systems could result in adverse environmental justice impacts. However, potential adverse affects are expected to be mitigated substantially, though not eliminated. Furthermore, potential long-term impacts on human health from contaminants in subsistence foods and climate change effects on subsistence resources and practices would be expected to exacerbate overall potential effects on low-income, minority populations.

Under Alternative 1 (No Action) the MMS would not approve seismic survey permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic. Because no seismic survey activity would occur, no environmental justice impacts would be expected.

Under alternatives 3 through 8, seismic surveys for geophysical exploration activities would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures for marine mammals, including an isopleth-specified exclusion zone. These alternatives would permit seismic surveys in the Beaufort and Chukchi seas and incorporate standard G&G-permit stipulations and additional protective measures to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. Theoretically, the larger the safety/exclusion zone, coupled with shut-down procedures, the greater protection is afforded marine mammals from potential harassment and injury. Therefore, the 120-dB isopleth safety zone would afford more protection from harassment and injury for marine mammals than the 180/190-dB isopleth exclusion zone alone.

Alternative 8 with its temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (which could be in the form of a CAA) negotiation process and reduce stress on local community organizations that normally negotiate such agreements. The more marine mammals are protected, the more subsistence-harvest activities are protected. If impacts on subsistence resources are mitigated, than consequent sociocultural and environmental justice impacts would be reduced, as well.

Inupiat Natives could be disproportionately affected by any alternative that allows seismic because of their reliance on subsistence foods; and actions under these alternatives could affect subsistence resources and harvest practices. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under IHA requirements as defined by NMFS and FWS and made a part of each alternative would serve collectively to mitigate disturbance effects on environmental justice. Mitigating measures likely would incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and tribal and local governments. With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts would not be expected to occur as a result of this action, thereby avoiding significant impacts on sociocultural systems and disproportionately high adverse impacts on low income and minority populations in the region—significant environmental justice impacts.

II.B.3.h Archeological Resources. Alternatives 3 through 8 include potential use of ocean bottom cables (OBC) surveys to gather seismic data. The OBC surveys could be used in the Beaufort Sea Planning Area to acquire seismic-survey data in water that is too shallow (14 m or shallower) for the data to be acquired using marine streamers and too deep to have bottomfast ice in the winter, which would allow over-ice winter operations. It is possible that cables would be laid in water deeper than 14 m, if the deeper water data was part of a larger acquisition program that went from shallow to deeper water. The OBC surveys require the use of multiple ships (usually two ships for cable layout/pickup, one for recording, one for shooting, and two smaller utility boats). These vessels are generally smaller than those used in streamer operations, and the utility boats are quite small.

After a source line is shot, the source ship takes about 10-15 minutes to turn around and pass down between the next two cables. When a cable is no longer needed to record seismic data, it is retrieved by the cable-pickup ship and moved to the next recording position. A particular cable can lay on the bottom anywhere from 2 hours to several days, depending on operation conditions. Normally, a cable is left in place about 24 hours; however, cables left on the bottom during storms sometimes can work into the substrate before they can be recovered. The OBC surveys might occur in the Beaufort Sea but are not anticipated to occur in the Chukchi OCS because of its great water depths and the greater efficiency of streamer operations in deep water.

The OBC seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water as part of one program. Activities associated with such offshore seismic-exploration activities projected for the 2006 open-water season could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' G&G Permit Stipulation 6 (regarding the discovery of archaeological resources) and CFR 251.6 (a)(5) regarding G&G Explorations of the Outer Continental Shelf to not "disturb archaeological resources," most impacts to archaeological resources in shallow offshore waters of the Beaufort Sea Planning Area would be avoided. Therefore, no impacts or only minor impacts to archaeological resources are anticipated.

III. Existing Environment and Impact Analysis

This section presents information about the Arctic Ocean's biological and physical environment and the human activities that depend on the fish and wildlife resources they provide. This section also describes and discusses the potential impacts associated with the Proposed Action alternatives.

III.A.1. Physical Oceanography. The Chukchi Sea Proposed Action area covers the relatively shallow, broad, continental shelf adjacent to the Arctic Ocean as well as the slope and abyssal plain. Water depths range from approximately 10-3,500 meters (m). Two shoals, the Hanna and Herald, are within the Chukchi Sea. These shoals rise above the surrounding seafloor to approximately 20 m below sea level. There are two major canyons—Herald Canyon and Barrow Canyon. The Barrow Sea Valley begins north of Wainwright and trends in a northeasterly direction parallel to the Alaskan coast. Herald Valley is to the north. Hope Valley, a broad depression, stretches from Bering Strait to Herald Canyon. These topographic features exert a steering effect on the circulation patterns in this area. In contrast, the Beaufort shelf is a narrow continental shelf with no large topographic features. Water depths range from approximately 10-3,500 meters (m).

The generalized circulation within the Beaufort and Chukchi seas is shown in Map III.A-1. The circulation is influenced primarily by the arctic circulation driven by large-scale atmospheric pressure fields. Cyclonic (counterclockwise) winds centered over the central Arctic Ocean predominate, alternating with anticyclonic (clockwise) winds for 5- to 7-year periods. In the Beaufort Sea, the large-scale, surface-water circulation is dominated by the Beaufort Gyre, which moves water to the west in a clockwise motion at a mean rate of about 5-10 centimeters per second (cm/s). Below the surface waters, on the shelf edge, the Beaufort shelf-break jet moves to the east as a narrow current (Pickart, 2004). Long-term mean speeds are about 5-10 cm/s, but daily mean values may be ten times greater. Deeper yet, Atlantic water flows to the east as a boundary current in the Arctic.

On the Beaufort Sea shelf, the currents are determined by the alongshore winds. There are two distinct circulation patterns—the open-water season from July to October and the ice-covered season from mid-October to June. During the open-water season, primarily wind-driven currents are energetic, ranging from 10-100 cm/s. During the ice-covered season, the landfast ice decouples the wind stress from the water, resulting in low current speeds. During this season, less than (<) 1% of the currents exceed 20 cm/s (Weingartner and Okkonen, 2005).

In the Chukchi Sea, three branches of North Pacific waters move across the shelf in a northward direction. This mean flow is primarily a product of the sea-level slope between the Pacific and the Arctic oceans. The first of these currents, the Alaska Coastal Current, flows northeastward along the Chukchi Sea coast of Alaska at approximately 4 cm/s (Coachman, 1993; Johnson, 1989; Weingartner et al., 1998). The Alaskan coastal water is relatively warm and fresh showing the input from rivers, especially the Yukon River. The other waters moving north are the Bering Sea-shelf water and the Gulf of Anadyr water. These move into the Arctic Basin through Herald Valley and around Hanna Shoal. The Siberian Coastal Current flows southward along the coast of Russia and is present in summer and fall (Weingartner et al., 1999).

The semidiurnal tidal range is only 6-10 cm in the Beaufort Sea (Matthews, 1980; Kowalik and Matthews, 1982; Morehead et al., 1992). Tidal currents generally are weak, about 4 cm/s (Kowalik and Proshutinsky, 1994). The level of the water changes constantly in response to the wind. Positive tidal surges occur with strong westerly winds, while negative surges occur with strong easterly winds. Tides are small in the Chukchi Sea, and the range generally is <30 cm. Tidal currents are largest on the western side of the Chukchi and near Wrangel Island, ranging up to 5 cm/s (Woodgate, Aagaard, and Weingartner, 2005).

Waves in the Beaufort and Chukchi seas are controlled by wind and the amount of ice in the water, as ice dampens waves. With a solid ice cover, no waves are generated. Under heavy ice-cover conditions during the colder months, there is little wave development. When the ice thins out, particularly during late summer, the available open-water surface increases, and the waves grow in height when the wind blows. Typical wave heights are <1.5 m, with a wave period of approximately 6 seconds during summer and <2.5 m during fall. Expected maximum wave heights are 7-7.5 m in the Beaufort Sea and 8-9.5 m in the Chukchi Sea (Brower et al., 1988). A late summer storm in the Beaufort and Chukchi seas in September 2000 developed waves 6-7 m high near Point Barrow (Lynch et al., 2003).

We do not know to what extent the recent changes in the Arctic Ocean are cyclic, whether they represent a linear trend, or if they are a modal shift. Changes in the Bering Sea as well as the Arctic Ocean have complex interactions with the Chukchi and Beaufort Seas.

Widespread changes of temperature and salinity occurred in the central Arctic Ocean water column during the 1990's. There were observations of widespread temperature increases in the Atlantic water layer (Carmack et al., 1995; McLaughlin et al., 1996; Morrison, Steel, and Anderson, 1998; Grotefendt et al., 1998). These appear related to an increased temperature (Swift et al., 1998) and strength (Zhang, Rothrock, and Steele, 1998) of the Atlantic inflow into the Arctic Basin. Increased transport caused a displacement of the Pacific-Atlantic water boundary toward the Canadian Basin. The pronounced warming of Atlantic water in the central basin tapered off by 1998-1999 (Gunn and Muench, 2001; Boyd et al., 2002). Kikuchi, Inoue, and Morison (2005) report that the temperature anomalies appear first on the Markov Basin side of the Lomonosov Ridge and then arrive on the Amundsen side of the basin approximately 7 years later. Karcher et al. (2003) suggest, from modeling, that the warming of the Atlantic Layer resulted from changes in inflow from Fram Strait and the Barents Sea as well as changes in local current speeds. They suggest these events are episodic with a warming event in the early 1980's and again in the early 1990's. Woodgate et al. (2001) and Zhao, Gao, and Jiao (2005) also present observations of warming and cooling events near the Chukchi Borderlands. There still is discussion in the literature regarding the cause of the warming. Carmack and Chapman (2003) discuss increasing upwelling of warm Atlantic water along the shelf break due to the reduction of sea ice and an increase in wind-driven circulation.

Shimada et al. (2004) and McLaughlin et al. (2004) identify the remnants of this warmed Atlantic Water recently reaching the Canadian Basin. Comparisons of recent and historical data show that the Canada Basin waters are in transition and are responding to inflow from upstream basins (McLaughlin et al., 2004, 2005). The appearance of higher temperatures near the Chukchi Plateau suggests that temperatures may continue to increase adjacent to the Chukchi shelf in the coming years. Steele et al. (2004) state that the distribution of summer Pacific halocline is changing in the Canadian Basin of the Arctic Ocean and so is its influence. They relate these changes to the two different Arctic Oscillation (AO) states where during a high AO, ACW and summer Bering Shelf Water may outflow at different locations from the Arctic. During a low AO, both watermasses are mixed into the Beaufort Gyre, and the separation of these watermasses is reduced.

Determining whether this trend persists depends on acquiring additional data. Polyakov et al. (2005) report two warm Atlantic Water anomalies (1999 and 2004) in the eastern Eurasian Basin that could propagate towards the Arctic Ocean interior with a time lag. Polyakov et al. (2004) present data showing multidecadal fluctuations in temperature, with time scales of 50-80 years for Atlantic Water temperature variability.

Observations in the next years may be particularly significant in view of the changes observed in the AO, which had a persistent, positive phase through the 1990's, but it has been negative or near neutral for 6 of the previous years from 1996-2004 (Overland and Wang, 2005). This warming in the early 1990's was thought to be associated with cyclical, large-scale shifts in atmospheric forcing called the Arctic Oscillation (Proshutinsky and Johnson, 1997; Proshutinsky et al., 2000). Even without the driving force of a positive Arctic Oscillation, Arctic indicators continue to indicate a continuing linear trend of warming. Tracking multiple lines of evidence will be crucial to understanding change in the Arctic as a whole (Overland, 2006).

Lynch et al. (2001) examined the Barrow high-wind events from 1960-2000, and concluded that high-wind events are common in fall and winter and rare in April, May, and June. They have not yet concluded whether the more frequent storms and the storms in April, May, and June are part of a new pattern. The longer open-water period and the increase in storm events could lead to increased storm-surge events.

III.A.1.a. Sea Ice. Sea ice is frozen sea water with the salt extruded out of the ice mass. The northern Alaskan coastal waters are covered by sea ice for three-quarters of the year, from approximately October until June. Sea ice has a large seasonal cycle, reaching a maximum extent in March and a minimum in September. The formation of sea ice has important influences on the transfer of energy and matter between the ocean and atmosphere. It insulates the ocean from the freezing air and the blowing wind.

There are three major forms of sea ice in the Arctic: landfast ice (which is attached to the shore, is relatively immobile, and extends to variable distances offshore); stamukhi ice (which is grounded, ridged sea ice); and pack ice (which includes first-year and multiyear ice and moves under the influence of winds and currents).

While there are wide-ranging spatial and temporal variations in arctic sea ice, the generalized annual patterns are as follows:

- September – Shore ice forms; the river deltas freeze; and frazil, brash, and greased ice form within bays and near the coast.
- Mid-October – Smooth, first-year ice forms within bays and near the coast. Thomas Napageak remarked: "…The critical months [for ice formation] are October, November, and December" (Napageak, as cited in Dames and Moore, 1996:7).
- November through May – Sea ice covers more than 97% of the areas. Spring leads form in the Chukchi Sea.
- Late May – Rivers flood over the nearshore sea ice.
- Early June – River floodwaters drain from the surface of the sea ice. Sarah Kunaknana stated: "In June and July when the ice is rotting in the little bays along the coast…." (Kunaknana, as cited in Shapiro and Metzner, 1979).

The southern Chukchi Sea is free of sea ice 1-2 months longer each year than the northern Chukchi Sea. Warmer water flowing north through the Bering Strait, combined with strong sunlight returning earlier in the year at lower latitudes, melts or pushes the pack ice north starting as early as mid-June. The same effect keeps the surface ice free longer in the fall, typically until mid-November.

Data obtained from aerial and satellite remote sensing show that leads and open-water areas form within the pack-ice zone. Southwesterly storms cause leads to form in the Beaufort and Chukchi seas. Along the western Alaskan Coast between Point Hope and Point Barrow, there often is a band of open water seaward of the landfast-ice zone during winter and spring. This opening is at some times a well-defined lead and at other times a series of openings (polynyas) in the sea ice. Between February and April, the average width is <1 kilometer (km) (the extreme widths range from a few kilometers in February to 20 km in April) and is open about 50% of the time. The Chukchi open-water system appears to be the result of the general westward motion seen in the Beaufort Gyre. There also appears to be a positive correlation between the average ice motion away from the coast and the mean wind direction, which is from the northeast for all months except July (Stringer and Groves, 1991).

The arctic sea ice is undergoing changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. The analysis of long-term data sets indicate substantial reductions in both the extent (area of ocean covered by ice) and thickness of the arctic sea-ice cover during the past 20-40 years, with record minimum summer extent in 2002 and again in 2005, and extreme minima in 2003, 2004 and 2006 (Stroeve et al., 2005; NASA, 2005; Comiso, 2006, NSIDC, 2006). In September 2002, sea ice in the Arctic reached a record minimum during summer, 4% lower than any previous September since 1978 and 14% lower than the 1978-2000 mean (Serreze et al., 2003). Four years of low ice extent followed 2002. Taking these 3 years into account, the September ice-extent trend for 1979-2004 declined by -7.7% per decade (Stroeve et al., 2005) , for 1979-2005 declined by -9.8% per decade (Comiso, 2006) and for 1979-2006 declined by 8.59 percent per decade (NISDC, 2006) . Within the Arctic, the Chukchi and Beaufort Seas have some of the largest declines in sea ice extent during summer. In 2005, the Beaufort Sea was not as wide open as the previous 3 years (Comisio, 2006). Polykov et al (2003) studied the long-term variability of August ice extent from 1900-2001 and reported a 1 $\pm$ 0.9% decrease per decade for the Chukchi Sea. The midsummer ice is reported as smaller in size and greater distances between the individual floes (Gearhead et al. 2006)

Comparison of sea-ice-draft data acquired on submarine cruises between 1993 and 1997, with similar data acquired between 1958 and 1976, indicates that the mean ice draft at the end of the melt season has decreased by about 1.3 m in most of the deepwater portions of the Arctic Ocean (from 3.1 m in 1958-1976 to 1.8 m in the 1990's). The decrease is greater in the central and eastern Arctic than in the Beaufort and Chukchi seas (Rothrock and Zhang, 2005). Preliminary evidence is that the ice cover has continued to become thinner in some regions during the 1990's (Rothrock, Yu, and Maykut, 1999). The average thinning of the ice appears to be the result of both the diminished fraction of multiyear ice and the relative thinning of all ice categories.

Changes in the landfast ice have been occurring. Events of shorefast ice breaking off have occurred near Barrow in January or February and even as late as March (George et al., 2003). These events also have increased in frequency. Hunters identified little or no old ice, the ice is thinner, shorefast break offs occur more often and changing patterns in the formation of the pressure ridges (Gearhead et al. 2006).

III.A.2. Air Quality. The combination of limited industrial development and low population density results in good to excellent air quality throughout the Chukchi and Beaufort seas area. Only a few small, scattered emissions from widely scattered sources exist on the adjacent onshore areas. The only major local sources of industrial emissions are in the Prudhoe Bay/Kuparuk/Endicott oil-production complex. During the winter and spring, additional pollutants are transported by the wind to the Alaska Arctic Ocean from industrial sources in Europe and Asia (Rahn, 1982). These pollutants cause a phenomenon known as arctic haze.

The U.S. Environmental Protection Agency (USEPA) defines Air Quality Control Regions (AQCR's) for all areas of the United States and classifies them based on six "criteria pollutants," and has established for each of them a maximum concentration above which adverse effects on human health may occur. These threshold concentrations are called National Ambient Air Quality Standards (NAAQS). When an area meets NAAQS, it is designated as an "attainment area." An area not meeting air quality standard for one of the criteria pollutants is designated as a "nonattainment area."

Areas are designated "unclassified" when insufficient information is available to classify areas as attainment or nonattainment. All areas in and around the Chukchi and Beaufort seas are classified as attainment areas.

The provisions of Alaska's Prevention of Significant Deterioration (PSD) program are applied to attainment areas and unclassified AQCR's with good air quality to limit its degradation from development activities. The areas are classified as PSD Class I, II, or III areas (in decreasing order of relative protection) based on land status/use and the associated protection afforded to the area. The region of Alaska adjacent to the Chukchi and Beaufort seas is a PSD Class II area. The nearest PSD Class I areas are the Bering Sea Wilderness Area within the St. Matthew Island group and the Denali National Park. There are no Class III areas in Alaska. States strive to allow industrial and commercial growth within PSD Class II areas without causing significant degradation of existing air quality or exceeding the NAAQS.

III.B. Acoustic Environment.

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. In addition, ambient-noise levels can change greatly throughout the course of a season at a particular site, and vary from site to site.

Sounds generated by the oil and gas industry in the Arctic are propagated into a marine environment that already receives sounds from numerous natural and human sources. Ambient noise levels in the Beaufort and Chukchi seas can vary dramatically between and within seasons because of: (1) variability in components of environmental conditions such as sea ice, temperature, wind, and snow; (2) the presence of marine life; (3) the presence of industrial shipping, research activities, and subsistence activities; and (4) other miscellaneous factors. In general, the ambient noise in the Arctic marine environment varies widely and seasonally. In the Beaufort Sea, Burgess and Greene (1999) measured ambient noise in September from about 63 to 133 dB re 1 µPa. A complete description of all producers of noise is beyond the scope of this document. The main sources of noise, both natural and anthropogenic (manmade), occurring in the Beaufort and Chukchi seas are described below.

III.B.1. Existing Environment. The acoustic environment of the Arctic Subregion varies greatly among seasons and between specific areas. During much of the year, in many marine areas in this subregion, there are few near-field marine-noise sources of human origin and limited, but increasing, land-based and nearshore-based sources of noise that affect the OCS in the Arctic Subregion.

III.B.1.a. Natural Sound. Natural sound sources in the Beaufort and Chukchi seas include the wind stirring the surface of the ocean, lightning strikes; animal vocalizations and noises (including whale calls, echolocation clicks, and snapping shrimp); subsea earthquakes; and ice movements.

The presence of ice can contribute significantly to ambient noise levels and affects sound propagation. As noted by the National Research Council (NRC) (2001:39), "An 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 Hertz (Hz).

Temperature affects the mechanical properties of the ice, and temperature changes can result in cracking. In winter and spring, land-fast 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 ice noise typically displays a broad range from 100 Hz-1 kiloHertz (kHz), and the spectrum level has been observed to vary as much as 15 dB within 24 hours due to the diurnal change of air temperature. Ice deformation occurs primarily from wind and currents and usually produces low frequency noises. Data are limited, but at least in one instance it has been shown that ice-deformation noise produced frequencies of 4-200 Hz (Greene, 1981). As icebergs melt, they produce additional background noise as the icebergs tumble and collide.

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, 1995a). As ice forms, especially in very shallow water, the sound propagation properaties of the underlying water are affected in a way that can reduce the transmission efficiency of low frequency sound (see 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 Arctic, 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., 1995a).

At least seasonally, marine mammals can contribute significantly to the background noise in the acoustic environment of the Beaufort and Chukchi seas. Frequencies and levels are highly dependent on seasons. For example, source levels of bearded seal songs have been estimated to be up to 178 decibels re 1 microPascal at 1 meter (178 dB re 1 μPa at 1 m) (Cummings et al., 1983). Ringed seal calls have a source level of 95-130 dB re 1 μPa at 1 m, with the dominant frequency under 5 kHz (Richardson et al., 1995a). Bowhead whales, which are present in the Arctic Region from early spring to mid- to late fall, produce sounds with estimated source levels ranging from 128-189 dB re 1 μPa at 1 m in frequency ranges from 20-3,500 Hz. Richardson et al. (1995a) summarized that most bowhead whale calls are "tonal frequency-modulated (FM)" sounds at 50-400 Hz. There are many other species of marine mammals in the arctic marine environment whose vocalizations contribute to ambient noise including, but not limited to, the gray whale, walrus, ringed seal, beluga whale, spotted seal, fin whale (in the southwestern areas) and, potentially but less likely, the humpback whale. In air, sources of sound will include seabirds (especially in the Chukchi Sea near colonies), walruses, and seals.

III.B.1.b. Anthropogenic Sound. Human sources include noise from vessels (motor boats used for subsistence and local transportation, commercial shipping, research vessels, etc.); navigation and scientific research equipment; airplanes and helicopters; human settlements; military activities; and marine development. Table III.B-1 provides a comparison of manmade sound levels from various sources associated with the marine environment.

III.B.1.b(1) Vessel Activities and Traffic. Shipping noise, often at source levels of 150-190 dB re 1 μPa, since 1950 has contributed a worldwide 10- to 20-dB increase in the background noise in the sea (Andrew et al., 2002; McDonald et al., 2006). The types of vessels that produce noise in the Beaufort and Chukchi seas include barges, skiffs with outboard motors, icebreakers, scientific research vessels, and vessels associated with geological and geophysical exploration and oil and gas development and production. In the Beaufort and Chukchi seas, vessel traffic and associated noise presently is limited primarily to late spring, summer, and early autumn.

In shallow water, vessels more than 10 km away from a receiver generally contribute only to background noise (Richardson et al., 1995a). In deep water, traffic noise up to 4,000 km away may contribute to background-noise levels (Richardson et al., 1995a). Shipping traffic is most significant at frequencies from 20-300 Hz (Richardson et al., 1995a). 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. The use of aluminum skiffs with outboard motors during fall subsistence whaling in the Alaskan Beaufort Sea also contributes noise. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson et al., 1995a).

Icebreaking vessels used in the Arctic for activities including research and oil and gas activities produce louder, but also more variable, sounds than those associated with other vessels of similar power and size (Richardson et al., 1995a). 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 more than 50 km away. In general, spectra of icebreaker noise are wide and highly variable over time (Richardson et al., 1995a).

III.B.1.b(2) Oil and Gas Development and Production Activities. There currently are a few oil-production facilities on artificial islands in the Beaufort Sea. Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995a). Typically, noise propagates poorly from artificial islands, as it must pass through gravel into the water (Richardson et al., 1995a). Richardson et al. (1995a) reported that during unusually quiet periods, drilling noise from ice-bound islands would be audible at a range of about 10 km, when the usual audible range would be ~2 km. Richardson et al. (1995a) also reported that broadband noise decayed to ambient levels within ~1.5 km, and 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. 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.

Recently Richardson (2006) summarized results from acoustic monitoring of the offshore Northstar production facility from 1999-2004. Northstar is located on an artificial gravel island in the central Alaskan Beaufort Sea. 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." However, based on later measurements, that tone was not repeated in future years. Based on sounds measurements of noise from Northstar obtained during March 2001 and February-March 2002 (during the ice-covered season), Blackwell et al. (2004) found that background levels were reached underwater at 9.4 km when drilling was occurring and at 3-4 km when it was not. Irrespective of drilling, in-air background levels were reached at 5-10 km from Northstar.

During the open-water season, vessels such as tugs, self-propelled barges, and crew boats were the main contributors to Northstar-associated 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 William, 2003). In the absence of vessel noise, averaged underwater broadband sounds generally reached background levels 2-4 km from Northstar. Underwater sound levels from a hovercraft, which British Petroleum Exploration (Alaska) (BPXA) began using in 2003, were quieter than similarly sized conventional vessels. Hovercraft also replaced helicopter traffic to the Northstar facility.

III.B.1.b(3) Miscellaneous Sources. Acoustical systems are associated with some research, military, commercial, or other vessel use of the Beaufort or Chukchi seas. Such systems include multi-beam sonar, sub-bottom profilers, and acoustic Doppler current profilers. Active sonar is used for the detection of objects underwater. These range from depth-finding sonar, found on most ships and boats, to powerful and sophisticated units used by the military. Sonar emits transient, and often intense, sounds that vary widely in intensity and frequency. Although not commonly used in the Arctic, acoustic pingers used for locating and positioning oceanographic and geophysical equipment also generate noise at frequencies greater than about 10-20 kHz. LGL, Ltd. (2005) describes many examples of acoustic navigational equipment.

III.B.1.c. Potential Effect of Climate Change. Available evidence indicates that the total extent of arctic sea ice has declined over the past several decades; these declines are not consistent across the Arctic (Gloersen and Campbell, 1991; Johannessen, Miles, and Bjorgo, 1995; Maslanki, Serreze, and Barry, 1996; Parkinson et al., 1999; Vinnikov et al., 1999). 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,b).

The presence, thickness, and movement of sea ice significantly influence the ice's contribution 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; whale 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 can vary dramatically between seasons and sea-ice conditions. The presence of ice also impacts which marine species are present, another factor that influences ambient noise levels.

If arctic warming continues, it is likely that changes in the acoustic environment also will occur in many parts of the waters off Alaska (Tynan and DeMaster, 1997; Brigham and Ellis, 2004). Climate warming potentially could: (a) increase noise and disturbance related to increased shipping and other vessel traffic, and possibly increased seismic exploration and development; (b) expand commercial fishing and/or cause a change in areas where intensive fishing occurs; (c) decrease year-round ice cover; (d) change subsistence-hunting practices; and (e) change the distribution of marine mammal species (MacLeod et al., 2005).

III.B.2. Sound Propagation. Underwater sound essentially is the transmission of energy via compression and rarefaction of particles in the conducting medium (i.e., in this case, seawater). The pressure pulse from a sound source propagates outwards in an expanding spherical shell at approximately 1,500 meters per second (m/s) (in seawater). As the shell expands, the energy contained within it is dispersed across an ever-increasing surface area, and the energy per unit area decreases in proportion to the square of the distance traveled from the source. However, sound propagation is made significantly more complex as a result of sound interaction with acoustically "hard" boundaries such as the water surface and the sea bottom and "soft" internal features like thermal gradients.

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 amplitude, frequency, wavelength, directivity (beam pattern) 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 usually is measured in Hertz, pressure level in microPascals (Gausland, 1998), and intensity levels in decibels (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 dB 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), hearing characteristics 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; Ketten, 1998), and other references as noted, the following information about sound transmission is relevant to understanding the characteristics of sound in the marine environment:

- Sound travels faster and with less attenuation in water than it does in air.
- 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).
- Sound propagation can vary seasonally in the same environment.
- Sound propagation varies significantly as a function of sound frequency owing to differential absorption. Low frequencies can travel much further than high frequencies.
- Extrapolation about the likely characteristics of a given type of sound source in a given location within the Chukchi and Beaufort seas based on published studies conducted elsewhere is 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.
- Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998).

Measurement of underwater sound levels historically has been complicated by a system of inconsistent and confusing units. Sound pressures in underwater sound studies are reported in terms of peak-peak, 0-peak, rms (root-mean-square), and peak-equivalent rms (Madsen, 2005). RMS is linked to the derivation of amplitude measurements from phase-oscillating signals. The magnitude of sound pressure levels in water normally is described by sound pressure on a logarithmic (decibel: dB) scale relative to a reference rms pressure of 1 μPa (dB re 1 μPa) (Madsen, 2005). Different reference units are appropriate for describing different types of acoustic stimuli.

Results from underwater-noise studies can be difficult to evaluate and compare, as decibel levels may vary by 10 dB or more between the different units of measure. Sound pressure of continuous sound sources normally is parameterized by an rms measure, while transient sound normally is given in peak pressure measures.

In unbounded seawater (i.e., in the deep oceanic locations, or at close ranges to a source in shallower shelf waters), free field spherical spreading will occur. Once the horizontal propagation path becomes substantially greater than the water depth, a ducted form of spreading tends to occur due to reflections from the seabed and surface. In a duct with perfectly reflective boundaries, the spreading would become cylindrical. In reality, the boundaries, and the seabed in particular, are not perfect reflectors, and there is some loss of energy from the water column as the sound propagates. When impulse sounds propagate in a highly reverberant environment, such as shallow water, the energy becomes spread in time due to the variety of propagation paths of various lengths. The precise rate at which loss will occur is variable and will be site specific, depending on such factors as seabed type.

III.B.3. Seismic Sound. The oil and gas industry in Alaska conducts marine geophysical surveys in the summer and fall, and on-ice seismic surveys in the winter, to locate geological structures potentially capable of containing petroleum accumulations. These surveys use individual airguns or a combination of individual airguns called an airgun array to produce sound waves that typically are aimed directly at the seafloor. The sound is created by the venting of high-pressure air from the airguns into the water column and the subsequent production of an air-filled cavity (a bubble) that expands and contracts, creating sound with each oscillation. Airgun output usually is specified in terms of zero-to-peak or peak-to-peak levels. Airgun sizes are quoted as chamber volumes in cubic inches, and individual guns may vary in size from a few tens to a few hundreds of cubic inches. 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) and thousands of kilometers in the open ocean (Nieukirk et al., 2004). Typically, an airgun array is towed behind a vessel at 4-8 m depth (see Figures I.E-1 and III.B-1) and is fired every 10-15 seconds. The ship also may be towing long cables with hydrophones (streamers), which detect the reflected sounds from the seafloor.

Airgun-array sizes are quoted as the sum of their individual airgun volumes and again can vary greatly. The array output is determined more by the number of guns than by the total array volume (Fontana, 2003, pers. commun.). For single airguns the zero-peak acoustic output is proportional to the cube root of the volume. As an example, compare two airgun configurations with the same total volume. The first array consists of one airgun with a total volume of 100 cubic inches (in^3) resulting in a cube root of 4.64. The second array has the same total volume, but consists of five 20-in^3 guns. The second array has an acoustic output nearly three times higher (5 times the cube root of 20 = 13.57) than the single gun, while the gun volumes are equal. The output of a typical two-dimensional/3-dimensional (2D/3D) array has a theoretical point-source output of ~255 dB $\pm$ 3 dB (Barger and Hamblen, 1980; Johnston and Cain, 1981); however, this is not realized in the water column, and maximum real pressure is more on the order of 232 dB $\pm$ 3 dB and typically only occurs within 1-2 m of the airguns.

The depth at which the source is towed has a major impact on the maximum near-field output, and on the shape of its frequency spectrum. The root-mean-square (rms) received levels that are used as impact criteria for marine mammals are not directly comparable to the peak or peak-to-peak values normally used to characterize source levels of airguns. The measurement units used to describe airgun sources, peak or peak-to-peak decibels, are always higher than the rms decibels referred to in much of the biological literature. A measured received level of 160 dB rms in the far field typically would correspond to a peak measurement of about 170-172 dB, and to a peak-to-peak measurement of about 176-178 dB, as measured for the same pulse received at the same location (Greene, 1997; McCauley et al., 1998, 2000). The precise difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source.

Tolstoy et al. (2004) collected empirical data concerning 190-, 180-, 170-, and 160-dB (rms) distances in deep (~3,200 m) and shallow (~30 m) water for various airgun-array configurations during the acoustic calibration study conducted by Lamont-Doherty Earth Observatory in the northern Gulf of Mexico. Results demonstrate that received levels in deep water were lower than anticipated based on modeling, while received levels in shallow water were higher.

Seismic sounds vary, but a typical 2D/3D seismic survey with multiple guns would emit energy at about 10-120 Hz, and pulses can contain significant energy up to at least 500-1,000 Hz (Richardson et al. 1995a). Goold and Fish (1998) recorded a pulse range of 200 Hz-22 kHz from a 2D survey using a 2,120-in^3 array.

Richardson et al. (1995a) summarized that typical signals associated with vibroseis sound source used for on-ice seismic survey 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.

Safety Radii for Marine Mammals. Exclusion zones are traditionally established around a seismic-survey operation to help prevent potential harm to marine mammals that are exposed to the acoustic sound sources. Typically, lower output systems produce smaller exclusion zones. The exclusion zone radii around an airgun array vary with water depth. Tolstoy et al. (2004) provide both predicted and measured values for a variety of airgun configurations ranging from 2-20 airguns. Recent National Marine Fisheries Service (NMFS) incidental harassment authorizations (IHA's) (e.g., Lamont-Doherty, 2005; University of Alaska, 2005) used the data from Tolstoy et al. (2004) to estimate exclusion zones for shallow (<100 m), intermediate, (100-1,000 m), and deep (greater than [>] 1,000 m) waters, depending on the type of airgun configuration used. No measurements were made for intermediate-depth waters. The NMFS currently estimates these exclusion zones using a 1.5x correction factor from deepwater data.

The MMPA has established two levels of harassment for marine mammals: Level A and Level B. Simplified, Level A harassment has the potential to injure a marine mammal, while Level B harassment is a disturbance impact. NMFS has established criteria for Level A harassment for nonexplosive sounds at 180 dB re 1 µPa rms for cetaceans and 190 dB re 1 µPa rms for pinnipeds. A Level B harassment criterion for impulse noises is 160 dB 1 µPa rms. These criteria are then coupled with existing data (e.g., Tolstoy et al., 2004) or field-test data to determine exclusion zones on a case-by case basis based on water depths and airgun configurations.

As stated earlier in Section II and discussed later in Section III.F.3, the 120-dB (rms) isopleth is the approximate zone where marine mammal scientists found in 1998, at 20-km almost total bowhead whale exclusion (P=0.0012, estimated reduction of 90 % with seismic (Richardson, 1999). Sound level received by bowhead whales in 1998 at 20 km ranged from 117-135 dB re 1 µPa rms and 107-126 dB re 1 µPa rms at 30 km. At 30-40 km from the shot-point however, sightings were considerably higher than expected, possibly meaning that bowheads were disproportionately displaced into that area as a result of avoiding zones closer to the vessel (Richardson, 1999). Airgun arrays used in 1998 were an 8-gun array totaling 560 in^3 and a 16-gun array totaling 1500 in^3. The 120-dB (rms) level is the level recommended by the 2001 open-water meeting participants to show where significant responses by bowhead whales in the Beaufort Sea occurs. An issue complicating the use of the 120-dB isopleth for delimiting the safety zone is that it lies within the reported ambient range of sounds (66-133 dB) in the Arctic marine environment (Burgess and Greene, 1999) and, therefore, depending upon frequency, may be masked by other sound sources, including marine mammal sounds.

III.C. Cumulative Activity Scenario.

This section primarily focuses on those activities and events that could introduce noise into the marine environment or otherwise potentially impact local fish, wildlife, and subsistence activities. The Proposed Action is to possibly permit six marine seismic surveys in both the Chukchi and Beaufort seas. The scenario will serve as the basis for assessing the cumulative impacts (see Sec. III.H - Cumulative Impacts Analysis) of the Proposed Action on local fish and wildlife resources and the Inupiat culture that depends on them for subsistence-harvest activities.

The main agents of the cumulative activities scenario are past, present and foreseeable: (1) marine seismic surveys; (2) vessel traffic and movements; (3) aircraft traffic; (4) oil and gas exploration in Federal and State waters; and (5) miscellaneous activities and factors. Incorporated by reference are the following reports and documents, which have a more thorough description of the cumulative activities associated with oil and gas exploration and development on the North Slope and neighboring Beaufort and Chukchi seas: NRC, 2003; USDOI, BLM and MMS, 1998; USDOI, BLM 2002, 2005. Also see Section III.B for a detailed description of the acoustic environment in the Chukchi and Beaufort seas.

III.C.1. Marine Seismic Surveys in the Beaufort and Chukchi Seas.

III.C.1.a. OCS Seismic-Survey Activities. MMS-permitted seismic surveys have been conducted in the Federal waters of the Chukchi and Beaufort seas since the late 1960's/early 1970's. Between 1970 and 1975, 12 MMS Geological and Geophysical (G&G) permits were issued for Chukchi Sea 2D marine seismic surveys, and no MMS G&G permits were issued between 1976 and 1982. Seismic-survey activity increased between 1982 and 1991, when MMS issued 30 G&G permits. The first 3D seismic surveys conducted in the Chukchi Sea OCS occurred in 2006. Approximately 80,000 line-miles of 2D seismic surveys were shot and 1,500 square miles of 3D seismic surveys were covered to date in the Chukchi Sea Planning Area.

More MMS-permitted 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 G&G permits issued in 1968 and four in 1969. Both over-ice (29 G&G permits) and marine (43 G&G permits) 2D seismic surveys were conducted in the 1970's. With one exception, the 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980's were 2D. In the 1990's, both 2D (2 over-ice and 21 marine) and 3D (11 over-ice and 7 marine ocean-bottom-cable [OBC]) seismic surveys were conducted. The first 3D over-ice survey occurred in the Beaufort Sea OCS in 1983 and the first marine (OBC) 3D seismic survey occurred in 1996. More than 100,000 line-miles of 2D and 3D seismic surveys have been collected to date in the Beaufort Sea Planning Area.

The most G&G permits issued in any one year in the Chukchi Sea was seven (6 marine and 1 over-ice) in 1986. In 2006, 3 G&G permits were issued for the Chukchi Sea. 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, 2D over-ice surveys; and, 9, 2D marine surveys). In 2006, 1 G&G permits were issued for the Beaufort Sea. Figures III.C-1, III.C-2, and III.C-3 illustrate cumulatively, the geographic extent of OCS-permitted seismic surveys conducted in the Beaufort and Chukchi seas beginning in the 1970's and through 2004.

As part of a lease agreement between the MMS and lessee and per regulations (30 CFR 250), high-resolution site-clearance surveys are conducted on leased blocks, along with side-scan sonar surveys to detect geohazards, archaeological resources, and certain types of benthic communities. Such high-resolution data may be used for initial site evaluation for drilling rig emplacement and for platform or pipeline design and emplacement. In the 1980's, five high-resolution site-clearance surveys were conducted in the Chukchi Sea OCS prior to five exploration wells being drilled. To date, high-resolution site-clearance surveys in the Beaufort Sea OCS were conducted for 30 exploration wells. Additional site-clearance surveys may have been conducted in the Proposed Action area where no exploration wells were drilled. No high-resolution site-clearance surveys are expected to occur in the Chukchi Sea until after the proposed Chukchi Sea Lease Sale 193 in 2007. In 2006, shallow hazard surveys occurred on Beaufort Sea leases held by Shell Oil Company.

Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, there is the potential that seismic surveys will continue in the Chukchi and Beaufort seas into the near future and be dependent on: (1) the amount of data that is collected in 2006; (2) what the data indicate about the subsurface geology; and (3) the results of Beaufort Sea Sale 202 and Chukchi Sea Sale 193. Potential seismic-survey activity is addressed in the draft EIS for the OCS Oil and Gas Leasing Program, 2007 to 2012. The MMS anticipates that future seismic surveys will focus on areas surrounding currently and previously leased blocks in the Beaufort and Chukchi seas. Figure III.C-4 illustrates the existing locations of MMS OCS leases in the Beaufort Sea. Figure III.C-5 illustrates the locations of those MMS OCS blocks previously leased to the oil and gas industry in the Chukchi Sea, all of which have been relinquished or expired.

III.C.1.b. State of Alaska Seismic-Survey Activities. Seismic surveys for exploration purposes in State of Alaska (State) waters (mean high tide line to 3 miles [mi] offshore) are authorized under Miscellaneous Land Use Permits; however, seismic surveys conducted for other purposes, such as shallow hazard assessments, do not require permits unless they are not conducted from the ice and/or involve contact with the seafloor (Schultz, pers. commun., as cited in Wainwright, 2002).

Since 1969, the State has issued 42 permits for seismic-survey activities in the Beaufort Sea. The number and types of airgun-type seismic permits issued since then are as follows:

- 1969 — 1 — 2D
- 1970's — 23 — 20, 2D marine streamer and 3, 2D OBC
- 1980's — 13 — 2D marine streamer
- 1990's — 3 — 2, 3D OBC and 1, 2D marine streamer
- 2000-2002 — 3 — 3D OBC
- 2002 to date — 0

To date, the State has not issued any seismic survey permits for the Chukchi Sea (Rader, ADNR, pers. commun.).

III.C.1.c. Other Seismic-Survey Activities. Occasionally, seismic surveys are conducted in the Arctic Ocean for scientific-research purposes. These surveys often use seismic-research vessels that employ a variety of airgun configurations, as well as multibeam bathymetric sonar, a sub-bottom profiler, and other standard acoustic-research instrumentation. The MMS issues geophysical scientific-research permits for any oil- and gas-related investigation conducted in the OCS for scientific and/or research purposes. Historically the MMS rarely issued such permits for the Beaufort and Chukchi seas, and none are expected to be issued in the foreseeable future. The MMS is aware of at least one non-oil- and gas-related scientific seismic survey conducted in 2006. The University of Texas, Austin, with research funding from the National Science Foundation conducted a marine seismic survey in the western Canada Basin, Chukchi Borderland, and Mendeleev Ridge, Arctic Ocean. The project included collection of seismic reflection and refraction data as well as sediment coring. Additional information about the University of Texas's research is located at http://www.nsf.gov/od/opp/arctic/arc_envir/healy_ea_06.pdf.

III.C.2. Vessel Traffic and Movements.

Vessels are the greatest contributors to overall noise in the sea. Sound levels and frequency characteristics of vessel noises underwater generally are related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and those underway with a full load, or those pushing or towing a load, are noisier than unladed vessels. The primary sources of sounds are engines, bearings, and other incidental mechanical parts. The sound from these sources reaches the water through the vessel hull. The loudest sounds are made by the spinning propellers. Navigation and other vessel-operation equipment also generate subsurface sounds.

In addition to the seismic survey vessels associated with the Proposed Action, vessel traffic associated with exploration activities (e.g. drilling vessels, support vessels, and ice breakers) on leased blocks in the Beaufort Sea is expected to increase. The majority of other vessels expected to transit through the Proposed Action area and/or within 12.5 mi (20 km) of the coast will include, at a minimum, vessels used for fishing and hunting, cruise ships, icebreakers, Coast Guard vessels, and supply ships and barges (LGL Alaska Research, 2006).

The Beaufort and Chukchi seas, unlike other OCS areas in the United States, do not support an extensive maritime industry transporting goods between major ports. However, during ice-free months (June to October), barges are used for supplying the local communities, Alaskan Native villages, and the North Slope oil-industry complex at Prudhoe Bay with larger items that cannot be flown in on regular commercial air carriers. Barge-transported commodities include diesel fuel for electric power generation, gasoline and other petroleum products, raw materials, and manufactured goods. Usually, one large fuel barge and one supply barge visit the villages per year and one barge per year traverses through the Arctic Ocean to the Canadian Beaufort Sea.

Existing oil-field developments on the North Slope are serviced by land, air, and sea. Tug and barge traffic associated with the onshore oil-development travel mainly in nearshore waters along the coast. Major sealifts into the industrial complex at Prudhoe Bay occur frequently. Between 1968 and 1990, approximately 480 sealifts (averaging 22 per year) were made to Prudhoe Bay, which corresponds to the time period when the complex was constructed and subsequently expanded. Since then, approximately 40 sealifts have been made to Prudhoe Bay (averaging 2-3 per year); however, in many years, no sealift occurred.

The Proposed Action area lies within the Northwest Passage, and from the first transit through 2004, 99 vessel transits (62 eastbound and 37 westbound), mostly by icebreakers, have occurred. Twenty-seven of these carried passengers (Brigham and Ellis, 2004). Arctic marine transport in the Proposed Action area is likely to increase as indicated by the following: from 1977-2005 there have been 61 North Pole transits (17 in just the last year) and 7 trans-Arctic voyages (Brigham, 2005). Cargo transport in the Arctic (primarily outside the Chukchi and Beaufort seas area) is also expected to increase due to increased petroleum and mining activities and the need for future supplies for these industries (PAME, 2000).

Service vessels that support various requirements of offshore oil and gas activities are categorized into supply, crew, and utility vessels, each of which produce noise above and under water; discharges; and air emissions. Service-vessel trips usually are greatest during exploration, drilling, and construction phases and are greatly reduced during the production phase.

Vessel strikes and gear interactions with marine mammals, a biological resource category of concern in this PEA, in the Arctic Ocean is rare, in part because commercial fisheries and overall vessel traffic in the Alaska Beaufort Sea are very limited. The rate of interactions may have increased slightly in recent years (NMFS, 2003a).

III.C.3. Air Traffic. Underwater sounds from aircraft are transient, that is, passing quickly into and out of existence. The primary sources of aircraft noise are the engine(s) (either reciprocating or turbine) and rotating rotors or propellers. Sound levels from both helicopters and fixed-wing aircraft are at relatively low frequencies (usually below 500 Hz) and are dominated by harmonics associated with the rotating propellers and rotors (Smith, 1989; Hubbard, 1995). The duration of sound from a passing aircraft is variable, depending on the aircraft type, direction of travel, receiver depth, and altitude of the source (Green, 1985).

Aircraft are used in the Beaufort and Chukchi seas area for transporting supplies and personnel to local communities and industrial complexes (e.g., Deadhorse, Prudhoe Bay, and Red Dog Mine); conducting research (e.g., marine mammal and marine bird surveys); recreation and tourism; monitoring weather and oceanographic conditions; and military exercises and surveillance. Much of this air traffic occurs over land.

In 2006, MMS will continue its annual Bowhead Whale Aerial Survey Program (BWASP), which usually begins September 1 and ends October 20. All surveys would be conducted at an elevation between 1,000 and 1,500 feet (ft). Other marine mammal research-related aerial surveys are likely to occur in the Arctic Ocean in 2006, and possibly at elevations lower than 1,000 ft.

Hovercraft and helicopter support has largely replaced crew boat traffic to the Northstar Island oil production facility during the open-water season.

The Proposed Action is expected to generate some aircraft traffic, as helicopters may be used to transport personnel and supplies to and from the seismic survey vessels.

III.C.4. Oil and Gas Development in Federal and State Waters.

III.C.4.a. Federal OCS Activities. The following summary of OCS-related oil and gas activities contains information obtained from MMS' Liberty Development and Production Plan EIS (USDOI, MMS, 2002) and Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a).

There have been no lease sales and virtually no petroleum exploration in the Chukchi Sea since 1991. Two lease sales were held on different parts of the Chukchi OCS in 1988 and 1991, but only a small fraction of the tracts were leased by industry (483 leases, or approximately 5% of the tracts offered). The northeast portion of the current Chukchi Planning Area was part of the Beaufort Planning Area until 1995 and was offered for lease in several Beaufort sales. Five exploration wells drilled in 1989-1991 tested five large prospects, none of which resulted in commercial-size discoveries. There have been no active leases in the Chukchi Sea since 1998.

In February 2005, the MMS issued a Call for Information to the oil and gas industry and found that there was renewed interest in leasing blocks in the Chukchi Sea. Based on this show of interest, MMS issued a Notice of Intent in September 2005 indicating that MMS planned to prepare an EIS and proposed to hold Lease Sale 193 in the Chukchi Sea. The lease sale is scheduled to occur in late 2007 or later, pending decisions in the 2007-2012 5-Year OCS Leasing Program.

The seven Beaufort Sea lease sales that occurred between 1979 and 1998 resulted in 686 issued leases. During 20 years in the Beaufort Sea, the oil and gas industry has drilled 30 exploration wells, and 10 leases have been determined capable of producing. Of the 686 original leases, 592 have been relinquished or have expired. As a result of Beaufort Sea Sales 186 and 195 under the current 5-year program, a total of 151 leases were awarded. As of January 2006, there are 181 active leases in the Beaufort Sea Planning Area. In 2006, Shell Offshore Inc. submitted an Exploration Plan to MMS for further exploration of Shell leases in the Beaufort Sea. Shell's operations would evaluate the oil and gas potential of the Siv Ullig Prospect (drilling two wells) and Olympia Prospect (drilling two wells). The Siv Ullig Prospect was named previously the Hammerhead Prospect, and was explored initially during 1985 and 1986. Shell proposes to use two drilling vessels with each vessel drilling two wells between July and early November, depending on the ice conditions. Two ice breakers will support the drill ships.

Geological and geophysical information obtained from exploratory seismic surveys in 2006 was acquired by the oil and gas industry so that they could effectively participate in MMS-proposed Chukchi Sea Lease Sale 193 and Beaufort Sea Lease Sale 202, which are part of MMS' current 5-year program that expires in July 2007. As required by the OCS Lands Act, MMS has prepared a draft proposed 5-year program (2007-2012) to succeed the current program, and it is currently under public review. The new 5-year program proposes to conduct lease sales in the Chukchi Sea in 2010 (Sale 211) and 2012 (Sale 221) and in the Beaufort Sea in 2009 (Sale 208) and 2011 (Sale 216). In those leased blocks proposed for exploration drilling or development and production, geological site surveys and shallow hazard surveys would be required. Table III.C.1 lists the anticipated lease sales in both State and Federal OCS waters.

III.C.4.b. State of Alaska Activities. The following summary of State of Alaska activities contains information obtained from MMS' Liberty Development and Production Plan EIS (USDOI, MMS, 2002) and the Bureau of Land Management's (BLM's) Northeast NPR-A final Amended Integrated Activity

Plan/EIS (USDOI, BLM, 2005). Since 1959, the State has held 32 oil and gas lease sales involving the North Slope and Beaufort Sea, resulting in more than 4.6 million acres being leased. About 78% of the leased areas are onshore, and about 22% are offshore. Of the leased tracts, about 10% actually have been drilled, and about 5% have been developed commercially. From the early 1960's through 1997, 401 exploration wells were drilled in State onshore and offshore areas. Fifty-three of the exploration wells have resulted in discoveries. From 1990 through 1998, the number of exploration wells drilled annually has averaged about 10 per year.

The State develops and approves an oil and gas leasing plan for a 10-year period. The State reassesses the plan, and publishes a schedule every other year. Except for the Northstar development, all of the North Slope and Beaufort Sea's commercially producible crude oil is on 931 active State leases (as of December 2000). The State held a Beaufort Sea lease sale on March 1, 2006, and drew 76 bids for 62 tracts, covering 231,680 acres.

III.C.5. Miscellaneous Activities and Factors.

Miscellaneous activities possibly contributing to the cumulative effects on the PEA's resources of concern include subsistence-harvest activities, military activities, industrial and community development, and climate changes.

III.C.5.a. Subsistence-harvest Activities. The Inupiat people's entire history, culture, and identity have revolved around their subsistence-harvest activities lifestyle, and only within the last 60 years have semi-nomadic Inupiat settled into sedentary villages and been subjected to managed hunts (USDOI, BLM, 2005). The collapse of the whaling industry in 1910 coincided with a depletion in the number of whales available for harvest, making the ongoing subsistence harvest difficult for the Inupiat remaining along the Arctic coast. The U.S. Department of Defense (USDOD) construction on the North Slope and oil exploration resulted in additive impacts on subsistence resources, harvest patterns, and users. The most intense oil and gas development activity, and increased impacts to subsistence activities, occurred during the 1970's and early 1980's with the development of the Prudhoe and Kuparuk oil fields and the construction of the Trans-Alaska Pipeline System (TAPS) and haul road. Subsistence is part of the rural economic system of the North Slope, called a "mixed subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods (USDOI, BLM, 2005).

III.C.5.b. Military Activities. Unlike in other OCS areas of the United States, the surface and airspace of the Beaufort and Chukchi seas are not used extensively by the military for testing, evaluating, training, and qualification of aircraft, vessels, weapon systems, and personnel. On occasion, military vessels may transit through the area, and military personnel may conduct winter survival exercises. No military vessels or aircraft are home ported or stationed in the Beaufort and Chukchi seas. None of the airspace over the Chukchi and Beaufort seas is reserved by the Federal Aviation Administration as "special use airspace" for the military.

Past military activities were primarily associated with operations of the Defensive Early Warning system (DEW-Line), which was an integrated chain of radar and communications sites stretching across Alaska, Northern Canada and Greenland. The DEW-Line was initiated in 1954 and, of the 22 sites built in Alaska, 14 were located along the coast of the North Slope. The Dew-Line program was discontinued in 1963 and replaced with long- and short-range radar. Some stations are still manned, but most were abandoned in the 1990's. The USDOD's Formerly Used Defense Sites program is in the process of dismantling the abandoned sites and cleaning up any associated contaminated soil.

III.C.5.c. Industrial Development. The terrestrial environment adjacent to the Beaufort Sea has experienced most of the industrial development on the North Slope. Oil and gas exploration and production activities have occurred on the North Slope since the early 1900's, and production has occurred for more than 50 years. Associated industrial development has included the creation of an industry-support community airfield at Deadhorse and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks (Figure III.C-6).

Since the discovery and development of the Prudhoe Bay and Kuparuk oil field, more recent fields generally have been developed not in the nearshore environment, but on land in areas adjacent to existing producing areas. Notable exceptions to this are the Northstar, Endicott, and Badami fields. Pioneer Natural Resources Co. is beginning the development of its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit. In the 2006 winter construction season, Pioneer built an ice road over which they hauled gravel for the installation of an offshore gravel drilling and production facility. In addition, some open-water activities in 2006 involved placing armor (gravel bags) on the side slopes of the gravel island to protect it from erosion. A subsea flowline and flowline facilities will be installed during 2007 to carry produced liquids to existing onshore processing facilities at the Kuparuk River unit. Ongoing oil-development projects such as Badami and Alpine do not have permanent gravel roads connecting to Prudhoe Bay. Transportation would occur via aircraft and marine vessels in ice-free conditions. In winter, temporary ice roads are used.

The Northstar facility was just issued a Letter of Authorization under the Marine Mammal Protection Act (MMPA) (71 *Federal Register* [*FR*] 11314) from the NMFS to cover Level A and Level B taking of bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals, incidental to operation of the facility. This includes potential effects from presence of personnel, structures, and equipment; oil spills; on-ice construction or transportation; vessel and helicopter activity; and acoustic impacts from power generation and oil production; but it excludes seismic-survey operations.

Transportation to and from Northstar Island during the ice-covered season is primarily by hovercraft, tracked vehicles, and standard tired vehicles. In 2004, helicopters made approximately 250 round trips during the broken-ice periods and approximately 190 trips to Northstar during the open-water period (LGL, 2005). A small hovercraft made approximately 140 roundtrips during the broken ice period and approximately 300 round trips during the open water season (LGL, 2005). Barges made 24 round-trips to and from the island during the period July 29 to October 3, 2004, and a fuel transfer was made in August 2004 (LGL, 2005).

Anadarko Petroleum has announced that they intend to conduct 3D seismic surveys in the Brooks Range Foothills in 2007. FEX plans to drill more exploratory wells in the winter of 2007 in the remote northwest section of the National Petroleum Reserve-Alaska. Eni plans to drill two or three exploratory wells on the Rock Flour prospect near the Kuparuk oil field. AVCG/Brooks Range Petroleum Corp. plans to drill its first two exploratory wells in 2007 on its Gwydyr Bay holdings on the North Slope. Pioneer Natural Resources Co. is pushing ahead on construction of its island-based Oooguruk oil field. The project involves drilling 38 wells on a small gravel island six miles offshore in the Beaufort Sea. Conoco plans five exploratory wells on sites including the Intrepid prospect inside the NPR-A south of Barrow. Conoco drilled seven exploratory wells in the winter of 2006. ConocoPhillips and its partner, Anadarko Petroleum Corp., launched a new satellite oil field, Nanuq, in November 2006. Oil from Nanuq will be pumped to the much larger Alpine oil field in the Colville River delta. Another Alpine satellite, named Fiord, opened in August.

On the Chukchi Sea west of the North Slope major industrial complex and outside the southern boundary of the proposed action area, the major industrial developments have been and continue to be associated with Red Dog Mine and Delong Mountain Terminal (DMT). These facilities are included in the cumulative activities scenario, because their activities have the potential to affect the Programmatic Environmental Assessment's (PEA's) biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the Proposed Action area.

Red Dog mine is the world's largest producer of zinc concentrate, and mining operations have reserves for 40-plus years. The DMT receives ore concentrate from the Red Dog Mine and stores it until the Chukchi Sea is ice free in the area. About 250 barge trips per year are needed to transfer 1.5 million tons of concentrate a year to bulk cargo ships, which are anchored 6 mi offshore due to the shallow depths at the terminal. About 27 cargo ships are loaded each year. The U.S. Army Corps of Engineers is in the process of evaluating the feasibility of expanding the DMT port, so that deep-draft cargo ships can access the terminal directly instead of having to be loaded 6 mi offshore. Other development projects involving the Red Dog Mine facility being proposed in the foreseeable future include building a road to connect Noatak airport to the Red Dog Mine and developing the Deadfall Syncline Coal Mine near Point Lay, which would require the construction of a 90-mi-long road to the DMT.

III.C.5.d. Community Development. The following seven Alaskan Native communities located on the North Slope and vicinity, and their associated growth and development, are considered part of the cumulative scenario: Kaktovik, Barrow, Nuiqsut, Atqasuk, Wainwright, Point Hope, and Point Lay. Most of these communities' populations are increasing annually, with Barrow having the largest population of approximately 4,400 people. These communities have been established or reestablished since 1900 and consist of dwellings and other private and commercial buildings, gravel roads, gravel airstrips/airports, and other structures. For a more detailed description of each community and the status of future capital improvement projects see the State of Alaska, Community Online Database web site: http://www.dced.state.ak.us/dca/commdb/CF_COMDB.htm

Nearshore development activities in some of the aforementioned communities, notably in Barrow and Kaktovik, include curtailing shoreline erosion. If this activity requires fill material to be placed in navigable waters of the United States, a Section 10/404 permit from the U.S. Army Corps of Engineers would be required. The MMS does not anticipate any community development projects occurring in the nearshore environment of the Beaufort and Chukchi seas.

III.C.5.e. Climate Change. Global and regional climates have changed throughout the Earth's history, but warming during the past several decades on the North Slope and vicinity has been unusually rapid (NRC, 2003). Changes associated with arctic warming complicate and confound the assessment and isolation of the effects of oil and gas activities on the North Slope and the Beaufort and Chukchi seas. If recent warming trends continue, their effects could accumulate to alter the extent and timing of sea ice; affect the composition, distribution, and abundance of marine and terrestrial plants and animals; affect permafrost; affect existing oil-field infrastructure; and affect coastal Alaskan Native subsistence cultures (NRC, 2003).

Ice cover in the Arctic Ocean has been shrinking by about 3% per decade over the past 20 years (Johannessen, Shalina, and Miles, 1999). However, recent studies found new patterns of cooling ocean currents and prevailing winds which suggest the Arctic may be reverting in some ways to normal conditions not seen since the 1970s (NOAA, 2006). The loss of sea ice would reduce necessary habitat for marine mammals and seabirds that use ice shelves and floes as platforms for feeding, resting, reproducing, and molting. The increases in the amount and duration of open water could make the Northwest Passage more available for ocean transport and improve opportunities for offshore oil and gas development and military naval operations (NRC, 2003). Accompanying increases of vessels movements are the increased risks of environmental effects caused by spills, noise, or collisions.

III.D. Preliminary Screening of Seismic-Survey Activities and Potential Impacts.

This preliminary screening focuses the more detailed environmental impact analysis on those resources most at risk for potential adverse impacts from seismic survey operations as described in earlier sections of the PEIS.

Relevant literature (NRC, 2003, 2005); previous environmental documents (USDOI, MMS, 2002, 2003a, 2004; USDOI, BLM and MMS, 1998; USDOI, BLM, 2005); professional judgment; and traditional knowledge about marine seismic-survey operations and the biological resources of the Beaufort and Chukchi seas were used to initially identify the following resources and activities for impact analysis:

- Air Quality
- Archaeological Resources
- Marine Invertebrates
- Coastal Wetlands
- Coastal and Marine Birds
- Essential Fish Habitat
- Marine Fish
- Freshwater Fish
- Commercial Fisheries
- Geology and Sediments
- Marine Mammals
- Sociocultural Resources
- Subsistence Activities
- Terrestrial Mammals
- Water Quality
- Aquatic Invasive Species

In this preliminary analysis, a matrix was prepared listing the categories of seismic-survey impact agents and the above list of resource categories of concern (Table III.D-1). The "level of impact" associated with each interaction was ascertained as either: (1) potentially adverse; (2) likely negligible; (3) not likely; or (4) not applicable. Those resources having any potential to be adversely impacted by any impact agent are environmentally analyzed in more detail in Sections III.F (Biological Resources), III.G (Community Setting), and III.H (Cumulative Impacts Analysis). In addition, Section IV (Summary of Findings, Mitigation Measures, and Recommendations) addresses what actions should be taken to ensure that seismic surveys in 2006 operate in an environmentally sound manner, do not cause significant impacts, and do not interfere with subsistence-harvest activities of the Inupiat community.

III.D.1. Resources Not Considered Further.

The preliminary screening indicates that airgun noises have the greatest potential to cause adverse impacts. Vessel and aircraft traffic, vessel noise and lights, and seafloor disturbances associated with seismic surveys might also have associated potential adverse impacts.

The following resources were determined to be negligibly or not impacted by the Proposed Action, and are not considered further beyond the analysis provided in their respective sections.

III.D.1.a. Air Quality. Air emissions from seismic operations arise primarily from the main engines and generators of the seismic and support vessel. A typical seismic vessel has up to 8,000 kilowatts (kW) of engine propulsion power, consuming 20-30,000 liters (L) of fuel per day (WesternGeco, 2005). In addition to the seismic vessel, operations in the Chukchi and Beaufort seas will require an additional support vessel to serve as a resupply, fueling, and chase vessel, which also would be capable of assisting with ice management, if needed. The support vessel would contribute up to 6,000 kW of additional engine propulsion power to the mix of engines in a typical seismic operation. Table III.D-2 lists the potential to emit (PTE) for a likely seismic operation in the Chukchi and Beaufort seas. It assumes an average seismic survey of approximately 5,556 km (3,252 mi) as described in recent IHA's. The PTE calculations represent a worst-case estimate of pollutants emitted by each seismic operation, based on emission factors and operating assumptions listed in Table III.D-3. It is likely that actual emissions would be significantly less than the PTE, because not all emission sources would be operating 100% of the time.

The significance criteria used in the impact analysis for air quality is whether emissions cause an increase in pollutants over an area of at least a few tens of square kilometers that exceeds half the increase permitted under the PSD criteria or the NAAQS for nitrogen dioxide, sulfur dioxide, or particulate matter <10 microns in diameter; or exceeds half the increase permitted under the NAAQS for carbon monoxide or ozone. Table III.D-4 lists the emission thresholds for PSD and NAAQS analysis.

To assess the significance of emissions from anticipated seismic operations in the Chukchi and Beaufort seas, we reviewed the analysis of potential air quality impacts for the proposed Liberty development and production facility (USDOI, MMS, 2002). Table III.D-5 lists the PTE for criteria pollutants for the Liberty project. Air quality modeling for Liberty shows that at distances greater than 1-2 km from the proposed facility, the highest predicted concentrations of criteria pollutants were less than half the maximum allowable increases under PSD regulations. The conclusion for the Liberty analysis was that the predicted increase in pollutant concentrations was below the significance threshold. Comparatively speaking, the PTE for seismic operations is appreciably less than the PTE calculated for the Liberty project, and pollutant concentrations are spread out over a significantly broader area. Accordingly, the predicted increase in pollutant concentrations for marine seismic work at distances greater than 1-2 km from the seismic vessel would be appreciably below the significance threshold.

Marine seismic operations would cause only a short-term, local increase in the concentration of criteria pollutants. Emissions would be within NAAQS. In addition, because emissions would be from mobile sources, they would be spread over a substantially larger area and are expected to be rapidly dispersed by prevailing offshore winds. The potential impacts to air quality from marine seismic work in the Chukchi and Beaufort seas are therefore considered negligible.

III.D.1.b. Coastal Wetlands. All marine seismic surveys that are part of the Proposed Action would occur in Federal waters and outside the boundaries of State of Alaska waters, which lie between the mean-high-tide-line and the 3-mi limit. Seismic surveys operating near the 3-mi limit would generate high-energy acoustic sounds that would spread towards shore. Because of ice scouring during breakup, no wetlands exist along the exposed Beaufort and Chukchi seas coastline. However, wetlands do occur landward of the Chukchi and Beaufort seas barrier islands in protected bays and lagoons. The small amount of anticipated petroleum spills (120 gallons per seismic survey operation: ~5 gallons [gal] per refueling operation; four refueling operations for each seismic survey operation; 6 seismic surveys in both the Chukchi and Beaufort seas) are not expected to adversely affect coastal wetlands and associated fish and wildlife resources. Overall, the Proposed Action’s seismic activities are not likely to have any adverse impacts on coastal wetlands and the fish and wildlife resources they support.

III.D.1.c. Freshwater Fishes. The Proposed Action scenario considers seismic surveys to be conducted on the OCS in Federal waters of the Chukchi and Beaufort seas; it does not include seismic surveys being conducted in freshwater environments of the North Slope. While seismic surveys using airguns operating in Federal waters may ensonify nearshore waters, airguns would not be expected to ensonify lacustrine (e.g., lakes) or fluvial (e.g., rivers) habitats used by freshwater fishes. Freshwater fishes are not likely to be exposed to airgun emissions, wastewater discharges, and accidental spills from vessels, and are not considered further. Anadromous and/or amphidromous fishes (which inhabit both marine and freshwater) might be exposed to airgun emissions, and are considered further.

III.D.1.d. Geology and Sediments. Bottom sampling and shallow coring, which are typical G&G activities that can disturb, resuspend, and create minor surficial features, are not part of the Proposed Action. Conducting ocean bottom cable seismic surveys does require placing instruments (hydrophones) on the seafloor and later retrieving them. Normally, this activity does not alter the local geology or surficial sediment features of the ocean bottom. However, during storm events some cables could become partially buried when bottom sediments are shifted around. Retrieving cables under these circumstances likely would cause negligible, short-term impacts (such as localized turbidity) as the cables are pulled out of the seafloor sediment and hauled back on board a vessel.

III.D.1.e. Terrestrial Mammals. Terrestrial mammals would not be impacted by the acoustic energy generated by airguns. Offshore vessel movements, lights, and sounds may alert terrestrial mammals of human presence and cause wildlife to flee an area or, in some cases, cause wildlife to be curious about the offshore activity and linger. Survey-related aircraft also may startle wildlife and cause them to flee an area. The small amount of anticipated petroleum spills (~120 gallons in both the Chukchi and Beaufort seas) are not expected to adversely affect terrestrial mammals. Overall, the Proposed Action's seismic activities are not likely to have any adverse impacts on terrestrial mammals.

III.D.1.f. Water Quality. Marine water quality could be affected by accidentally spilled lubricating oil or diesel fuel from vessels and equipment associated with seismic survey operations. The MMS believes that the risk of vessel collisions is low, and the incidents involving the release of oil and fuel from vessels during refueling will likely be small, on the order of ~120 gallons in both the Chukchi and Beaufort seas. Vessel-damaging collisions with ice are not likely to occur, because seismic surveys will be conducted in relatively ice-free conditions. Vessels colliding with each other or equipment-entanglement problems also are not likely to occur because vessels maintain a minimum separation of at least 15 mi so that their electronic equipment doesn't interfere with each other.

We assume that there would be no unauthorized discharges, such as engine oil, etc., from the seismic vessel. Therefore, any effects would be due to accidental discharges, such as a spill of fuel oil during a fuel transfer from a support vessel to a seismic vessel. The analysis further assumes that the operators would be cautious and vigilant during fuel transfers; for example, if a fuel hose broke, the fuel valves would be shut off quickly.

A previous assessment of Chukchi Sea exploration included the effects of seismic exploration and of small spills (USDOI, MMS, 1990a). The assessment distinguished the effects during the open-water and ice-covered seasons; the Proposed Action seismic surveying would be conducted during the open-water season. The 1990 assessment explains that a 1,000-barrel (bbl) spill in restricted waters during flat calm might exceed the applicable ambient-water-quality standards. The assessment does not include a conclusion specifically about the effect of a spill of a few barrels or a few gallons. The effects of the latter in offshore waters during normal conditions probably would not exceed the standards and might be unmeasurable. The Beaufort Sea multiple-sale EIS also assessed the effects of a 1,000-bbl spill, concluding that the effects would be low regionally, but moderate locally (USDOI, MMS, 2003a). The effect of spills of a few barrels or a few gallons is not assessed. Again, the effects of the latter probably would be unmeasurable.

III.D.1.g. Aquatic Invasive Species. The introduction of aquatic invasive species (AIS) into a marine ecosystem potentially could result in adverse impacts. Such introductions occur when species establish self-sustaining populations beyond their historical geographic ranges. On February 13, 2003, the International Maritime Organization agreed to the International Convention for the Control of Ship's Ballast Water & Sediments. The Convention will enter into force 12 months after the date on which at least 30 nations, representing more than 35% of the World Merchant Shipping tonnage, ratify it. Nations that are party to the Convention are given the right to implement additional, more stringent measures than are provided in the Convention. The Convention's ballast-water-management regulations would apply to both port nations and flag nations that ratify the Convention. Under the Convention, all new and existing vessels with ballast tanks are required to implement a ballast-water-management plan when entering a nation's waters from outside its exclusive economic Zone (EEZ). The Convention specifies both an interim ballast-water-exchange standard (efficiency of 95% volumetric exchange) and ballast-water-performance standards (reduce the concentration of viable organisms per unit volume discharges). The Convention provides for a phasing-in period through 2016 for new and existing vessels to meet requirements.

The U.S. Coast Guard developed regulations (33 CFR 151) that implements provisions of the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) (16 U.S.C. 4701-4751) as amended by the National Invasive Species Act of 1996 (NISA). The NISA reauthorized the Great Lakes ballast-management program and expanded NANPCA's applicability to vessels with ballast tanks (as opposed to vessels that carry ballast water). The NISA required the development of national guidelines to prevent the introduction and spread of nonindigenous species into U.S. waters via ballast water of commercial vessels. Under NISA, the Coast Guard may approve alternative ballast-water-management technologies that are at least as effective as ballast water exchange in preventing invasions. This began the Shipboard Technology Evaluation program a voluntary, experimental, 5-year research and development program to bring about a 98% reduction in the number of live organisms found in ballast water. As required under NEPA, the U.S. Coast Guard prepared a Programmatic Environmental Assessment for Ballast Water Management Program for U.S. Waters (http://dmses.dot.gov/docimages/pdf87/250004_web.pdf) that was published in June 2003. The purpose of that environmental assessment was to revise 33 CFR 151 as required by NISA.

In June 2004, the Coast Guard made mandatory the voluntary measures to comply with NISA, with the primary means of prevention being exchange of ballast water on the high seas. The regulations mandate a ballast water management program and reporting requirements. The rule specifically addresses all vessels equipped with ballast tanks bound for ports or places within the U.S. and/or entering U.S. waters. At this time, midocean ballast-water exchange is the most practicable method to help prevent the introduction of invasive species into U.S. waters. There is no international consensus on a water-depth criterion for ballast-water exchange. The Coast Guard considers that any ballast-water-management plan that meets International Maritime Organization guidelines meets the regulatory requirements of 151.2035. Vessels that conduct coastwise trade (within the 200-mi EEZ) are not addressed in the final 2004 regulations because they cannot conduct a mid-ocean ballast water exchange. The Coast Guard is examining the possibility of establishing alternative ballast water-exchange zones. The coastwise trade vessels are still required to submit ballast-water reporting forms.

Potential vectors for introducing aquatic invasive species (AIS) are ballast-water discharge, hull fouling, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, OBC). Seismic survey vessels for the Proposed Action may be brought in from other U.S. or foreign waters. Vessels brought into State of Alaska or Federal waters would be subject to current Coast Guard regulations at 33 CFR 151, which are intended to reduce the transfer of invasive species. Section 151.2035 (a)(6) requires the "removal of fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations."

More than 180 marine seismic surveys have been performed in Arctic OCS waters under G&G permits since 1968, and more than 40 marine seismic surveying operations have been permitted and completed in adjacent State waters (see Sec. III.C.1.a and b). To date, no AIS studies have been conducted nor have any AIS been documented in the Alaskan Chukchi or Beaufort seas. The Chukchi and Beaufort seas pose harsh and frigid environmental conditions that are believed to impose major and difficult challenges to AIS's that might be introduced into the region's waters by vessels or equipment. Therefore, the likelihood of AIS successfully being introduced into the Arctic Ocean from the Proposed Action is considered to be low, and this issue is not considered further in this PEA. Climate change, however, may facilitate the introduction of aquatic invasive species from vessels transiting into the Arctic Ocean from outside the area.

III.D.2. Resources to be Evaluated in Greater Detail. The preliminary screening indicates that marine seismic surveys might adversely impact archaeological sites, marine invertebrates, coastal and marine birds, essential fish habitat, marine fish, commercial fisheries, marine mammals, the sociocultural environment, and subsistence-harvest activities. Therefore, the remaining sections of this PEIS focus on the analysis of the following resources categories: (1) Fish /Fishery Resources; (2) Marine Birds; (3) Threatened and Endangered Marine Mammals; (4) Other Marine Mammals; (5) Subsistence-Harvest Patterns; (6) Sociocultural Systems; (7) Environmental Justice; and (8) Archaeological Resources.

III.E. Significant Impact Criteria.

The Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) regulations (40 CFR 1500-1508) defines the term "significantly" in terms of both context and intensity (40 CFR 1508.27). "Context" considers the setting of the Proposed Action, what the affected resource might be, and whether the effect on this resource would be local or more regional in extent. Factors to be considered in evaluating "intensity" include: (1) the severity of the impact; (2) whether the impact is beneficial or adverse; (3) the degree to which the Proposed Action affects public health and safety; (4) the unique characteristics of the affected area; (5) the degree of controversy; (6) uncertainty; (7) establishing precedence; (8) the cumulative, direct, and indirect aspects of the impact; (9) the affects upon endangered or threatened species; and (10) whether Federal, State, or local laws may be violated.

Our analyses address the significance of the Proposed Action's potential impacts on the biological and cultural resources, considering such factors as the nature of the impact (e.g., habitat disturbance or mortality); the spatial extent (local and regional); temporal and recovery times (years, generations); and the effects of mitigation and any associated mitigation monitoring plan. Impacts to some environmental resources may be measurable, but are considered insignificant, because their potential effects and contribution to cumulative effects (additive, synergistic and countervailing) would be minimal and/or short term. Our analyses also consider whether proposed mitigation measures can reduce or eliminate all or part of the potential adverse effects. Mitigation measures that reduce adverse impacts to below "significance thresholds" are incorporated into the alternatives.

III.E.1. Significance Thresholds for Resource Categories. For this document, we have defined a "significance threshold" for each Arctic Ocean resource category as the level of effect that equals or exceeds the adverse changes indicated:

- **Threatened and Endangered Species of Whales (Bowhead, humpback, and fin whales):** An adverse impact that could affect the survival and reproduction of twelve or more whales (of an affected species and/or stock) annually. See Section III.E.2 for a detailed explanation of this significance threshold.
- **Threatened and Endangered Species of Birds (spectacled and Steller's eiders)**: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.
- **Biological Resources (seals, walrus, beluga whale, gray whale, polar bear, marine and coastal birds, lower trophic-level organisms, and fish/fishery resource and essential fish habitat [EFH]):** An adverse impact that results in an abundance decline and/or change in distribution requiring three or more generations (or having an impact lasting 10 or more years) for the indicated population to recover to its former status, and one or more generations for "rare" fish resources (see section III.F.1 – Fish/Fishery Resources and EFH for a discussion about "rare" fish resources) and their EFH, and polar bears.
- **Subsistence-Harvest Patterns:** One or more important subsistence resources would become unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years.
- **Sociocultural Systems:** Chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns.
- **Archaeological Resources:** An effect-producing factor produces a loss of unique archaeological information.
- **Environmental Justice:** The significance threshold for Environmental Justice would be disproportionate, high adverse human health or environmental effects on minority or low-income populations. This threshold would be reached if one or more important subsistence resource becomes unavailable, undesirable for use, or available only in greatly reduced numbers for a period of 1-2 years; or chronic disruption of sociocultural systems occurs for a period of 2-5 years, with a tendency toward the displacement of existing social patterns. Tainting of subsistence foods from oil spills and contamination of subsistence foods from pollutants would contribute to potential adverse human-health effects.

III.E.2. Criteria for the Evaluation of the Potential for Significant Effects on Endangered Whales. In determining the potential significance of the Proposed Action to bowhead whales and other endangered whales, we considered the following NEPA-relevant factors: unique characteristics of the geographic area; degree of controversy; degree of highly uncertain effects or unique or unknown risks; precedent-setting effects; cumulative effects; adverse effects on scientific resources (we evaluate cultural effects in other portions of this document); and violations of Federal, State, or local environmental law. We based our conclusions also on consideration of 1) NMFS 2005 potential biological removal estimates and determination of removal level (PBR) that would be "significant" to the population (Angliss and Outlaw, 2005), and 2) NRC Guidance on Determining when Noise Causes Biologically Significant Effects (NRC, 2005:3).

1) NMFS 2005 potential biological removal estimates and determination of removal level that would be "significant" to the population (Angliss and Outlaw, 2005). Under the MMPA, the term "potential biological removal level" means the maximum number of animals, excluding natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (OSP). The PBR level is the product of the following factors: (A) The minimum population estimate of the stock; (B) One-half the maximum theoretical or estimated net productivity rate of the stock at a small population size; and (C) A recovery factor of between 0.1 and 1.0.

In the most recent stock assessment for the western Arctic or Bering-Chukchi-Beaufort seas stock of bowhead whales, NMFS (Angliss and Outlaw, 2005) stated that:

> Under the 1994 reauthorized Marine Mammal Protection Act (MMPA), the potential biological removal (PBR) level is defined as the product of the minimum population estimate, one-half the maximum theoretical net productivity rate, and a recovery factor: PBR = N_{MIN} x $0.5R_{MAX}$ x FR. The recovery factor (FR) for this stock is 0.5 rather than the default value of 0.1 for endangered species because population levels are increasing in the presence of a known take (see guidelines Wade and Angliss 1997). Thus, PBR = 95 animals (9,472 x 0.02 x 0.5) The development of a PBR level for the Western Arctic bowhead stock is required by the MMPA even though the subsistence harvest is managed under the authority of the International Whaling Commission (IWC). Accordingly, the IWC bowhead whale quota takes precedence over the PBR estimate for the purpose of managing the Alaska Native subsistence harvest from this stock. For 2002-07, a block quota of 280 bowhead strikes will be allowed, of which 67 (plus up to 15 unharvested in the previous year) could be taken each year. This quota includes an allowance of 5 animals to be taken by Chukotka Natives in Russia.

For the purposes of this analysis, we assume that each year Alaska Native and Russian Native hunters will take the maximum number of whales allowed in their annual quota from the population. In addition, we assume that no more than one animal will be removed annually incidental to commercial fisheries operations based on NMFS' estimation within its 2005 stock assessment report (Angliss and Outlaw, 2005). Thus, the remaining number of whales that may be taken from the population while maintaining OSP would then be equal to: PBR - subsistence quota – commercial fishery interactions. The resulting number is then where we set the significance criteria for the purposes of this analysis. For example, in 2006 there was a PBR of 95 animals, a subsistence quota of 82 whales, and no more than one mortality predicted through interactions with commercial fisheries. This left 12 animals (95-82-1) that theoretically could be removed from the population while allowing that stock to reach or maintain its OSP. This assumption of take by subsistence hunters is the maximum that could be taken, but exceeds the average number of whales taken in recent years.

Thus, based on the aforementioned logic, and based on the assumption that the loss of animals from the population from any source other than subsistence take is of equal "significance" we assume that removing more than the resultant number (PBR – subsistence quota – commercial fishery mortalities) of animals annually from this population stock would be significant.

Further, NMFS can only grant an MMPA authorization if takings would result in no more than a neglible impact to the stock. Each year during the MMPA authorization process associated with the Proposed Action, NMFS will need to review the stock assessment reports (which identify PBR and anthropogenic mortality estimates) and the IWC set subsistence quotas in order to determine the maximum number of animals that can be removed from the population while maintaining its OSP. Exceeding this number would then result in significance and preclude the negligible determination under the MMPA (and thus denial of the application(s)). Therefore, applications will only be approved where takings will be negligible and would cumulatively not result in exceeding PBR or affecting the stock at its OSP.

NMFS and MMS do not expect the Proposed Action to result in serious injury or death of bowhead whales. However, Level B harassment (behavioral disturbance) may occur and if biologically significant (see discussion below), could potentially remove animals from the stock by limiting reproductive potential or recruiting success, impeding important mother/calf bonding, etc. Therefore, significance could be reached if these behavioral disturbances resulted in the effective loss of animals to move the stock below its OSP. However, NMFS and MMS consider the levels of significance set within this PEIS to be conservative and protective so as to help ensure that significance is not reached.

2) NRC Guidance on Determining when Noise Causes Biologically Significant Effects. The NRC (2005:3) reviewed and characterized "current scientific understanding of when animal behavior modifications induced by transient and non-transient ocean acoustic sources, individually or cumulatively, affect individuals in ways that have negative consequences for populations." Their charge was to "clarify the term *biologically significant*" (NRC, 2005:3). The NRC (2005:3-4) summarized that

> An action or activity becomes biologically significant to an individual animal when it affects the ability of the animal to grow, survive, and reproduce. Those are the effects on individuals that can have population-level consequences and affect the viability of the species. However, those effects are separated in time and usually in space from the precipitating event. What can be observed, with difficulty…, are the direct behavioral and in some cases physiological responses of individual animals…On reflection, it became clear that wild animals rarely engage in activities that are not biologically significant…so the primary concern should be with determining when human activity elicits behavioral or physiological responses in marine mammals that rise to the level of biological significance.
>
> Changes in behavior that lead to alterations in foraging efficiency, habitat abandonment, declines in reproduction, increases in infant mortality and so on are difficult to demonstrate in terrestrial animals…and more difficult to demonstrate in animals that may only rarely be observed….

The NRC (2005:x) further stated that "...today many important habitat threats involve habitat degradation and the cumulative effects of harassment."

The NRC (2005:9) encouraged precautionary management in instances when there is greater uncertainty about the potential population effects of behavioral changes resulting from noise exposure. They specifically (NRC, 2005:10) recommended that "mortality equivalents for injury and disruption need to be added to the biological removal…" in the PBR model "…to encompass the multitude of effects, including acoustic effects, of human activities on marine mammal populations." They recommended that NMFS "…expand the PBR model to include injury and behavioral disturbance with appropriate weighting factors for severity of injury or significance of behavioral response" (NRC, 2005:10).

In discussing the uncertainty around determining the biological significance of marine mammal responses to sound, the NRC (2005:xi) stated that:

> A basic tenet of responsible management and conservation is the need to balance the risks posed by overregulation and those posed by underregulation; the latter carry more weight in conditions of greater uncertainty...The depth of our uncertainty in these issues can make it difficult to calibrate the proper extent of precaution...For most other...[other than effects on beaked whales lethal strandings]…the primary source of uncertainty stems from our difficulty in determining the

effects of behavioral or physiological changes on an individual animal's ability to survive, grow, and reproduce.

III.F. Biological Resources

III.F.1 Fish/Fishery Resources and Essential Fish Habitat. This section focuses on coastal and marine fish/fishery resources and habitats occurring in nearshore and offshore waters of the Chukchi and Beaufort Seas. The proposed seismic-survey activity would be conducted in Federal waters offshore and, therefore, likely would not impact freshwater habitats. In addition, there are few commercial fisheries in the Alaskan Beaufort and Chukchi Seas and, therefore, there are few species covered by fishery-management plans in these waters. Presently, the five species of Pacific salmon occurring in Alaska are the only managed species with essential fish habitat (EFH) designated in the Alaskan Beaufort and Chukchi Seas. The Pacific salmon species and their EFH are described.

III.F.1.a. Lower Trophic-level Organisms. Information on lower trophic-level organisms in the northeastern Chukchi Sea was summarized extensively in the EIS's for two lease sales (USDOI, MMS, 1987, 1990). They include information on the pelagic community, epontic community, benthic communities, and also on trophic interactions. In addition, the information in two recent Beaufort Sea assessments (USDOI, MMS, 2003:Sec III.B.1; USDOI, MMS, 2004:Sec. IV.B.2.e(3)) is relevant to both the Beaufort and the Chukchi, because many of the organisms and habitats in the offshore Chukchi Sea are similar to those in the Beaufort Sea. Only a few of the lower trophic species are well known with the possible exception of kelp; these species can be important as prey. For example, plankton is consumed by fishes, birds, and the endangered bowhead whales; the epibenthic and benthic organisms are consumed by walruses, gray whales, and threatened spectacled eiders.

The Chukchi Sea and Beaufort Seas are both Large Marine Ecosystem (LME) with a subarctic and high arctic climates (Ray and Hayden, 1993). Both are characterized by a short, summer, open-water period of growth and then a long winter, ice-covered season. As a result, the net annual growth rates of organisms are slow, resulting in slow recovery to disruption or damage. Several ongoing, broad-scale changes have been observed in lower-trophic level resources, making the Chukchi Sea food web more like the ones in the Northern Bering Sea (Grebmeier and Dunton, 2000; Grebmeier et al., 2006; http://www.arctic.noaa.gov/aro/russian-american/2004_2005/GrebRUSALCA). For example, plankton blooms are now more prolonged, and the relative importance of the benthic activity has changed, as shown in part by changes in the distribution of benthic feeding gray whales. The authors conclude that reductions in the ice cover create the more prolonged plankton blooms, and that the plankton is grazed more efficiently by pelagic consumers such as fish, allowing less to settle to the benthos where it was consumed mainly by marine mammals and seabirds.

The following sections update the information for the northeastern Chukchi and Beaufort Seas. The update is separated into sections on (a) planktonic and epontic organisms, (b) benthic organisms, (c) coastal habitats, and (d) an overall summary.

III.F.1.a(1) Planktonic and Epontic Organisms. The Chukchi Lease Sale 126 EIS describes the distribution and production of phytoplankton in the eastern Chukchi Sea. It explains that water masses moving northward through the Bering Strait and into the Chukchi Sea transport not only nutrients and phytoplankton, but also zooplankton from the Bering Sea (USDOI, MMS, 1990:III-11 and Fig. III-B-1a).

There is extensive new information on the distribution of phytoplankton chlorophyll because of the availability of satellite chlorophyll data since 1997. The satellite sensors measure the distribution and concentration of chlorophyll, or the "greenness" of the surface water. Comsio (2005) reported high concentrations of phytoplankton chlorophyll (i.e., a bloom or biological "hot spot") in the southwestern Chukchi Sea near the Bering Strait and along the eastern Russian coast during August for the years 1998 through 2005 (Comiso, 2005). The influence of the rich Bering Sea water and a seasonal bloom near the retreating ice edge are noted by Wang, Cota, and Comiso (2004), who analyzed many similar images during a detailed study of phytoplankton variability in the Beaufort and Chukchi seas. Comiso (2005) reported high concentrations of chlorophyll around Point Hope and Cape Lisburne, and in Ledyard Bay. Moderate chlorophyll concentrations were reported in the northeastern Chukchi Sea along the northwestern

Alaskan coast. The concentration in the offshore waters of the sale area, including the new northern area, is relatively uniform and generally low, about one-fifth of the concentration along the coast.

A different distribution of chlorophyll is described by Dunton et al. (In press). They synthesized old measurements of chlorophyll, mainly from late-summer icebreaker cruises during the 1980's and 1990's for the MMS and NOAA OCS Environmental Assessment Program. They standardized the measurements and integrated them for the whole water column. The results indicate that high chlorophyll concentrations occurred in the water across the northern Chukchi Sea (Dunton et al., In press:Fig. 4). The results are possibly influenced by the location of ice-edge blooms during the late-summer icebreaker cruises in 1980's and 1990's. During the past 10 years, the late-summer ice edge has been located farther north (Comiso, 2005); the location of late summer ice-edge blooms presumably also would be located farther north. The area of high primary production illustrated by Dunton et al. might not be a permanent "hot spot" biologically within the proposed sale area.

Regarding epontic communities, their production is related primarily to under-ice light levels. Previous studies in offshore ice have shown that those levels are related to the thickness of the ice and snow cover. Chlorophyll a measurements under thick multi-year ice showed that the concentrations were about two orders of magnitude less than the concentration under first-year ice (Gradinger et al., 2005). A similar study by Gradinger and Bluhm (2005) examined the influence of sediment concentrations in first-year ice. They found that the spring ice bloom remained up to two orders of magnitude lower in sea ice with a high sediment load. The studies indicate that the epontic production under offshore pack ice which would be relatively thick but sediment-free, would be relatively high.

The ecological importance of epontic communities would be related partly to the persistence of their substrate—the ice cover. A study of the Chukchi Sea ice cover indicates that the summer melt season has increased slightly (Belchansky et al., 2002). They concluded that the mean annual melt duration increased 2-3 weeks since 1989 in the Chukchi Sea. The longer duration of the melt season, especially during the spring, might have changed slightly the ecological importance of the epontic community as opposed to the pelagic one. (Refer also to the study of epontic communities under offshore opaque pack ice in the Beaufort Sea [Gradinger et al., 2005]), which would indicate the abundance of epontic organisms under multiyear ice in the area of the proposed action.)

The MMS' significance criteria for assessments of species are based primarily on generation times, e.g., a significant effect is one that would affect three or more generations. Because of the criteria, information on generation times, lifespans, and doubling times are important. The doubling time for a phytoplankton population in the surface layer is very short, even in the Arctic. For example, phytoplankton intrinsic growth rates up to 0.4/day (i.e., doubling time of less than a few days) were measured by Sherr et al. during a recent Shelf Basin Interaction study at Point Barrow (http://bioloc.coas.oregonstate.edu/SherrLab/SBIresults.html). Further, the lag between a phytoplankton bloom and the retreating edge of the sea ice usually is only 2-3 weeks (Wang, Cota, and Comiso, 2004). In contrast to phytoplankton, most arctic zooplanktonic organisms reproduce once during the year (Gislason, 2003). For example, the copepod *Calanus finmarchicus* reproduces in May in the surface layers at the time of the spring bloom; therefore, the generation length of arctic zooplanktonic organisms is approximately 1 year.

III.F.1.a(2). Benthic Organisms. The benthos in the northeast Chukchi Sea contains components of both the Bering Sea and Beaufort Sea biota (USDOI, MMS, 1990:III-13, Table III-B-1, and Fig. III-B-1d). The area around the Burger Prospect is inhabited by the following group of species: the polychaete *Maldane*, the brittle star *Ophiura*, the sipunclid (peanut worm) *Golfingia*, and the bivalve *Astarte*. However, a recent study found that brittle stars were overwhelmingly dominant in some parts of the northeastern Chukchi Sea (Ambrose et al., 2001).

The distribution of the fauna is related partly to the sediment type. In offshore areas near the Burger Prospect, the sediment is muddy sand or gravelly mud (Naidu, 2005). The distribution of infauna and epifauna mollusks was related particularly to the percentage of sand and pebbles, respectively (Feder et al., 1994). They concluded also that the abundance and biomass of snails and other epifaunal mollusks around the Burger prospect to the south of Hanna Shoal is relatively low compared to the mollusks near the Alaskan coast (Fig. III.B-2). In contrast, amphipods are relatively abundant in areas with pebbly sand between Point Franklin and Wainwright (USDOI, MMS, 1990:Fig. III-B-1d). The sediment is muddy in Ledyard Bay, where eider ducks feed on epibenthic organisms like amphipods (Naidu, 2005); and along other parts of the coast it is muddy sand or gravelly muddy sand.

Sidescan-sonar surveys have detected feeding traces from gray whales in water over about 50 m deep with fine sand and mud, and traces of walruses feeding in other areas (USDOI, MMS, 1990:III-15 and Sec. III.B.1.c(3)). The seafloor marks, the sediment types, and the presence of soft-bodied benthic organisms, such as worms, indicate that the most of the surface sediment in the proposed sale area is unconsolidated.

The Beaufort Sea multiple-sale EIS explains that a special benthic community is the Boulder kelp community (USDOI, MMS, 2003a). It is located behind the barrier islands of Stefansson Sound (USDOI, MMS, 2002). Kelp also grows sparsely in West Camden Bay (USDOI, MMS, 1998). Kelp beds are likely to occur elsewhere in the western Beaufort Sea but have not been systematically surveyed, and other kelp beds may be discovered as more areas are explored. Similar kelp communities in the Chukchi Sea are located close to shore,.

Another type of benthic habitat and community might be located in portions of the Chukchi Sea A recent sidescan-sonar survey detected “pockmarks” on the seafloor in an area to the north of the proposed sale area (MacDonald et al., 2005; www.ccom-jhc.unh.edu/healy/img_20.htm). The pockmarks are much larger than animal-feeding traces; they are 250-1,000 m in width, with depths up to 50 m below the surrounding seabed, like small craters. Several dozen pockmarks were detected on the slope between 500 m and 950 m in depth. The sidescan-sonar survey was limited by ice; therefore, the geographical extent of the area of the pockmarks was not determined (Appendix A.1, Map A-1). MacDonald and others sampled the organisms in a Chukchi pockmark (MacDonald et al., 2005). They concluded that the abundance and diversity of benthos within the pockmark was unusually high, consisting of brittle stars, anemones, shrimps, gooseneck barnacles, mysids, and possibly a new species of benthic ctenophore.

Similar pockmarks have been observed and studied on the slope in the Gulf of Mexico (Kennicutt et al., 1985; McDonald, 2002; MacDonald et al., 2003). An MMS Gulf of Mexico study notes that some of the pockmarks are associated with methane seeps, forming “brine-filled pockmarks” (MacDonald, 2002:Exec. Summary, p. 14). The methane apparently provides a source of biological energy for chemosynthetic bacteria, and the bacteria support cold-seep communities of organisms that are similar to the special warm-seep communities around hot vents on the mid-ocean ridges.

The Chukchi Sea benthos generally is richer than that on other arctic shelves (Grebmeier and Dunton, 2002; Dunton et al., In press). The benthic faunal biomass is relatively high in northeastern Chukchi, compared to central and western Chukchi and compared to the rest of the arctic seas (Grebmeier and Dunton, 2000:Fig. 1). Grebmeier and Dunton (2000) explain that the richness probably is due partly to the inability of Chukchi fauna to consume all of the primary production, thereby allowing a lot of organic matter to sink to the seafloor. They refer to the situation as weak or loose trophic “coupling”, and the Arctic Climate Impact Assessment (ACIA) refers to such loose coupling as “mismatch” between trophic levels (ACIA, 2005:Sec. 9.3.2.2). The ongoing research by Grebmeier et al. on Russian-American Long-term Census of the Arctic (RUSALCA) cruises on both sides of the Chukchi Sea has detected areas with high benthic biomass, such as the southcentral portion, but no areas with special benthic communities. Regardless, because of the relatively large amount of organic matter that sinks to the seafloor in the Chukchi Sea, there are many areas which are important to benthic grazers such as ducks, walruses, and gray whales (Grebmeier and Dunton, 2000).

The concentration of heavy metals in the sediments and benthic organisms from the Chukchi and Beaufort Seas has been the subject of two recent studies. Naidu (2005) reviewed samples that were collected during the 1990’s after operation of the Red Dog Mine in the southeastern Chukchi Sea. He concluded that the trace-metal concentrations in the sediments there and from the northeastern Chukchi Sea were low, and that the environment was “pristine”. Stern and Macdonald (2005) determined the concentration of total and methyl mercury (HgT and CH_3Hg) in a common *Calanus* copepod and other organisms that were collected during the late 1990's. They concluded that the background concentrations of HgT were low in samples from the Chukchi Plateau, and that the concentrations in samples from the Canadian Basin were about twofold higher. They related the relatively high concentrations in the Canadian Basin to the input from land and spring melt. The concentrations in the Chukchi Sea are similar to those that have been observed in the Beaufort Sea (USDOI, MMS, 2003a:Sec. III.A.5.a(2)). An important aspect for the present assessment is that both sets of the above "pristine" Chukchi samples were collected after the discharge of drilling fluids during the exploratory drilling in 1989, 1990 and 1991.

The recovery time for benthic communities is indicated by a study of ice gouges (Conlan and Kvitek, 2005). They studied the recolonization of ice gouges in relatively shallow water (12-28 m) in the Canadian high Arctic. They found that new scours were recolonized quickly by some animals, such as polychaetes, but predicted that recolonization of the original community would require many years. Two ice scours that they studied for 8 or 9 years achieved only 65-84% recolonization of the original community within that time. The fastest recolonization rate (65% in 8 years) might be appropriate for the slightly deeper but warmer northeastern Chukchi Sea. The general recolonization rate that will be used for subsequent assessment of the persistence of pipeline-burial effects is about three-quarters of the community within a decade.

III.F.1.a(3). Coastal Habitats. The Chukchi Sea Lease Sale 126 EIS summarizes the information on habitats along the Alaskan coast (USDOI, MMS, 1990). Sea ice dominates the Chukchi Sea coastal habitats, as noted also for the Beaufort Sea coastal habitats (USDOI, MMS, 2003a:III-30) and for Arctic Ocean coastal habitats in general (Gutt, 2001). Due to the thick ice cover, the shallow benthos and coastline are highly disturbed during the winter and are, therefore, not inhabited year-round by large organisms.

The Sale 126 EIS describes the well-known kelp community in the center of Peard Bay (USDOI, MMS, 1990:III-13 and IV-C-14). Information on the kelp community is summarized also in the recent Programmatic EA (PEA) for 2006 seismic exploration (USDOI, MMS, 2006a). There is no new information on the kelp community, so the previous descriptions are incorporated by reference. The descriptions do not specify the areal extent of the kelp within the bay, but that EIS does explain (USDOI, MMS, 1990:III-15) that bivalves and polychaetes were dominant in the deeper, central section of Peard Bay. Therefore, the extent of the kelp bed in Peard Bay might be limited to just part of the bay.

The 126 EIS and PEA explain that there is kelp also along the coast near Skull Cliffs, about 20 km to the northeast of Peard Bay, and along the coast about 25 km southwest of Wainwright in water depths of 11-13 m. The EIS also explains that the spatial extent, which has not been examined closely, probably is limited by the presence of rock and other hard substrate. All three kelp communities are close to the coast; they are located outside of the proposed action area but within the area through which an oil pipeline might be constructed. We are aware of no new information on the distribution of kelp offshore, but there is additional information on the recovery of kelp after disturbance. Previous studies had shown that when kelp was removed experimentally from boulders in the Beaufort Sea, only 50% of the denuded area was re-colonized within 3 years. The study concluded that grazing by invertebrates might be a reason for the limited re-colonization. Recently, re-colonization rates were measured for kelp within cages that excluded invertebrates (Konar, 2005). However, even within the cages, there was no recruitment within 2 years, demonstrating again that kelp recovers very slowly from disturbance.

The general characteristics of the Chukchi coastline were determined for Sale 109, and those characteristics were incorporated in the Lease Sale 126 EIS. The characteristics included four basic categories, depending on the substrate and vegetation (USDOI, MMS, 1987:Fig. IV-13). During 2001, MMS contracted for a reexamination of the shoreline characteristics from Point Barrow to Point Hope (USDOI, MMS, 2003a). The new classification system distinguishes 10 basic categories and 5 subcategories and is consistent with the results of the previous system.

III.F.1.a(4). Summary. As a summary of the information above, lower trophic-level organisms were described very well in previous EIS's. The recent data on plankton and epontic organisms is consistent with the information in the Chukchi Sea Lease Sale 126 EIS and recent Beaufort Sea assessments. The recent data further indicates that production probably is high within the proposed project area during the early summer retreat of the ice edge and that during midsummer, the production generally is low and relatively uniform within the proposed sale area. The data also indicate that there is higher production near the Bering Strait and along the Russian Chukotka coast, around Point Hope and Cape Lisburne, and along the Alaskan coast, including Ledyard Bay. The length of the melt season is 2-3 weeks longer than it was in the late 1980's. The generation times of Chukchi phytoplanktonic and zooplanktonic organisms are a few days and a year, respectively.

The benthos in the Chukchi Sea is relatively rich. The richness and the presence of feeding marks on the seafloor from walruses and gray whales indicate that the benthos supports abundant consumers. The sediment is partly muddy sand or gravelly mud; i.e., an unconsolidated type of sediment. When the natural benthic community is disturbed by ice scour, only about two-thirds of the community probably would recolonize the gouge within 8 years. The background concentration of total mercury and methyl mercury is low in zooplankton from the Chukchi and Beaufort Seas , indicating that both are relatively pristine. Pockmarks have been observed on deep Chukchi slope; the pockmarks may be an indication of methane seeps and cold-seep communities of organisms. Dense kelp beds grow on a few areas in the Beaufort Sea., with the best know being the Boulder Patch which is located beyond the barrier islands of Stefansson Sound.

Nearshore habitats in the Chukchi Sea include kelp communities in Peard Bay, near Skull Cliffs about 20 km northeast of Peard Bay, and along the coast about 25 km to the southwest of Wainwright. The sensitive parts of the coastline include the lagoons.

III.F.1.b. Fish Resources. This section focuses on coastal and marine fish/fishery resources and habitats occurring in nearshore and offshore waters of the Beaufort and Chukchi Seas, because most impacts would occur in these areas, but freshwater habitats also are important. There are few species covered by fishery-management plans in these waters. The issue of aquatic invasive species is directly pertinent to the conservation and management of fishery resources. Presently, the five species of Pacific salmon occurring in Alaska are the only managed species with EFH designated in the Alaskan Chukchi Sea. Essential fish habitat is described in Section III.F.1.C.

III.F.1.b(1) Major Surveys of Coastal and Marine Fish Resources and Habitats. This section briefly reviews some important surveys conducted in these waters in the last century. Walters (1955) briefly summarized the history of arctic Alaska ichthyology to date. He wrote: "The ichthyofauna of western Arctic America has been studied the least of any major sector of the northern polar regions, and that of Arctic Alaska the least of any equally great area of North America" (Walters, 1955). Fifty years later, Walters' comment remains, for the most part, accurate.

The first major scientific collections of fishes in the Chukchi Sea were those made by the Russians A.P. Andriyashev, K.I. Panin, and P.V. Ushakov in 1932 and 1933 (Raymond, 1987). Andriyashev (1955; a translation of a report published in 1937) described basic information concerning fishes collected by Russian expeditions of the Bering and Chukchi Seas.

Frost and Lowry (1983) reported on thirty-five successful otter-trawl tows that were conducted in the northeastern Chukchi and western Beaufort seas in August-September of 1976 and 1977. In 1976, two tows were made in the western Beaufort Sea in water 40 m and 123 m deep. In 1977 (August 2-September 3), 33 tows were made in the northeastern Chukchi and western Beaufort seas in waters 40-400 m deep. Many were conducted near the southern edge of pack ice. Frost and Lowry (1983) caught 133 fishes belonging to 14 species in trawls made in 1976. In the more extensive trawls conducted in 1977, they caught 512 fishes belonging to 17 species. A total of 19 species or species groups of fishes were identified from the combined tows. Frost and Lowry's surveys are the latest surveys made of demersal marine fishes in the western Beaufort Sea.

Fechhelm et al. (1984) reported results of an ichthyological survey conducted in 1983 that focused primarily on arctic fish usage of and ecological dependence on marine estuarine environments along the northeastern Chukchi Sea coast from Peard Bay to Point Hope. Data were collected for the most part during the open-water, summer season and, to a lesser extent, in winter. Their survey revealed the most prominent species encountered during 1983 were arctic cod, arctic staghorn sculpin, fourhorn sculpin, capelin, shorthorn sculpin, hamecon, arctic flounder, and saffron cod. Fourhorn sculpin and arctic flounder occurred in nearshore waters (<1 km), while the remaining sculpins were found exclusively in deeper, offshore (>1 km) waters. Arctic and saffron cod were found to occupy both nearshore and offshore waters.

Barber, Smith, and Weingartner (1994) reported data obtained in the northeastern Chukchi Sea between Cape Lisburne in the south to the ice edge in the north between 1989 and 1992. These surveys (1989-1992) are the most recent fish surveys conducted within the proposed action area. Collectively, these surveys and associated studies reflect a sparse sampling of fish resources across the northeastern Chukchi Sea. Sampling effort has been spatially and temporally irregular and disjunct. Coastal waters of the western Beaufort Sea are better sampled than coastal waters of the northeastern Chukchi Sea.

A 3-year study (1988, 1990, and 1991) of epipelagic fishes inhabiting Beaufort Sea coastal waters in Alaska documented spatial and temporal patterns in fish distribution and abundance and examined their relationships to thermohaline features during summer (Jarvela and Thorsteinson, 1999). Significant interannual, seasonal, and geographical differences in surface water temperatures and salinities were observed. In 1990, sea ice was absent and marine conditions prevailed whereas in 1988 and 1991, heavy pack ice was present and the dissolution of brackish water along the coast proceeded more slowly. Arctic cod, capelin, and snailfishes were the most abundant marine fishes in catches, while arctic cisco was the only abundant diadromous species. The epipelagic fish survey is the most recent pelagic fish survey conducted in the western Beaufort Sea.

In summer 2004, a RUSALCA expedition was conducted in the Bering and Chukchi Seas (Mecklenburg et al., 2005). The primary study area lay between Wrangel Island and Herald Canyon in Russia Federation territorial waters to Cape Lisburne, Alaska to Point Barrow, Alaska and south to the Bering Strait. Fish biologists on the RUSALCA expedition noted the following qualitative conclusions: (1) the Chukchi benthic community is highly diverse and patchy; and (2) both fish abundance and diversity seem lower in the Chukchi Sea than in the Bering Sea. The largest catches occurred to the south, and were usually at least one order of magnitude higher than those in the north. Also, biologists noted several range extensions or rare species.

Surveys often have been directed at one fish assemblage (e.g., subadult and adult demersal fishes) and, consequently, did not sample for other fish assemblages (pelagic life stages and species). Information from many surveys was reported only for abundant species, and that information was not standardized. Surveys of coastal and marine fish resources in the Chukchi and Beaufort Seas are typically conducted during periods that ice cover is greatly reduced (late July, August, or September) and information concerning the distribution, abundance, habitat use, etc., of marine fishes outside this period is limited. Due to the lack of specific information for many species, it is necessary to discuss the biology and ecology at the family level. Generalized life-history strategies of the families with fish species known to be occurring in the region (see USDOI, MMS, 2006:Appendix B). Most of this information was taken from Mecklenburg, Mecklenburg, and Thorsteinson (2002).

Despite these previous works, several data deficiencies remain. Information of current distribution and abundance (e.g., fish per square kilometer) estimates, age structure, population trends, or habitat use areas are not available for fish populations in the northeastern Chukchi Sea. Many fish studies reporting distribution and/or abundance are 20-30 years old. Other studies are still older. For example, the only survey of demersal fishes in the region is more than 20 years old. Fish assemblages and populations in other marine ecosystems of Alaska (e.g., Gulf of Alaska, Bering Sea) have undergone observable shifts in diversity, distribution, and abundance during the last 20-30 years; it is not known if the findings of Frost and Lowry (1983) still accurately portray the diversity and abundance of demersal fishes in the Alaskan Beaufort Sea. The same is true for other dated studies. It is possible that they no longer accurately and precisely reflect the current distribution, abundance, and habitat use patterns of fish resources in the northeastern Chukchi and western Beaufort seas. If so, the lack of updated information could make it more difficult to assess the environmental impacts from the proposed action.

Another important data gap is the lack of information concerning discrete populations for arctic fishes. The literature abounds with casual references made of various fish populations without having delimited the population other than by perhaps using arbitrary boundaries of a study area, or presenting data without discriminating one discrete population unit from another. Additionally, a few marine species are regarded as widespread and/or abundant, yet distribution and density statistics for discrete populations are scarce, unknown, and therefore, incomplete. Several species are known only from a single specimen of each species; others are known from perhaps a handful of specimens collected years to decades ago. Population information is entirely lacking for such species.

III.F.1.b(2) Fish Resources of Arctic Alaska and Their Ecology. Three large marine ecosystems (LMEs) encompass coastal and offshore waters of arctic Alaska. They are the Bering Sea, Chukchi Sea, and the Beaufort Sea. Each LME is characterized by distinct hydrographic regimes, submarine topographies, productivity, and trophically dependent populations, yet influences the others. The Chukchi Sea LME represents a transition zone between the fish assemblages of the Beaufort and Bering LME's. Aspects of all three LME's are discussed below because they interact and influence each other

The Alaskan Chukchi and western Beaufort Seas support at least 98 fish species; representing 23 families (Table III.F-1) have been documented to occur (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). These families include lampreys, sleeper sharks, dogfish sharks, herrings, smelts, whitefishes, trouts and salmons, lanternfishes, cods, sticklebacks, greenlings, sculpins, sailfin sculpins, fathead sculpins, poachers, lumpsuckers, snailfishes, eelpouts, pricklebacks, gunnels, wolffishes, sand lances, and righteye flounders. Dogfish sharks, sailfin sculpins, and gunnels have been documented in the Beaufort Sea, but not the Chukchi Sea. Forty-nine species are common to both large marine ecosystems. Additional species are likely to be found in the Beaufort and Chukchi Seas if and when coastal and offshore waters are more thoroughly surveyed.

Aquatic systems of the Arctic undergo extended seasonal periods of frigid and harsh environmental conditions; therefore, fish inhabiting such systems must be biologically and ecologically adapted to surviving such conditions so as to produce offspring that eventually do the same. Behavioral strategies of each life stage are evolutionarily timed to coincide with environmental conditions favoring survival to the next life stage. The process of natural selection does not favor individuals or populations that are not adapted to survive such conditions. Important environmental factors that arctic fishes must contend with include reduced light, seasonal darkness, prolonged low temperatures and icecover, depauperate fauna and flora, and low seasonal productivity (see McAllister, 1975 for a description of environmental factors relative to arctic fishes).

The lack of sunlight and extensive ice cover in arctic latitudes during winter months influence primary and secondary productivity, making food resources very scarce during this time, and most of a fish's yearly food supply must be acquired during the brief arctic summer (Craig, 1989). There are fewer fish species inhabiting arctic waters of Alaska as compared to those inhabiting warmer regions of the State. The Chukchi Sea is warmer, more productive, and also supports a more diverse fish fauna than occurs in the western Beaufort Sea (Craig, 1984, citing Morris, 1981; Craig and Skvorc, 1982). Also, most fish species inhabiting the frigid polar waters are thought to grow and mature more slowly relative to individuals or species inhabiting boreal, temperate, or tropical systems.

Marine waters of the Chukchi and Beaufort Seas offer the greatest two- and three-dimensional area for arctic fishes to exploit; these include neritic waters and substrates (occurring landward of the continental shelf break, as delimited by the 200-m isobath) and oceanic waters and substrates (occurring seaward of the continental shelf break [>200-m isobath]). The diverse fishes of the eastern Chukchi and western Beaufort seas use a range of waters and substrates for spawning, breeding, feeding, or growing to maturity (Table III.F-2).

Arctic fishes of Alaska are classified into primary assemblages by occurrence in basic aquatic systems and by life-history strategies that allow the fishes to survive the frigid polar conditions (Craig, 1984; Craig, 1989; Moulton and George, 2000; Gallaway and Fechhelm, 2000). A life-history strategy is a set of co-adapted traits designed by natural selection to solve particular ecological problems (Craig, 1989, citing Stearns, 1976).

III.F.1.b(2)(a) Primary Fish Assemblages. The primary assemblages of arctic fishes are:

- freshwater fishes that spend their entire life in freshwater systems (although some also might spend brief periods in nearshore brackish waters);
- marine fishes that spend their entire life in marine waters (some also spend brief periods in nearshore brackish waters along the coast); and
- diadromous fishes that move between and are able to use fresh, brackish, and/or marine waters due to various biological stimuli or ecological factors.

While some arctic fish species are described in the scientific literature and in surveys as being abundant in the region, they are only so in a relative context and are of low overall abundance.

Species having low abundance and/or small ranges occurring in the first quartile of the frequency distribution of species abundances or range sizes (i.e., 25%; the quartile definition from Gaston, 1994) are termed "rare" (Gaston, 1994). The terms "common" and "widespread" are used as an antithesis of "rare" (Gaston, 1994). Rare as used in this sense does not imply protected status under the law, such as under the Endangered Species Act.

Marine waters support the most diverse, although least well known, fishes of the proposed project area. Studies of marine fishes in the region are very limited; most of the surveys/studies have been performed in coastal waters landward of the 200-m isobath, with scant surveys having sampled deeper waters (for example, Frost and Lowry, 1983; Jarvela and Thorsteinson, 1999). In areas where coastal surveys have been conducted, seasonal trends in relative abundance of dominant (abundant) fish species are evident (Jarvela and Thorsteinson, 1999). However, robust population estimates or trends for marine fishes of the region are unavailable. Distribution or abundance data for marine fish species are known only generally at the coarsest grain of resolution (for example, common, uncommon, rare), although a few studies include abundance estimates (qualitative or quantitative) for localized areas (Frost and Lowry, 1983; Griffiths et al., 1998; Jarvela and Thorsteinson, 1999). Detailed information generally is lacking concerning the spread, density, or patchiness of their distribution in the proposed project area. Data concerning habitat-related densities; growth, reproduction, or survival rates within regional or local habitats; or productivity rates by habitat, essentially are unknown for fishes inhabiting waters seaward of the nearshore, brackish-water ecotone.

Frost and Lowry (1983) reported anatomical, reproductive, and prey statistics for selected species sampled (arctic cod, polar eelpout, twohorn sculpin, hamecon, arctic alligatorfish, leatherfin lumpsucker, fish doctor, and spatulate sculpin) from 35 otter-trawl tows performed in the northeastern Chukchi and western Beaufort seas in August-September 1976 and 1977. Prey of the summarized species as a group consists of copepods, amphipods, isopods, mysids, euphasiids, polychaete worms, cumaceans, caprellids, shrimp, brittle stars, and arctic cod. Nineteen species of fishes were identified; three species (arctic cod, polar eelpout, and twohorn sculpin) accounted for 65% of all fishes caught.

Marine fishes prefer the colder, more saline coastal water seaward of the nearshore brackish-water zone. As summer progresses, the nearshore zone becomes more saline due to decreased freshwater input from rivers and streams. During this time, marine fishes often share nearshore brackish waters with diadromous fishes, primarily to feed on the abundant epibenthic fauna or to spawn (Craig, 1984). In the fall, when diadromous fishes have moved out of the coastal area and into freshwater systems to spawn and overwinter, marine fishes remain in the nearshore area to feed.

Marine fishes in the region primarily feed on marine invertebrates and/or fish. They rely heavily on epibenthic and planktonic crustacea such as amphipods, mysids, isopods, and copepods. Because the feeding habits of marine fishes in nearshore waters are similar to those of diadromous fishes, some marine fishes are believed to compete with diadromous fishes for the same prey resources (Craig, 1984; Fechhelm et al., 1996). Competition is most likely to occur in the nearshore brackish water ecotone, particularly in or near the river deltas. As nearshore ice thickens in winter, marine fishes probably continue to feed under the ice but eventually depart the area as ice freezes to the bottom some 2 m (6 ft) thick. Seaward of the bottomfast ice, marine fishes continue to feed and reproduce in coastal waters all winter (Craig, 1984). Many evidently spawn during winter, some in shallow coastal waters, and others in deeper waters. Arctic cod spawn under the ice between November and February (Craig and Halderson, 1981). Snailfishes spawn farther offshore by attaching their adhesive eggs to a rock or kelp substrate.

III.F.1.b(2)(b) Secondary Marine Fish Assemblages. To better understand fish resources and the potential impacts of disturbances to their populations and habitats, we further refined the scale of primary fish assemblages into secondary (ecological) assemblages based on fish behavior and ecology, and general oceanographic/landscape features, such as the continental shelf break or polar ice (Table III.F-2). The purpose of characterizing finer scale hierarchical organization of arctic fishes is to enhance our analysis of potential impacts in a data-deficient setting, particularly concerning marine fishes. Many species overlap to some degree in these assemblages, due in part to the different habitat areas used by different lifestages (e.g., arctic cod occur in both neritic (<200 m depth)-demersal [as adults] and cryopelagic [as juveniles] assemblages).

Based on the general ecology and three-dimensional occurrence of marine fishes in the sea, we identified the following secondary marine fish assemblages: neritic-demersal, neritic-pelagic, oceanic-demersal, and oceanic-pelagic. An additional and important assemblage that is unique to polar regions is the cryopelagic fish assemblage. Distribution, abundance, life-history statistics, and trophic data for fishes are listed in Table III.F-2. Following are characterizations of each secondary fish assemblage.

The Neritic-Demersal Assemblage. The neritic-demersal assemblage is comprised of marine fishes living at or near the seafloor of the continental shelf (landward of the 200-m isobath) and capable of active swimming. Studies of species other than those seasonally using the nearshore brackish ecotone are scarce. Some uncommon or rare species of this assemblage include the toothed cod, whitespotted greenling, spinyhook sculpin, veteran poacher, leatherfin lumpsucker, kelp snailfish, fish doctor, and Alaska plaice. Species of this assemblage that are attributed as being widespread and/or abundant include the fourhorn sculpin, twohorn sculpin, polar eelpout, and arctic flounder. Life-history data for many of the demersal species using neritic substrates is lacking (e.g., whitespotted greenling, twohorn sculpin, spinyhook sculpin, veteran poacher); consequently, assessing the species resilience to perturbations is not feasible until additional information becomes available.

The Neritic-Pelagic Assemblage. Fishes inhabiting the water column over the continental shelf (landward of the 200-m isobath) comprise the neritic-pelagic assemblage. Some fishes of this assemblage are prone to occupying the upper water column (pelagic species), while others exhibit greater use of the lower depths or the entire water column and seafloor (benthopelagic species). Surveys and studies of pelagic fishes inhabiting "offshore waters" (as defined by Jarvela and Thorsteinson [1999] as marine waters deeper than 2 m), especially those more than 30 m in depth, are scant. Species of this assemblage regarded as widespread or abundant include the Pacific herring, arctic cod, capelin, and Pacific sand lance. Two benthopelagic species are uncommon (fourline snakeblenny and slender eelblenny); the polar cod is regarded as rare. No species of this assemblage are assessed as being of low resilience, because life-history data are lacking.

The Cryopelagic Assemblage. The term "cryopelagic" is used to describe fishes that actively swim in neritic or oceanic waters but, during their life cycle, are associated in some way or other with drifting or fast ice (Andriashev, 1968). The cryopelagic fish assemblage is further described by Andriashev (1970) as such:

> Both young and adult fishes can be associated with ice or water immediately below the ice. These relationships are usually trophic in nature, but in some cases ice provides fishes with a shelter from predators or even a substratum for sucking. The association of fishes with ice can be

> observed easily and often. The more intimate aspects of their behavior are, however, still little known….

Andriashev (1970) described what may be the first known cryopelagic fish species, the arctic cod (*Boreogadus saida*; previously known as polar cod), stating:

> According to many eyewitness observations, arctic cod often occur in ice holes, cracks, hollows and cavities in the lower surface of the ice. They are most common among broken ice or near the ice edge. Here, as the ice thaws and breaks up phyto- and zooplankton develop and provide food for arctic cod. It is possible that the fish also feed on organisms of the amphipod-diatom ice community inhabiting the lower "fluffy" ice layer. This peculiar ice biocoenosis is known now from both the Arctic and Antarctic. At the same time polar cod apparently use sea ice as shelter from the numerous enemies attacking them from both water and air.

Andriashev (1970) described the arctic cod as:

> ... one of the main consumers of Arctic plankton;…it is a common food of Greenland seal (*Pagohoca groenlandica*), ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and other marine mammals, many marine birds (including gulls, guillemots, etc.) and fishes (citing Klumov, 1937, Andriashev, 1954).

The arctic cod is abundant in the region and their enormous autumn-winter pre-spawning swarms are well known. The species is also very widely distributed and they make distant migrations, not only along the shelf areas in the Arctic Basin but also in higher latitudes.

In addition to the arctic cod, other cryopelagic fishes of the Alaskan arctic region include polar cod, toothed cod, and Pacific sand lance. Arctic cod and Pacific sand lance are assumed to be of medium resilience to exploitation; polar cod and toothed cod are data deficient such that an assessment of resilience is not feasible with available information.

The Oceanic-Pelagic Assemblage. Fishes inhabiting the water column of oceanic waters seaward of the 200 m isobath comprise this assemblage; most species exhibit some preference of bathymetric stratification. Those species chiefly occurring within the upper 200 m of the water column are regarded as epipelagic fishes. Fishes inhabiting oceanic waters between 200 and 1,000 m in depth are termed mesopelagic fishes. Bathypelagic fishes are those species inhabiting depths >1,000 m in depth; as yet, there are no known bathypelagic fishes in the Alaskan Beaufort Sea. Several of the epipelagic species include the Pacific herring, arctic cod, polar cod, and Pacific sand lance (note that several of these species also use neritic and ice-covered waters). The glacier lanternfish is largely a mesopelagic fish; however, it is known to sometimes use the epipelagic zone. Oceanic waters are poorly surveyed; hence, relative abundance estimates of oceanic fishes (demersal or pelagic) in Table III.B-1 are extremely crude. Life-history statistics indicate that the noted species are of medium to high resilience to exploitation; however, population estimates are ambiguous at best in the region, thereby canceling out the resilience assessments.

The Oceanic-Demersal Assemblage. Fishes living on or close to substrates below oceanic waters are encompassed in the oceanic-demersal assemblage. The ogac, ribbed sculpin, spatulate sculpin, shorthorn sculpin, spinyhook sculpin, archer eelpout, pale eelpout, and daubed shanny are among the fishes included in this assemblage. Life-history statistics for most species covered in this assemblage are data deficient, chiefly for lack of fish surveys and studies in oceanic waters of the Alaskan arctic. For those with suitable life-history data, the Bering flounder and Alaska plaice are assessed as of low resilience to exploitation; the Greenland halibut is of very low resilience to exploitation.

The Diadromous Fish Assemblage. Diadromous fishes move between and are able to live in fresh, brackish, and/or marine waters.. Such fishes demonstrate variations in their uses of fresh, brackish, and/or marine waters, leading biologists to describe these variations with terms such as "anadromous, amphidromous, or diadromous." Each term requires some form of migration; diadromy involves the migration between marine and fresh waters. However, many marine fishes are migratory but are unable to withstand waters of lower salinity, such as freshwater. Therefore, it is important to distinguish diadromous fishes from other migratory fishes. Because various scientists use different terms (anadromous, amphidromous, or diadromous) in preference to another for describing such variations, the literature is sometimes inconsistent and confusing. The use of such terms in this section are as used by the cited authors; however, it should be generally understood that they are referring to basically the same assemblage of fishes that we characterize here as diadromous fishes.

Craig (1989) wrote:

> The nearshore zone is marked by a series of bays, lagoons, deltaic mudflats, and narrow barrier islands. A biologically important feature of the nearshore zone is the occurrence of relatively warm and brackish water (5-10 C, 10-25 ppt) that frequently lies adjacent to the shoreline in summer (citing Craig, 1984). This estuarine zone extends over much of the length of the coast and is often distinctly different from adjacent marine waters (-1 to 3 C, 27-32 ppt). This nearshore zone provides a transportation corridor for fishes not fully adapted to the marine environment as well as an important feeding habitat for anadromous and marine fishes such as Arctic cisco, least cisco, humpback whitefish, broad whitefish, Arctic char, fourhorn sculpin, and Arctic cod. In winter, the estuarine band is absent, and nearshore waters freeze solid to a depth of about 2 m.

Gallaway and Fechhelm (2000) describe the nearshore ecotone during warmer months as such:

> In June, rising air temperatures and increasing periods of solar radiation bring about the spring freshet. Snowmelt increases river discharge, which overflows shorefast ice attached to land in and near river deltas. By mid-July, the nearshore zone of the Beaufort Sea is usually ice-free from the shore to the edge of the pack ice, which by late summer may retreat from 10 to 100 km offshore. River runoff coupled with the melting of coastal ice creates brackish conditions (low to moderate salinities) in nearshore areas, with lower salinities near the mouths of rivers. The relatively warm river discharge, plus increased solar radiation, elevates nearshore water temperatures. As the summer progresses, this nearshore coastal band of warm, brackish water begins to deteriorate as it mixes with the vast sink of cold, arctic marine water. By late summer, rapidly decreasing daylight, decreased river discharge, and the relentless mixing of nearshore with ocean water all contribute to the dissipation of the warm, brackish nearshore band. Nearshore waters remain cold and saline from then until the September freeze that marks the onset of another winter.

The short arctic summer is a period of intense biological activity in coastal waters (Gallaway and Fechhelm, 2000). Nearshore waters are the prime feeding area for North Slope diadromous fishes (Gallaway and Fechhelm, 2000). Most coastal summer feeding studies have identified varying degrees of dietary overlap among the four (most common) diadromous species (Gallaway and Fechhelm, 2000). Broad whitefish chiefly consume amphipods, copepods, polychaetes, and chironomids. Mysids dominate the diets of arctic cisco and least cisco; however, chironomids, amphipods, and copepods also are important prey to these fish species. Dolly Varden feed on mysids, amphipods, and other fishes. Feeding is opportunistic, and the specific prey consumed may vary with concentration (i.e., prey availability) (Gallaway and Fechhelm, 2000).

Most anadromous species vacate Alaskan coastal waters in winter and return to rivers, deltas, and lakes to overwinter (Craig, 1989). Overwintering sites are more than places where fish simply reside during winter. Anadromous salmonids and coregonids are all fall-spawners whose eggs incubate in streambed gravels throughout the winter (Craig, 1989). Spawning must occur in an area where a winter water supply is ensured. Because such areas are scarce, spawning often occurs in or adjacent to the same areas where the fish overwinter.

Craig (1989) also states that the life history patterns of anadromous fishes involve repeated migrations between overwintering sites and coastal waters, followed by a spawning migration into fresh water at maturity. This cycle consists of three broad phases: spawning, freshwater residency (of juveniles), and anadromy (diadromy).

Craig (1989) describes at greater length the life-history characteristics of arctic anadromous fishes. He concludes that arctic anadromous fishes possess the following characteristics:

- Arctic anadromous fishes have long life spans, with maximum ages of 18-25 years for five species described in his monograph (arctic char, arctic cisco, least cisco, broad whitefish, and humpback whitefish). This contrasts markedly with other anadromous salmonids in temperate latitudes whose maximum recorded ages range from 2-12 years.
- The growth rate of arctic (anadromous) fishes declines markedly once sexual maturity is reached, as is common among fish in general because of the energy demands of reproduction (Craig, 1989, citing Roff, 1984; Craig, 1985). Older arctic (anadromous) fish grow only about 1-2 cm each year.
- The ages at which half the members of a population spawn for the first time are 7-8 years for char and ciscoes, and 10-11 years for the whitefishes.
- Arctic anadromous fishes do not die immediately after spawning (as do the five species of Pacific salmon). Some live to spawn again, but the frequency of spawning after maturity is probably variable, with some members of a population spawning annually and others at intervals of two or more years, depending on how well the fish fared nutritionally between spawning periods.

These life-history characteristics imply that recruitment of young arctic anadromous fishes is, on the average, low (Craig, 1989). Craig (1989) suggests mechanisms responsible for a generally low recruitment of young could be several, among which are:

- Food supply probably plays an important role in the recruitment of young. Because reproduction entails a heavy energy demand, mature arctic fish will not spawn if food is insufficient prior to spawning.
- Winter mortality is undoubtedly important in limiting populations, and mortality may be especially high for young fish. If finding a suitable overwintering site is a learned response for the fish rather than a programmed (genetic) response, many young-of-the-year presumably would be unsuccessful in locating a suitable overwintering site during their first winter. The fortunate survivors, however, could return in subsequent winters to the site in which they successfully overwintered. The net result would be a large loss of young each winter.
- Two additional factors that could contribute to reduced number of young are (a) predation and (b) a limited extent of suitable spawning habitat in the Alaskan Beaufort Sea region.

Craig (1989) also notes that populations with similar life history strategies (i.e., long-lived, have low population turnover rates, and have relatively stable numbers of adults) implies something about their population stability. By having many year classes of older, mature fish, they are capable of withstanding an occasional reproductive loss without jeopardizing the survival of the population.

III.F.1.b(3) Pacific Salmon. All five species of Pacific salmon occur in the Alaskan Beaufort and Chukchi Seas (Craig and Halderson, 1986; NMFS, 2005); the pink, chum, sockeye, chinook, and coho salmon. A large body of information exists on the life histories and general distribution of salmon in Alaska (NMFS, 2005). Pacific salmon life history, general distribution, fisheries background, relevant trophic information, habitat, and biological associations are described in Appendix F.5 of NMFS (2005) and incorporated herein by reference. More information regarding the biology, ecology, and behavior of Pacific salmon is described in Augerot (2005), Quinn (2005), and the Alaska Department of Fish and Game (ADF&G) Fish Distribution Database-Fish Profiles.

Salmon numbers decrease north of the Bering Strait (Craig and Halderson, 1986). Spawning runs in arctic streams are minor compared to those of commercially important populations farther south (Craig and Halderson, 1986). Rivers south of Point Hope support comparatively large runs of chum and pink salmon (Craig and Halderson, 1986), although this appears no longer so. Craig and Halderson (1986) noted that only a few pink salmon and, to a lesser degree, chum salmon, occur with any regularity in arctic waters north of Point Hope and presumably maintain small populations in several of the northern drainages; most occurring in streams along the Chukchi Sea coast west of Barrow.

III.F.1.b(3)(a) Chinook, Sockeye, and Coho Salmon. The northernmost known spawning population of chinook salmon is believed to be in Kotzebue Sound (Healy 1991), however, there are indications of a small run of chinook salmon in the Kugrua River southwest of Point Barrow at Peard Bay (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Small numbers of chinook salmon reportedly are taken each year in the Barrow domestic fishery, which operates in Elson Lagoon (Fechhelm and Griffiths, 2001, citing George, pers. commun.). Strays have been captured in the Kuk River, near Wainwright (Craig and Halderson, 1986).

The northernmost known population of spawning coho salmon is in the Kuchiak River (ADFG anadromous catalog) and coho salmon have occasionally been captured in marine waters farther east, near Prudhoe Bay (Craig and Halderson, 1986). This is particularly important because juvenile fish must over-winter at least one winter in freshwater before entering the marine environment. Overwintering stream habitat may be reduced by as much as 97-98% by late winter (Craig, 1989).

There are no known stocks of sockeye salmon in arctic waters north of Point Hope (Craig and Halderson, 1986). Sockeye salmon have their northernmost known spawning population in Kotzebue Sound (Stephenson, 2006, citing Burgner, 1991).

Climate change in arctic Alaska (i.e., warming) may facilitate the range expansion of chinook, sockeye, and coho salmon (e.g., Babaluk et al., 2000).

III.F.1.b(3)(b) Pink Salmon. Pink salmon are widely distributed over the northern Pacific Ocean and Bering Sea; they also occur to a lesser degree in arctic waters (Augerot, 2005). Pink salmon are the most abundant salmon species in the Beaufort and Chukchi Seas, although their abundance is greatly reduced compared to waters farther south (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001). Their abundance generally increases from east to west along the Alaskan Beaufort Sea coast. Augerot (2005) depicts pink salmon of limited spawning distribution in the Alaskan Arctic.

Craig and Halderson (1986) proposed that pink salmon spawn successfully and maintain small but viable populations in some arctic drainages. Small runs of pink salmon occur in nine drainages north of Point Hope (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001), including the Kuk, Kokolik, Kugrua, and Kukpowruk rivers (Fechhelm et al., 1983 as cited in Kinney, 1985). They are reported as present in the Pitmegea and Utukok rivers.

Unlike other nonsalmonid anadromous fish species in arctic Alaska, the pink salmon is a short-lived species that places all its reproductive effort into a single spawning event, and then dies. With its rigid 2-year lifecycle, there is virtually no reproductive overlap between generations; therefore, every spawning event must be successful for the continued survival of the stock (Craig and Halderson, 1986).

Run timings are inexact. Along the northeastern Chukchi Sea coast, run times in spawning streams may occur in mid-July; while along the western Beaufort coast, run times appear to commence in late July until the end of August (Craig and Halderson, 1986). Occurrence of adult salmon in spawning streams in mid- to late July indicates their presence in marine waters along the arctic coast as much as several weeks in advance of the runs.

Schmidt, McMillan, and Gallaway (1983) describe the life cycle of pink salmon:

> Eggs are laid in redds dug in gravel. The eggs hatch during the winter however the alevins remain in the gravel, until the yolk sac is absorbed, emerging later in spring. After emerging from the gravel, the fry begin moving downstream. They remain in the estuary for up to a month prior to moving offshore. Little is known of the movements undertaken during the 18 months the salmon spend at sea. It is likely the North Slope populations move westerly towards the Chukchi Sea and upon maturing at the age of 2 years, the salmon then return to their natal streams to spawn in the fall.

Generally, early marine schools of pink salmon fry, often in large, dense aggregations, tend to follow shorelines and, during the first weeks at sea, spend much of their time in shallow water only a few centimeters deep (NMFS, 2005:Appendix F). It has been suggested that this nearshore period involves a distinct ecological life-history stage in both pink and chum salmon. In many areas throughout their ranges, pink salmon and chum salmon fry of similar age and size co-mingle in both large and small schools during early life in the marine environment.

Diet studies show that pink salmon are both opportunistic and generalized feeders and on occasion they specialize in specific prey items (NMFS, 2005:Appendix F). Young-of-the-year probably do not feed significantly during the short period spent in natal streams but feed on copepods and other zooplankton in the estuary (Schmidt, McMillan, and Gallaway, 1983). As the fish grow, larger prey species become important, including amphipods, euphausiids, and fishes (Schmidt, McMillan, and Gallaway, 1983, citing Morrow, 1980 and Scott and Crossman, 1973). Craig and Halderson (1986) state that most (adult) pink salmon caught in Simpson Lagoon had not fed recently (88% empty stomachs, n=17). The only available information on marine feeding is from Kasegaluk Lagoon, where stomachs of 17 captured adult salmon contained mostly fish (chiefly arctic cod), with some amphipods and mysids (Craig and Halderson, 1986, citing Craig and Schmidt, 1985). Studies indicate that juvenile pink salmon are primarily diurnal feeders (NMFS, 2005:Appendix F).

III.F.1.b(3)(c) Chum Salmon. Chum salmon are widely distributed in arctic waters but are relatively less common than pink salmon (Craig and Halderson, 1986; Babaluk et al., 2000; Fechhelm and Griffiths, 2001). The Pitmegea, Kukpowruk, Kuk, Kukolik, Kuchiak, and Kugrua rivers along the northeastern Chukchi Sea coast are reported to support small populations of chum salmon. They are reported as present in the Utukok and Kuchiak rivers. Individual salmon and small schools have been collected in the Kukpuk River, Kasegaluk Lagoon, and along the Wainwright Coast (Craig and Halderson, 1986; Fechhelm and Griffiths, 2001).

Generally, chum salmon return to spawn as 2-7-year olds (NMFS, 2005). In general chum salmon get older from south to north. Seven-year-old chum are rare and occur mostly in the northern areas (e.g., the Arctic). Slow to rapid growth in the ocean can modify the age at maturity. Slower growth during the second year at sea causes some chum salmon to mature 1 or 2 years later.
Chum salmon fry, like pink salmon, do not overwinter in streams but migrate (mostly at night) out of streams directly to sea shortly after emergence. The timing of outmigration in the arctic is unknown, but occurs between February and June (chiefly during April and May) in more southern waters.

Chum salmon have two habitat requirements that are essential in their life history that make them very vulnerable: (1) reliance on upwelling ground water for spawning and incubation and (2) reliance on estuaries/tidal wetlands for juvenile rearing after migrating out of spawning streams. Chum salmon tend to linger near their natal stream and forage in estuaries and intertidal areas at the head of bays during summer. Estuaries are very important for rearing chum salmon. Rearing juvenile chum salmon use a wide variety of prey species, including invertebrates (including insects) and gelatinous organisms (NMFS, 2005).

In late summer, juvenile chum salmon migrate southward toward the Bering Sea, thereby avoiding the cold waters of the arctic marine environment in winter. Chum salmon eat a variety of foods during their ocean life, e.g., amphipods, euphausiids, pteropods, copepods, fish, and squid larvae.

III.F.1.b(4) Distribution and Abundance Trends of Fish in the Northeastern Chukchi Sea. Fish resources of the northeastern Chukchi Sea were last surveyed 15-17 years ago. Additionally, other surveys over the years and area reflect a pattern of temporally and spatially irregular and disjunct sampling. Such disorganized sampling and data reporting greatly influences the information quality necessary to determine population trends and adjustments to environmental perturbations. Establishing a current, accurate, and precise baseline is critical to assessing potential changes to biotic resources. It is unknown if the distribution and abundance information gathered by the last surveys remains an accurate and precise description of arctic fish populations today. This is an important because the Chukchi and Bering Seas are considered to be large marine ecosystems serving as principle bellwethers to climate change in North America and the Arctic Ocean.

The climate of the Arctic is changing. Arctic warming is altering the distribution and abundance of marine life in the Arctic. The better known fish resources (i.e., abundant species) can exhibit very large interannual fluctuations in distribution, abundance, and biomass (e.g., capelin, arctic cod, Pacific sand lance, Bering flounder). Climate change experienced in the past and apparently accelerating in arctic Alaska likely is altering the distribution and abundance of their respective populations from what was known from past surveys.

While climatic warming is not distributed evenly across the Arctic, the Bering, Chukchi, and Beaufort Seas are clearly experiencing a warming trend (ACIA, 2005). Over the last 50 years, annual average temperatures have risen by about 2-3 ˚C in Alaska and the Canadian Yukon, and by about 0.5 ˚C over the Bering Sea and most of Chukotka (ACIA, 2004). The largest changes have been during winter, when near-surface air temperatures increased by about 3-5 ˚C over Alaska, the Canadian Yukon, and the Bering Sea.

Climate change can affect fish production (e.g., individuals and/or populations) through a variety of means (Loeng, 2005). Direct effects of temperature on the metabolism, growth, and distribution of fishes occur. Food-web effects also occur through changes in lower trophic-level production or in the abundance of predators, but such effects are difficult to predict. Fish-recruitment patterns are strongly influenced by oceanographic processes such as local wind patterns and mixing and by prey availability during early lifestages. Recruitment success sometimes is affected by changes in the time of spawning, fecundity rates, survival rate of larvae, and food availability.

For example, a climate shift occurred in the Bering Sea in 1977, abruptly changing from a cool to a warm period (ACIA, 2004, 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and noncrustacean invertebrates. The species composition of seafloor organisms changed from being crab dominated to a more diverse assemblage of echinoderms, sponges, and other sea life. Historically high commercial catches of Pacific salmon occurred. The walleye pollock catch, which was at low levels in the 1960's and 1970's (2-6 million metric tons), has increased to levels greater than 10 million metric tons for most years since 1980. Additional recent climate-related impacts observed in the Bering Sea large marine ecosystem include significant reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. While the Bering Sea fishery has become one of the world's largest, numbers of salmon have been far below expected levels, fish have been smaller than average, and their traditional migratory patterns appear to have been altered.

The Arctic Climate Impact Assessment (ACIA, 2004, 2005) concluded that:

- The southern limit of distribution for colder water species (e.g., Arctic cod) are anticipated to move northward. The distribution of more southerly species (e.g., from the Bering Sea) are anticipated to move northward. Timing and location of spawning and feeding migrations are anticipated to alter;
- Wind-driven advection patterns of larvae may be critical as well as a match/mismatch in the timing of zooplankton production and fish-larval production, thereby influencing productivity (e.g., population abundance and demography);
- Species composition and diversity will change: Pacific cod, herring, walleye pollock, and some flatfish are likely to move northward and become more abundant, while capelin, Arctic cod, and Greenland halibut will have a restricted range and decline in abundance.

The following patterns, can exhibit very large interannual fluctuations in distribution, abundance, and biomass are indicative of changing processes influencing fish-resource distribution, abundance, habitat areas, and demography in response to climatic warming in the Arctic:

- the Bering Sea ecosystem has undergone some significant ecosystem shifts as a result of climatic warming;
- that warming in Alaska and adjacent lands and waters apparently has increased in the last decade and continues to increase;

- that patterns of sea-ice cover in the region are changing (e.g., ACIA, 2004, 2005), thereby influencing aquatic habitats;
- that the conclusions noted by the ACIA (see above) likely have been in action for one or more decades;
- the recent evidence of changing species distributions (i.e., new northern range limits of several fish species better known from the Bering Sea) in the Chukchi Sea as presented by RUSALCA ichthyologists; and
- fish resources are better known (i.e., abundant species).

Adjustments by one or more fish populations often require adjustments within or among large marine ecosystems, influencing the distribution and/or abundance of competitors, prey, and predators. Consequently, it appears reasonable to believe that the composition, distribution, and abundance of fish resources in the Beaufort and Chukchi Seas are changing and are now different from that measured in the surveys conducted 15-17 years ago or earlier. The magnitude of these differences is unknown.

The occurrence of pink and chum salmon in arctic waters probably is due to their relative tolerance of cold water temperatures and their predominantly marine life cycle (Craig and Halderson, 1986, citing Salonius, 1973). The expansion of chinook, sockeye, and coho salmon into the Arctic appears restricted by cold water temperatures, particularly in freshwater environments (Craig and Halderson, 1986). Babaluk et al. (2000) noted that significant temperature increases in arctic areas as a result of climate change may result in greater numbers of Pacific salmon in arctic regions. The recent range extensions of pink, sockeye, and chum salmon in the Canadian Arctic, as described by Babaluk et al. (2000), indicate that some Pacific salmon may be expanding their distribution and abundance in the proposed project area..

III.F.1.b(5). Invertebrate Fishery Resources and Fragile Biocenoses. In the western Beaufort and northeastern Chukchi seas, there are several additional forms of marine animal and plants that are important fishery resources. These forms include macroscopic algae (chiefly kelp communities forming biogenic structures), squid, and snow crab.

III.F.1.b(5)(a) Kelp and Macroscopic Algae. Dense kelp grows on a few areas of the seabed of the Beaufort Sea (USDOI, MMS, 2003a). The distribution of kelp is limited by three chief factors: ice gouging, sunlight, and hard substrate. Ice gouging restricts the growth of kelp to protected areas, such as behind barrier islands and shoals. Hard substrates are necessary for kelp to hold fast and are restricted to areas with low sedimentation rates. The best known kelp bed in the Beaufort Sea is the Boulder Patch. It is located behind the barrier islands of Stefansson Sound (USDOI, MMS, 2002). Kelp also grows sparsely in West Camden Bay (USDOI, MMS, 1998).

The Boulder Patch is well studied and supports about 300 known infaunal and epilithic species (Dunton and Schonberg, 2000). The total biomass of organisms is about an order of magnitude higher than for most of the OCS seabed; in contrast to the 30 grams per square meter (g/m^2) of benthos of most of the Beaufort OCS seabed, about 300 g/m^2 of epilithic organisms inhabit the Boulder Patch (Dunton and Schonberg, 2000). The kelp community spreads very slowly, taking almost a decade to recolonize denuded boulders (Martin and Gallaway, 1994). The plants live a long time; Dunton observed some that probably were more than 40 years old and noted that growth of kelp in the Boulder Patch has varied considerably from year to year (USDOI, MMS, 1998).

Distribution and density of kelp in western Camden Bay is not well known (USDOI, MMS, 2003a). During exploration of the Warthog Prospect in 1997, kelp was observed on a patch of boulders in about 11 m of water (USDOI, MMS, 1998). Kelp also has been observed shoreward in an area behind a shoal near Konganevik Point, although its spatial distribution and density are not known.

Kelp beds are likely to occur elsewhere in the western Beaufort Sea but have not been systematically surveyed, and other kelp beds may be discovered as more areas are explored. Systematic surveys of macroscopic algae, especially kelp beds, have not been conducted in the northeastern Chukchi Sea. Records from a variety of sources do indicate the presence of at least two kelp beds along the coast. One first described by Mohr, Wilimovsky, and Dawson (1957) and confirmed by Phillips et al. (1982) is located about 20 km northeast of Peard Bay near Skull Cliff. Another was reported by Phillips and Reiss (1985) approximately 25 km southwest of Wainwright in water depths of 11-13 m. The known kelp beds are located relatively close to the coast in State waters.

Macroscopic algal growth in nearshore areas of the Chukchi Sea probably is limited by the availability of suitable substrates (rock, cobble, and gravel) (USDOI, MMS, 1990a). The existent kelp beds and stand of green sea lettuce (*Ulva*) in Peard Bay are additional sources of primary production. Kelp beds provide three-dimensional structure in an otherwise homogeneous environment that, in some areas, increases the diversity of organisms living in the area. Mohr, Wilimovsky, and Dawson (1957) recorded that relatively few invertebrates (all polychaetous annelids and arthropods) were taken, as well as six species of fishes in association with the algae near Skull Cliff.

III.F.1.b(5)(b) Squid. Squid occur in the northeastern Chukchi Sea and western Beaufort Sea. Squid on occasion (e.g., in 1998 and 2005) strand on the beach near Barrow (George, 2005, pers. commun.). In general, squid can be among the more dominant prey species for some marine fishes, seabirds, and marine mammals. No information was found as to the species inhabiting the areas; hence, we cannot describe their biology and ecology as relating to a baseline description.

III.F.1.b(5)(c) Snow Crab (*Chionoecetes opilo*). The snow crab is a circumpolar species for which there are substantial fisheries in the Atlantic and Pacific oceans (Paul, Paul, and Barber, 1997), and it is the dominant benthic species in the proposed project area (Paul, Paul, and Barber, 1997, citing Slizkin 1989). In the northwest Pacific Ocean, snow crabs occur in the northern Sea of Japan, the Bering and Chukchi seas from Wrangel Island to Point Barrow, and the Beaufort Sea at the mouth of the Mackenzie River (Paul, Paul, and Barber, 1997, citing Slizkin 1989). Snow crab have not been historically harvested, therefore, their basic biology and ecology is poorly described.

Snow crabs may live to an estimated maximum age of 14 years (http://www.adfg.state.ak.us/pubs/notebook/shellfsh/tanner.php). Eggs hatch late in winter and spring, with the peak hatching period usually during April to June. This is normally the peak of the spring plankton bloom, so egg hatch coincides with the high availability of food for the larvae crab. The young, free-swimming larvae molt many times before being settling to the ocean bottom. After numerous molts and several years of growth, females mature at approximately 5 years of age. Males mature at about 6 years. Snow crabs feed on a wide assortment of marine life including worms, clams, mussels, snails, crabs, other crustaceans, and fish parts. They are fed on by demersal and pelagic fish, and humans. Migration patterns are not well understood. It is known that the sexes are separated during much of the year and move into the same areas during the reproductive season.

Paul, Paul, and Barber (1997) noted that little is known about the factors influencing the distribution and abundance of snow crabs, and that such factors must include larval recruitment dynamics, habitat requirements, thermal tolerance, water-depth preferences, predation, competition, and cannibalism, and that the relative importance of these factors is unknown. Theirs is the most recent study of snow crabs in the Chukchi Sea. Paul, Paul, and Barber, (1997) sampled 56 stations in the northeastern Chukchi Sea during1990-1991 and found snow crabs present at all stations, with the largest abundance and biomass tending to be in the southern part (south of 70° N. latitude to Point Hope) of their study area, but varying extensively between stations. Abundance and biomass estimates also varied considerably between trawls at most stations. The highest estimated mean abundance (100,000/km^2) was at station 1 (i.e., northwestern-most station sampled); the lowest mean abundance (190/km^2) was at station 28 (i.e., approximately 22 nmi southwest of Hanna Shoal). Mature crabs of both sexes were collected in the Chukchi Sea during their study. Paul, Paul, and Barber (1997) found that Chukchi snow crab tended to be smaller than Bering Sea or North Atlantic individuals. They also found that fecundity estimates for Chukchi snow crab are similar to other estimates. Fecundity of snow crabs positively correlated to increasing body size (Paul, Paul, and Barber, 1997, citing Haynes et al., 1981; Paul and Fuji, 1989). Paul, Paul, and Barber (1997) noted that contrasting observations with those of Jewett (1981, as cited by Paul, Paul, and Barber, 1997) suggest that the dates that snow crabs ovulate varies interannually.

Prior to the survey conducted by Paul, Paul, and Barber (1997), Frost and Lowry (1983) caught 49 snow crabs in eight trawls (of a total of 35 successful tows) made in the western Beaufort Sea and northeastern Chukchi Sea. All snow crabs were caught west of 155˚ W. longitude. Only one female caught was bearing eggs. Frost and Lowry (1983) cited MacGinitie (1955) as reportedly catching no egg-bearing females off Point Barrow. The ratio of males to females collected by Frost and Lowry (1983) was about 2:1.

III.F.1.c. Essential Fish Habitat. The U.S. Congress concluded in the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (P.L. 94-265) that the fish off the coasts of the U.S., the highly migratory species of the high seas, the species that dwell on or in the continental shelf of the U.S., and the anadromous species that spawn in U.S. rivers or estuaries, constitute valuable and renewable natural resources. These fishery resources contribute to the food supply, economy, and health of the Nation and provide recreational opportunities. Hence, fish are a valued natural resource in the U.S. The MSA defines "fish" to mean finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds. The term "fishery resource" means any fishery, any stock of fish, any species of fish, and fish habitat.

Recognizing the importance of fish habitat to the productivity and sustainability of U.S. marine fisheries, in 1996 Congress added new habitat conservation provisions to the MSA. Congress asserted the following in the Findings section of the MSA:

> One of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats. Habitat considerations should receive increased attention for the conservation and management of fishery resources of the United States (16 U.S.C. 1801 (A)(9)).

The MSA mandated the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary to fish to carry out their lifecycles. The MSA requires cooperation among the NMFS, the Fishery Management Councils, fishing participants, Federal and State agencies, and others in achieving EFH protection, conservation, and enhancement (see http://www.nmfs.noaa.gov/habitat/habitatprotection/efh/index.htm).

Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH guidelines under 50 CFR 600.10 further interpret the EFH definition as follows:

> Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

In Alaska, the NMFS and the North Pacific Fisheries Management Council recently completed the Final EIS for Essential Fish Habitat Identification and Conservation in Alaska (NMFS, 2005). Because commercial fisheries in the proposed project area are small relative to other areas commercially fished in Alaska, there are few managed species covered by fishery management plans in the Alaskan arctic. Presently, the five species of Pacific salmon occurring in Alaska are the only managed species with EFH designated in the proposed project area.

Essential Fish Habitat for each Pacific salmon species is described and mapped by NMFS (2005). Salmon EFH includes all those freshwater streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (EEZ). This habitat includes waters of the continental shelf (to the 200-m isobath). In the deeper waters of the continental slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m.

Chinook and chum salmon use deeper layers, generally to about 300 m, but on occasion to 500 m. A more detailed description of marine EFH for salmon found in Arctic Alaska is provided below:

- Chinook Salmon
    - Estuarine EFH for juvenile chinook salmon is the general distribution area for this lifestage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and post-smolt juveniles may be present in these estuarine habitats from April through September (NMFS, 2005).
    - Marine EFH for juvenile Chinook salmon is the general distribution area for this lifestage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nmi limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean. Juvenile marine chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea (NMFS, 2005).
    - The EFH for immature and maturing adult Chinook salmon is the general distribution area for this lifestage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean (NMFS, 2005:).
- Sockeye Salmon
    - Estuarine EFH for juvenile sockeye salmon is the general distribution area for this lifestage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August (NMFS, 2005).
    - Marine EFH for juvenile sockeye salmon is the general distribution area for this lifestage, located in all marine waters off the coast of Alaska to depths of 50 m and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean from midsummer until December of their first year at sea, (NMFS, 2005).
    - The EFH for immature and maturing adult sockeye salmon is the general distribution area for this lifestage, located in marine waters off the coast of Alaska to depths of 200 m and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).
- Coho Salmon
    - Estuarine EFH for juvenile coho salmon is the general distribution area for this lifestage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.
    - Marine EFH for juvenile coho salmon is the general distribution area for this lifestage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean (NMFS, 2005).
    - The EFH for immature and maturing adult coho salmon is the general distribution area for this lifestage, located in marine waters off the coast of Alaska to 200 m in depth and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).

- Pink Salmon
    - Estuarine EFH for juvenile pink salmon is the general distribution area for this lifestage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June (NMFS 2005).
    - Marine EFH for juvenile coho salmon is the general distribution area for this lifestage, located in all marine waters off the coast of Alaska from the mean higher tide line to

the 200-nmi limit of the U.S. EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).
    - The EFH for immature and maturing adult coho salmon is the general distribution area for this lifestage, located in marine waters off the coast of Alaska to 200 m in depth and range from the mean higher tide line to the 200-nmi limit of the U.S. EEZ, including the GOA, EBS, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).
- Chum Salmon
    - Estuarine EFH for juvenile chum salmon is the general distribution area for this lifestage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June (NMFS, 2005).
    - Marine EFH for juvenile chum salmon is the general distribution area for this lifestage, located in all marine waters off the coast of Alaska to approximately 50 m in depth from the mean higher tide line to the 200-nmi limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).
    - The EFH for immature and maturing adult chum salmon is the general distribution area for this lifestage, located in marine waters off the coast of Alaska to depths of 200 m and ranging from the mean higher tide line to the 200-nmi limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean, (NMFS, 2005).

The distribution and abundance of various squid in the Project Area are unknown, but it is generally thought that the number of squid species in the Arctic Region is relatively low compared to more temperate waters of the world. Therefore, the EFH has not been determined for squid in the proposed project area. Likewise, the paucity of information about snow crab in the Project Area precludes the identification of their EFH.

III.F.1.d Impact Assessment. Because of the paucity of studies in both the Chukchi and Beaufort Seas, a review of the available science and management literature shows that at present, there are no empirical data to document potential impacts from seismic surveys reaching a local population-level effect; also, the experiments conducted to date have not contained adequate controls in place to allow us to predict the nature of a change or that any change would occur. Thus, the information that does exist has not demonstrated that seismic surveys alone would result in significant impacts to marine fish or related issues (e.g., impacts to migration and spawning, rare species, subsistence fishing).

III.F.1.d(1) Potential Effects from 3-Dimensional Seismic Surveys. The principle impacting agent attributable to the 3D seismic surveys involves the acoustic-energy pulses emitted by airguns. Additional impacting agents involve vessel-traffic noise and anchoring and the introduction of hydrophone arrays towed or suspended in the ocean or placed on the seafloor. This section evaluates the acoustic impacts associated with airgun emissions and vessel noise and mechanical impacts to habitat (i.e., via anchoring, cable towing, deployment and retrieval from the seafloor, and cable hangups).

III.F.1.d(1)(a) Acoustic Detection and other Sensory Capabilities. Marine organisms have evolved a plethora of ways to sense their environment and use these senses to provide information that allows them to communicate and to find their way (Popper, 2003). Fish can detect sounds via the saccule of the ear (one of the inner ear end organs) (Popper et al., 2003). Studies have demonstrated that many fish species produce and use sounds for a variety of behaviors, with some discriminating between different frequencies and intensities, and detect the presence of a sound within substantial background noise (Popper et al., 2003). Fish use sounds in behaviors including aggression, defense, territorial advertisement, courtship, and mating (Popper et al., 2003). Hearing in fish is not only for acoustic communication and detection of sound-emitting predators and prey but it also can play a major role in telling fish about the acoustic scene at distances well beyond the range of vision (Popper et al., 2003).

Some teleost species can detect infrasound (sounds below 20 Hertz [Hz]). Juvenile salmonids display strong avoidance reactions to infrasound (Popper et al., 2003, citing Knudsen et al., 1992, 1997), and it is reasonable to suggest that such behavior has evolved as a protection against predators. Infrasound has been used as an effective acoustic barrier for downstream migrating Atlantic salmon (*Salmo salar*) smolts (Popper et al., 2003, citing Knudsen et al., 1994).

There probably is no other sensory system as specialized for sensory processing in the aquatic environment as the lateral-line system (Coombs and Braun, 2003). It is a water-current detector found exclusively in certain fish and some amphibians. The lateral-line system is generally a close-range system, capable of detecting current-generating sources (e.g., nearby swimming fishes) no more than one or two body lengths away. The lateral-line system also can detect ambient water motions, such as those in a stream or ocean current, as well as distortions in ambient or self-generated motions due to the presence of stationary objects, such as rocks or boulders. As such, the lateral-line system is believed to influence a number of different behaviors, including schooling, prey capture, courtship and spawning, and rheotaxis. In a more general sense, the lateral-line system undoubtedly also is used to form hydrodynamic images of the environment, enabling fishes to determine the size, shape, identity, and location of both animate and inanimate entities in their immediate vicinity.

Evidence suggests that the lateral line serves as a pressure gradient and particle-motion sensor enabling schooling fish to mediate their proximity and velocity within the body of their school (Stocker, 2002, citing Cahn, 1970, Partridge and Pitcher, 1980). Stocker (2002) suggests that a school of fish could be modeled as a low-frequency oscillating body that the individual fish synchronize to. This view is supported by the visual presentation of fish schools in sunlight that sometimes appear to “flash” simultaneously as they respond to disturbances. This is substantiated also by evidence that when startled by airgun noise, schooling fish fall out of rank and take time to reassemble (Stocker, 2002, citing McCauley et al., 2000). The startle response involves establishing a tighter grouping, so the observed response is not believed to be a scatter response. The interruption or startle response observed in the airgun study might indicate that the hearing of individual fishes is momentarily compromised, or the pressure-gradient field of the school is disturbed sufficiently to lose its integrity and takes time to reestablish, or perhaps some combination of both.

Squid have demonstrated responses to sound (Stocker, 2002). This may have something to do with their schooling nature that requires synchronization with the school, and predator-aversion perception akin to that of schooling fishes (Stocker, 2002).

While researchers noticed a predictable startle response from squid at 174 decibels (dB) (i.e., firing of ink sacks and avoidance behavior) from instantaneous impact noise, a ramped noise indicated a response threshold of 156 dB in a noticeable increase in alarm behavior-increase in swimming speed, and presumably shifts in metabolic rates (Stocker, 2002, citing McCauley et al., 2000). Squid response to ramped noise also includes their rising toward the surface where an acoustical shadow of 12 dB was observed. This indicates an annoyance sensitivity of perhaps 144 dB (Stocker, 2002).

III.F.1.d(1)(b) Potential Impacts from Airgun Acoustic Emissions. Fishes of greatest concern, due to their distribution, abundance, trophic relationships, or vulnerability, are: (1) the diadromous fishes that are abundant seasonally in the nearshore zone, especially arctic char, least cisco, and broad whitefish; (2) cryopelagic fishes such as the arctic cod, an abundant and trophically important fish; (3) intertidal/estuarine/nearshore spawning and/or rearing fishes (e.g., capelin and Pacific herring); and (4) Pacific salmon. Some of these species also are important because they figure prominently in subsistence (e.g., arctic char, ciscoes, whitefishes, arctic cod, rainbow smelt, capelin, and salmon).
In general, marine fish likely can hear airgun sounds with seismic airgun emissions, especially for hearing generalists (e.g., flatfishes) and specialists (e.g., herring). The frequency spectra of seismic-survey devices cover the range of frequencies detected by most fish (Pearson, Skalski, and Malme, 1992; Platt and Popper, 1981; Hawkins, 1981). Marine fishes are likely to detect airgun emissions nearly 2.7-63 km (1.6-39 mi) from their source, depending on water depth (Pearson, Skalski, and Malme, 1992). Fish responses to seismic sources are species specific (Pearson, Skalski, and Malme, 1992).

Mortality and Physiological Damage. Seismic-survey acoustic-energy sources may damage or kill eggs, larvae, and fry of some fishes occurring in close proximity to an airgun, but the harm generally is limited to within 5 m (15 ft) from the airgun and greatest within 1 m (3 ft) of the airgun (e.g., Kostyuchenko, 1973; Dalen and Knutsen, 1987; Holliday et al., 1986; Turnpenny and Nedwell, 1994). Airguns are unlikely to cause immediate deaths of adult and juvenile marine fishes. Sound sources that have resulted in documented physiological damage and mortality of adult, juvenile, and larval fish all have been at or above 180 dB re 1 microPascal (180 dB re 1 μPa) (Turnpenny and Nedwell, 1994). The likelihood of physical damage is related to the characteristics of the sound wave, the species involved, lifestage, distance from the airgun array, configuration of array, and the environmental conditions.

The CDFO (2004c) reviewed scientific information on impacts of seismic sound on fish and concluded that exposure to seismic sound is considered unlikely to result in direct fish or invertebrate mortality. Damage to fish from seismic emissions may develop slowly after exposure (Hastings et al., 1996). Table 1 of Turnpenny and Nedwell (1994) lists observed injuries (for fishes: adult, juvenile, larvae, and eggs) caused by exposure to high-level sound sources.

Overall, the available scientific and management literature suggests that mortality of juvenile and adult fish, the age-classes most relevant to future reproductive fitness and growth, likely would not result from seismic-survey activity. Fishes with impaired hearing may have reduced fitness, potentially making them vulnerable to predators, possibly unable to locate prey or mates, sense their acoustic environment or, in the case of vocal fishes, unable to communicate with other fishes. Given that this most likely would occur to fish within very close proximity to the sound source, MMS anticipates any injury to adult and juvenile fish to be limited to a small number of animals. A mitigation measure requiring the ramp up of the airgun emissions (Sec. II.B.4) would provide fish with an opportunity to move away from the source would reduce the risk of injury or altered behavior to negligible levels.

Impacts to Behavior. The most likely impacts to marine fish and invertebrates from seismic activity would be behavioral disruptions. Behavioral changes to marine fish and invertebrates from seismic-survey activity have been noted in several studies (e.g., Dalen and Knusten, 1987; McCauley et al., 2000; McCauley, Fewtrell, and Popper, 2003; Pearson, Skalski, and Malme, 1992), including: balance problems (but recovery within minutes); disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses (generally around 180 dB re 1 μPa and above). Behavioral impacts are most likely to occur in the 160- to 200-dB range (Turnpenny and Nedwell, 1994).

These responses are expected to be species specific. Displacement also may be relative to the biology and ecology of species involved. Available studies have indicated that these reactions are likely to be short-term in nature. Although repeated, short-term disturbances can result in long-term impacts, seismic activity associated with the proposed lease sale typically would be limited to the open-water season within discrete areas and, therefore, the timeframe is limited in scope.

Fish distribution and feeding behavior can be affected by the sound emitted from airguns and airgun arrays (Turnpenny and Nedwell, 1994). Pelagic fish-catch rates and local abundance were reduced within 33 km of the airgun array for at least 5 days after shooting (Engås, Lokkeborg, and Soldal, 1993, 1996). There is no conclusive evidence for long-term or permanent horizontal displacement, and vertical displacement may be the short-term behavioral response (Slotte et al., 2004). Normal fish behavior likely returns when the airguns are turned off. The repopulation of the vacated area is reliant upon a diffusion-like process (Turnpenny and Nedwell, 1994).

Seismic surveys potentially may disrupt feeding activity and displace diadromous and marine fishes (i.e., capelin, cisco, and the whitefishes) from critical summer feeding areas along the coast. While we cannot say with certainty the impacts of seismic surveys on fish feeding behavior, there is no present evidence that the behavioral impact of seismic surveys has a major effect on fish feeding, except perhaps in the immediate vicinity of an active survey vessel.

Impacts to Migration, Spawning, and Hatchling Survival. Most important to this issue are behavioral reactions that could result in disruption of migratory pathways or diminishing the availability of fish resources for subsistence resources (e.g., through fish abandoning important fishing grounds). For coastwise migratory fish species, acoustic disturbance may displace and disrupt important migratory patterns, habitat use, and life-history behaviors. The populations of many species move from one habitat to another and back again repeatedly during their life (Begon, Harper, and Townsend, 1990). The time-scale involved may be hours, days, months, or years.

For wide-ranging, migratory fish species, disturbance and displacement may disrupt important migratory and life-history behaviors and patterns or habitat areas. Seismic surveys conducted in Federal waters close to State waters, where many fishes migrate through to spawning sites along the coast or in anadromous streams of the Arctic, may disrupt or impede their migrations as fishes attempt to avoid airgun emissions. In addition, conducting more than one seismic operation simultaneously may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors) and concentrating many fishes in areas of unsuitable use.

Migratory species at risk of brief spawning delays include Pacific herring, capelin, Pacific salmon (chiefly pinks and chums), cisco, broad whitefish, and Pacific sand lance. Pacific herring and arctic cod are hearing specialists and are most likely the most acoustically sensitive species occurring in the Sale 193 area. They are, therefore, the most likely to exhibit displacement and avoidance behaviors of the arctic fishes occurring in the proposed sale area. Pacific salmon and the whitefish spawn in freshwater habitats of the Arctic coast. Pacific herring, capelin, and Pacific sand lance spawn on beaches or in nearshore waters.

The 3D/2D seismic surveys typically cover a relatively small area and only stay in a particular area for hours, thereby posing somewhat transient disturbances. Adverse effects to the migration, spawning, and hatchling survival of fish most likely would be temporary and localized, and only a moderate level of disturbance or displacement would occur.

III.F.1.d(1)(c) Impacts from Vessel Noise. Engine-powered vessels may radiate considerable levels of noise underwater. Diesel engines, generators, and propulsion motors contribute significantly to the low-frequency spectrum. Much of the necessary machinery to drive and operate a ship produces vibration, within the frequency range of 10 Hz-1.5 kiloHertz, with the consequence of radiation in the form of pressure waves from the hull (Mitson and Knudsen, 2003). In addition to broadband propeller noise, there is a phenomenon known as "singing," where a discrete tone is produced by the propeller, usually due to physical excitation of the trailing edges of the blades. This can result in very high tone levels within the frequency range of fish hearing. The overall noise of a vessel may emanate from many machinery sources. Pumps in particular often are significant producers of noise from vibration and, at higher frequencies, from turbulent flow. Sharp angles and high flow rates in pipework also can cause cavitation, and even small items of machinery might produce quite high levels of noise.

Mitson and Knudsen (2003) examined the causes and effects of fisheries research-vessel noise on fish abundance estimation and noted that avoidance behavior by a herring school was shown due to a noisy vessel; by contrast, there is an example of no reaction of herring to a noise-reduced vessel. They note a study wherein the FRV *Johan Hjort* was using a propeller shaft speed of 125 revolutions per minute, giving a radiated noise level sufficient to cause fish avoidance behavior at 560 m distance when traveling at 9 knots (kn), but it reduced to 355 m at 10 kn. Their Figure 5 shows that large changes in noise level occur for a small change in speed. Their data also suggest abnormal fish activity continues for some time as the vessel travels away from the recording buoy used in the study.

Vessel traffic associated with the seismic surveys, including the seismic-survey vessels and accompanying guard/chase boat or utility boat, are used chiefly during ice-free conditions. Vessel traffic may disturb some fish resources and their habitat during operations. Pacific salmon in the coastal and marine environment may be disturbed by vessel-traffic noise. However, vessel noise is expected to be chiefly transient; fishes in the immediate vicinity of such vessels are believed likely to avoid such noise perhaps by as much as several hundred meters. Vessel noise is likely to be of negligible impact to fish resources.

III.F.1.d(1)(d) Impacts from Anchor or Cable Deployment and Recovery. Anchoring by vessels is sometimes a necessary practice that locally may disturb the seafloor. In anchoring a vessel or in weighing anchor, fish resources may be crushed or injured during the practice. Anchors may not hold fast under some conditions and drag across the seafloor, damaging sessile organisms (e.g., sponges, corals, kelp) or their habitats (e.g., boulders).

Anchoring in fragile areas (e.g., kelp beds) likely would yield more damage to fish resources and habitat than anchoring offshore in sand or mud. There are few kelp beds in the Chukchi Sea, however, and these are located nearshore or in coastal lagoons, which is an unlikely site for a vessel to anchor unless necessary for safety. Dense kelp beds grow in a few areas of the Beaufort Sea (USDOI,MMS, 2003a), most noteably the Boulder Patch behind the barrier islands of Stepphanson Sound (USDOI, MMS, 2002). The magnitude of any damage to the seafloor would depend chiefly on exactly where anchors were placed, whether an anchor drags, and what an anchor might drag across. Direct impacts to benthic fish habitats would be restricted to the anchoring site, and these limited areas would be very small compared to the total area of benthic habitat available. These negative impacts are considered negligible.

III.F.1.d(1)(e) Impacts from Coincidental Multiple Seismic Surveys. Given the limited evidence of avoidance and displacement from survey areas, the interaction of coincident multiple surveys may influence the distribution of some juvenile and adult fishes, inadvertently herding them away from suitable habitat areas (e.g., nurseries, foraging, mating, spawning, migratory corridors, access to overwintering sites) and concentrating many fishes in areas of unsuitable use. Such areas may not include suitable prey species or in densities to support the concentrated fishes. Displacement also may expose them to more predation than naturally experienced.

Concurrent seismic surveys may facilitate the stranding of some schooling or aggregated arctic fishes onto coastal or insular beaches in the proposed sale area. Such strandings may be more likely if multiple surveys were to spatially “box in” fishes along the shoreline and, thus, limit their avenues of retreat to less ensonified waters. Given that seismic surveys would be operating at least 17 km (10 mi) from shore, it is improbable that this would occur. A mitigation measure to separate concurrent or coincidental seismic survey operations (Sec. II.B.4) would largely alleviate all risk of fish strandings.

III.F.1.d(2) Assessment of Alternatives. The following provides a comparison across the various alternatives of potential impacts to fish resources, EFH, and commercial fisheries in the Chukchi Sea and Beaufort Sea Planning Areas. This assessment is based on the available scientific and management information reviewed above. Sections I and II describe seismic-survey operations, the Proposed Action, airguns and their emissions (i.e., frequency range and sound-pressure levels), and the acoustic environment. Section III.F.1.i(2) above provides a summary of the current state of scientific knowledge on the range of potential impacts to marine fish and invertebrates from seismic activity similar to that described under the Proposed Action and various alternatives.

Alternative 1, the no-action alternative, poses no adverse impacts to fish/fishery resources or EFH.

Alternatives 3 through 8 all employ mitigation measures beyond those in the Proposed Action to avoid or limit the potential for impacts to fish resources and EFH. For Alternatives 3 through 8, there remains little difference across the various alternatives as to the degree of impacts for this species group and related issues. In theory, the alternatives with the more restrictive exclusion zones for marine mammals would provide more protection for marine fish and invertebrate species if shutdown were to occur, but again this would be considered only incrementally more protective for fish, invertebrates and related issues.

III.F.1.d(2)(a) Mitigation Measures. Alternatives 3 through 8 all employ mitigation measures beyond those in the Proposed Action to avoid or limit the potential for mortality and behavioral impacts to fish resources and EFH. These mitigation measures also are specifically designed to limit potential impacts to migration, spawning, rare species, subsistence fishing, and operation of multiple seismic surveys. These measures are outlined in Section IV.

Seismic cables and airgun arrays shall not be towed in the vicinity of fragile biocenoses, unless MMS determines the proposed operations can be conducted without damage to the fragile biocenoses.

- Based on the information provided by MMS on the known locations of fragile biocenoses in the Chukchi and Beaufort seas, the applicant shall clearly explain to what distance their operations will avoid fragile biocenoses and how they will avoid damaging fragile biocenoses.
- Permittees shall report to MMS if damage to fragile biocenoses occurs as a result of their operations. Additionally, Permittees shall notify MMS if they detect any fragile biocenoses otherwise not documented in their permit application.

Vessels shall not anchor in the vicinity of any documented fragile biocenoses (e.g., the Boulder Patch, natural gardens of coral/sponge or macroalgae [e.g., kelp beds]), unless an emergency situation involving human safety specifically exists and there are no other feasible sites to anchor at the time.

III.F.1.d(3) Conclusions. Overall, the Proposed Action and Alternatives 3 through 8 potentially could adversely impact EFH and fish/fishery resources. Many fish species are likely to hear airgun sounds as far as 2.7-63 km (1.6-39 mi) from their source, depending on water depth. Fish responses to seismic sources are species specific and may differ according to the species' lifestage. Immediate mortality and physiological damage to eggs, larvae, and fry, adult and juvenile marine fishes is unlikely to occur, unless the fish are present within 5 m of the sound source (although more likely 1 m). The potential for physical damage is related to the characteristics of the sound wave, the species involved, lifestage, distance from the airgun array, configuration of array, and the environmental conditions. Damage to tissue may not be immediately apparent.

Behavioral changes to marine fish and invertebrates may include balance problems (but recovery within minutes); disoriented swimming behavior; increased swimming speed; tightening schools; displacement; interruption of important biological behaviors (e.g., feeding, mating); shifts in the vertical distribution (either up or down); and occurrence of alarm and startle responses. Some fishes may be displaced from suitable habitat for hours to weeks. Thresholds for typical behavioral effects to fish from airgun sources occur within the 160-dB to 200-dB range.

Potential impacts from vessel noise, anchor or cable deployment, and recovery of fuel spills is regarded as a negligible adverse but not significant impact to fish/fishery resources and EFH. Commercial fisheries in the region are not expected to be impacted. There is a potential for impacts to migration, spawning or subsistence fishing.

There is relatively little information concerning the distribution and abundance of populations of rare fish resources from which to determine whether exposure to seismic airgun emissions would result and subsequently lead to a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status. It is logical to assume that these species would experience the same types of behavioral impacts and potential for immediate mortality as other fish species in the Proposed Action area. Therefore, despite the relatively limited information on these resources, the Proposed Action and various alternatives with the mitigation implemented could result in adverse but not significant impacts to rare fish resources in the Proposed Action area.

The MMS concludes, based on the above assessment, that the Proposed Action and Alternatives 3 through 8 would have adverse but not significant impacts on fish/fishery resources and EFH. The analysis notes specific issues that were afforded additional assessment given their importance to fish survival and reproduction and human uses, including impacts to migration and spawning, rare species, subsistence fishing, and operation of coincidental multiple seismic surveys. However, based on the above assessment, MMS concludes that the potential for impacts to these issues (e.g., migration, spawning, rare species, and subsistence fishing) also is adverse but not significant. In addition, vessels may not anchor and seismic cables and arrays would not be towed within the vicinity of known fragile biocenoses, unless MMS determines the proposed operation can be conducted without damage to the fragile biocenoses. Again, these measures would be consistent across Alternatives 3 through 8.

The MMS also considered the issue of basing its assessment on limited or lacking information on specific fish resources in the Alaskan Arctic. A review of the available science and management literature shows that at present, there are no empirical data to document potential impacts reaching a population-level effect nor have the experiments conducted to date contained adequate controls in place to allow us to predict the nature of a change or that any change would occur. The information that does exist has not demonstrated that seismic surveys would result in significant impacts to marine fish or related issues (e.g., impacts to migration/spawning, rare species, subsistence fishing). Therefore, based on the above review of available scientific and fishery management literature, MMS believes that seismic surveys as defined under the Proposed Action could result in adverse but not significant impacts to fish resources, EFH, and commercial/recreational fisheries.

III.F.2. Marine Birds.

III.F.2.a. Threatened and Endangered Marine Birds.

III.F.2.a (1) Spectacled Eider (Somateria fischeri). All spectacled eider populations were listed as a threatened species under the Endangered Species Act in May 1993. Listing was due to an estimated 96% decrease in nesting abundance in the Yukon-Kuskokwim Delta (Y-K Delta) from the 1970's to the early 1990's and uncertainty about the trends in nesting abundance on the arctic coastal plains in Alaska and Russia. The breeding population on the North Slope currently is the largest breeding population of spectacled eiders in North America. An estimated 4,744 pairs (± 907 pairs, average ± 2 standard errors of the sample) of spectacled eiders breed on the Arctic Coastal Plain of Alaska (66 *FR* 9146-9185). This breeding population represents about 2-3% of the estimated world population of 363,000 spectacled eiders (USDOI, FWS, 1999). Other major breeding populations are in the Y-K Delta and the Arctic Coastal Plain of Russia. The nonbreeding segment of any of the populations is unknown. Based on survey data, the spectacled eider breeding population on the North Slope has not shown a significant decline throughout most of the 1990's. The downward trend of 2.6% per year is bounded by a 90% confidence interval ranging from a 7.7% decline per year to a 2.7% increase per year (66 *FR* 9146-9185).

During the open-water period when seismic-survey activities are possible, spectacled eiders often are encountered moving between tundra breeding areas on the North Slope and the primary molting area at Ledyard Bay in the Chukchi Sea. The most accurate data on spectacled eider movements between breeding, molting, and wintering habitats is described in Petersen, Larned, and Douglas (1999) and forms the basis for the following discussion.

Spectacled eiders do not breed until age 2-3 years. The abundance and distribution of non-breeding eiders is unknown, but they presumably remain at sea. Paired male spectacled eiders begin their movement from nesting areas on the North Slope from late June to early July after the nest is initiated; unsuccessful females follow in late summer and successful females leave the nesting grounds in late August to September. Movement between North Slope breeding areas and the primary molting area in Ledyard Bay typically takes several weeks, indicating that several stops are made along the way in the Beaufort and Chukchi seas. The physiological importance of the stops during this extended migration is undetermined, but these stops could be very important to molt timing and survival during and after the molt. During this period of migration, most spectacled eiders travel offshore. Based on telemetry data for molt migration, male spectacled eiders migrate an average of 7 km offshore of the Beaufort Sea coast, and females fly an average of 17 km offshore (Figure III.F-1). This 10-km difference may be attributed to variation in the distance of ice from shore, and distance might change between years based on the extent of ice retreat. Based on telemetry data for molt migration in the Chukchi Sea, male spectacled eiders migrate an average of 35 m offshore of the Chukchi Sea coast, and females fly an average of 60 km offshore.

Ledyard Bay is an important molting area for North Slope-breeding spectacled eiders in the summer (males) and fall (breeding females). Using satellite telemetry, Petersen, Larned, and Douglas (1999) determined that most spectacled eiders molting at Ledyard Bay were between 30 and 40 km offshore. About 33,200 spectacled eiders were observed using Ledyard Bay during an aerial survey in September 1995. Most were concentrated in a 37-km-diameter circle, with their distribution centered about 67 km southwest of Point Lay and 41 km offshore. During the molt, eiders are flightless for a period of a few weeks. On average, male spectacled eiders arrive at molt locations in Ledyard Bay around the end of the first week of July and depart for wintering areas by the middle of September. Females with broods arrive around the end of the first week of September and depart around the middle of October (Petersen, Larned, and Douglas, 1999). Molting spectacled eiders may be encountered in this area during most of the open-water period. The Ledyard Bay area was designated critical habitat for the spectacled eider in 2001 (USDOI, FWS, 2001) (Figure III.F-2). The critical habitat includes the waters of Ledyard Bay within about 74 km (40 nmi) from shore, excluding waters less than 1.85 km from shore.

Although this relatively discrete molting area is routinely used by spectacled eiders, it does not correlate with known areas of high benthic biomass identified by Grebmeier and Dunton (2000). It may be that eiders are foraging on invertebrates in the water column or in epibenthic habitat. Although benthic biomass also is considered low in the Norton Sound molting area, spectacled eiders are thought to feed on locally abundant large snails (66 *FR* 9146-9185). It is unknown if large snails are abundant in the Ledyard Bay molting area.

III.F.2.a(2) Steller's Eider (Polysticta stelleri). The Alaska-breeding population of Steller's eiders was listed as a threatened species under the Endangered Species Act in June 1997. Three nesting populations of Steller's eiders are identified: (1) western arctic Russia, (2) eastern arctic Russia, and (3) arctic Alaska (Nygard, Frantzen, and Svazas, 1995). In Alaska, Steller's eiders primarily nest in two geographic areas: on the Y-K Delta and on the North Slope near Barrow. Most of the world population of Steller's eiders nests in arctic Russia from the Yamal Peninsula to the Kolyma Delta (Nygard, Frantzen, and Svazas, 1995). Less than 5% of the breeding population nests in arctic Alaska (Rothe and Arthur, 1994). It is the least-abundant eider in Alaska, with a discontinuous historic breeding range along the coast from the Alaska Peninsula northward to the Beaufort Sea (Cooke, 1906; Rothe and Arthur, 1994; USDOI, FWS, 1996). On the North Slope, the greatest breeding densities are found near Barrow (Quakenbush et al., 2002), although they do not breed every year when present (Suydam, 1997).

During the open-water period when seismic survey activities are possible, Steller's eiders could be encountered in the Beaufort and Chukchi seas. Although a few Steller's eiders might be encountered migrating along the Beaufort Sea coast during the period when seismic survey activities are possible, most use the Chukchi Sea as a migration corridor for fall migration. Paired male Steller's eiders depart the North Slope after the nest is initiated in mid- to late June. In some years, for unknown reasons, paired eiders leave the North Slope without initiating a nest. In breeding years, female eiders and young-of-the-year typically depart the North Slope from late September to early October (Johnson and Herter, 1989). Because Steller's eiders occur in such low numbers on the North Slope, it is difficult to observe large migrations by males after nest initiation or post-nesting females and young-of-the-year, as is the case with king and common eiders. It might be reasonable to expect that their movements would be loosely bounded by the distance of ice from shore and the water depth. It is unlikely that Steller's eiders would be further than 24 km offshore, because the water depth would be beyond their diving capability and the males would likely be traveling over sea ice.

Martin (2006) used satellite telemetry to study the seasonal movements of Steller's eiders. During fall migration, Alaskan breeding Steller's eiders stop and rest in areas of the Alaska Chukchi Sea, often in nearshore waters (within 2 km of shore) near Ledyard Bay and Icy Cape. There was less use at more northerly locations near Wainwright and Peard Bay. More males than females migrated from Alaska to areas along the coast of Chukotka. Males that did not go to Chukotka spent more time on the Alaska Chukchi Sea coast.

During extensive aerial surveys of Kasegaluk Lagoon in 1991, Johnson, Wiggins, and Wainwright. (1992) and Johnson, Frost, and Lowry (1992) found Steller's eiders in one of three survey years. During 1991, there were 0.04 Steller's eiders/km^2 compared with 21.59 long-tailed ducks/km^2. Although Steller's eiders may occur at greater densities outside Kasegaluk Lagoon, the total numbers probably are low given the low numbers that breed on the North Slope.

Unlike spectacled eiders, Steller's eiders do not molt in the Chukchi Sea. The primary molting areas are near Kuskokwim Shoals or in lagoons on the north side of the Alaska Peninsula.

III.F.2.a(3) Kittlitz's Murrelet (Brachyramphus brevirostris). This bird is listed as a candidate species throughout Alaska under the Endangered Species Act. This species may nest as far north as Cape Beaufort (100 km northeast of Cape Lisburne) in the Amatusuk Hills. Observations of breeding Kittlitz's murrelets are sparse within the action area. Thompson, Hines, and Williamson (1966) observed a nest several miles inland on the Lisburne Peninsula northeast of Cape Thompson near Angmakrok Mountain. Breeding farther north is unlikely due to lack of suitable habitat (Day, Kuletz, and Nigro, 1999). The Lisburne Peninsula has not been searched for Kittlitz's murrelets since 1983 (USDOI, FWS, 2004). These birds are solitary nesters and extensive survey effort is required to determine local abundance. Due to limited survey efforts, the size of the Kittlitz's murrelet breeding population in the Lisburne Peninsula area remains uncertain.

Foraging areas may occur in the action area. Kittlitz's murrelets have been observed on a regular basis as far north as Point Barrow (Bailey, 1948). Regular observations of Kittlitz's murrelets at sea were noted in late summer and early fall by Divoky (1987), but they have not been subsequently observed by others on similar cruises in the Chukchi Sea, suggesting that there is a great deal of annual variation in their occurrence in the Chukchi Sea.

III.F.2.b. Other Marine Birds. Most marine birds are present in the Beaufort and Chukchi seas on a seasonal basis. Arrival times usually coincide with the formation of leads during spring migration to coastal breeding areas. Many seabirds (e.g., murres) and sea ducks (e.g., common eiders and long-tailed ducks) will closely follow leads during spring migration. Although ice-associated migration is a critical aspect of life for these birds, it will not be discussed further because marine seismic work considered in this document involves ship-based surveys. These ships must operate during relatively ice-free periods, so seismic surveys will not be conducted and seismic survey vessels will not be present in the area during spring migration. Departure times from the Beaufort and Chukchi seas for the fall and winter vary between species and often by sex within the same species, but most marine birds will have moved out of the Beaufort and Chukchi seas by late fall before the formation of sea ice.

III.F.2.b(1) Cliff-nesting Seabirds.

III.F.2.b(1)(a) Murres. Common murres (*Uria aalge*) and thick-billed murres (*U. lomvia*) breed as far north as Cape Lisburne. Murres breed on cliffs and colonies and often are intermingled. Approximately 100,000 murres nest at Cape Lisburne, of which about 70,000 were common murres (USDOI, FWS, 2005). Farther south at Cape Thompson, there are about 390,000 nesting murres, of which 75% are thick-billed murres (Fadely et al., 1989). Long-term monitoring at Cape Thompson indicates a ~50% decline in murre numbers (species combined) since 1960, whereas the colony at Cape Lisburne has more than doubled between 1976 and 1995 (Fadely et al., 1989; Roseneau, 1996).

There are a few important aspects of murres breeding biology that are relevant to seismic surveys. Hatch et al. (2000), used satellite telemetry in the mid-1990's to document that the foraging ranges of the Cape Thompson and Cape Lisburne colonies were almost completely separate. The Cape Thompson colony foraged primarily southwest to southeast and north to Point Hope, whereas the Cape Lisburne colony foraged primarily northwest to northeast. These distributions were similar during the two summers of the study. Distances to foraging areas at Cape Lisburne for a thick-billed murre averaged 66 ± 26 km (range 47-84 km, n = 2 foraging bouts) and 79 ± 26 km (range 44-114, n = 8 foraging bouts) in a single common murre. These ranges are for likely breeders; failed breeders may range considerably farther. Areas regularly used for foraging covered an area of about 30,000 km^2. Based on these data, it is likely that areas used for both murres foraging and seismic surveys will overlap during a portion of the breeding season (Figure III.F-3).

Hatch et al. (2000) also determined that breeding murres began to leave their colonies in early September and adopted one of two distribution patterns. Most females flew south from the colonies, out of the action area. After leaving the colonies, males remained adrift in the Chukchi Sea, and it is thought that they remained with the flightless chicks. This scenario could not be confirmed, because the chicks were not equipped with satellite transmitters. Several researchers working in other areas have determined that only males care for flightless chicks at sea (Scott, 1973; Birkhead, 1976; Harris and Birkhead, 1985; Scott, 1990). The flightless period for juvenile murres at sea lasts from early September to mid-November when they, along with attendant adult males, move quickly to the Bering Sea. During part of this period at sea, male murres also molt and are flightless. While these murres were adrift, they drifted north and west towards Siberia and averaged 15-20 km/day over a large area of the Chukchi Sea. The general distribution of these post-nesting murres is shown in Figure III.F-3. Because the murres distribution during this period (early September through mid-November) covers a large area of the Chukchi Sea, it is possible that there could be co-location of flightless murres and seismic survey vessels.

III.F.2.b(1)(b) Puffins. Horned puffins (*Fratercula corniculata*) are the most abundant puffin species in the Chukchi Sea, where around 18,000 breed at colonies at Cape Lisburne and Cape Thompson (Sowls, Hatch, and Lensink, 1978). There are about 100 breeding tufted puffins (*F. cirrhata*) in the same area (Sowls, Hatch, and Lensink, 1978). Small numbers of tufted puffins breed at small colonies between Cape Thompson and Cape Lisburne. The offshore distance traveled during foraging trips by horned puffins breeding at colonies in the Chukchi Sea is unknown, but trips in excess of 100 km have been reported from horned puffins in other areas of Alaska, although the breeding status of the satellite-tagged birds was not confirmed (Hatch et al., 2000). Horned puffins have been seen near Barrow and have started to breed on Cooper Island in the western Beaufort Sea in recent years (Friends of Cooper Island, 2005). Because horned puffins are not obligate cliff nesters, they can breed on suitable beach habitat on islands nearshore by digging burrows or hiding under large pieces of driftwood or debris. Given their primarily fish-based diet and patchy nature of prey items, it is possible that horned puffins have a range similar to murres, although the degree to which the foraging areas overlap is unknown. Numbers of horned puffins in the Chukchi Sea were greatest in the vicinity of Cape Lisburne after the breeding season in September.

III.F.2.b(1)(c) Black-legged Kittiwake (*Rissa tridactyla*)**.** Approximately 48,000 black-legged kittiwakes breed along the Chukchi Sea coast between Cape Thompson to Cape Lisburne (USDOI, FWS, 2005). These data are more than 25 years old and the current status of the population is unknown. The center of the North Pacific breeding range for black-legged kittiwakes is in the Gulf of Alaska and the Bering Sea (Sowls, Hatch, and Lensink, 1978); therefore, breeding colonies in the Chukchi Sea are at the northern limit of their breeding range in Alaska. Black-legged kittiwakes are common in the Chukchi Sea north of Cape Thompson from mid-July until late September, where they range far offshore (Divoky, 1987) through most of the action area. From late August to late September, the kittiwake density for the central and southern portion of the Chukchi Sea is 2.3 birds/km^2. Divoky (1987) estimated a population in excess of 400,000 black-legged kittiwakes in the pelagic Chukchi Sea, but the portion of this population in the action area is unknown.

III.F.2.b(2) Bering Sea Breeders and Summer Residents.

III.F.2.b(2)(a) Northern Fulmar (Fulmarus glacialis). Northern fulmars do not breed in the Chukchi Sea and those observed in this area during the summer are non-breeders or failed breeders. When present, fulmars are most numerous from late August to mid-September. An estimated 45,000 northern fulmars occupy the Chukchi Sea during this period (Divoky, 1987), but this number is relatively small compared with an estimated 2.1 million that are present in the Bering Sea in the summer (Gould, Forsell, and Lensink, 1982). Divoky (1987) reported that most fulmars in the Chukchi Sea are found in the southern portion (latitude south of Cape Lisburne at 68° 45' N. latitude).

III.F.2.b(2)(b) Short-tailed Shearwaters (Puffinus tenuirostris). These birds breed in the southern hemisphere. In the northern hemisphere, short-tailed shearwaters are found primarily in the Bering Sea, where the population was estimated between 20 and 30 million in 1981 by Hunt, Kaiwi, and Schneider (1981). Short-tailed shearwaters in the Chukchi Sea are most common in the southern portion, although they are routinely found in the central and northern portion, which are in the action area. Short-tailed shearwaters have been reported as far north as Barrow (71° N. latitude) and beyond (Divoky, 1987), depending on the presence of sea ice. At northern latitudes, they likely forage at highly productive patches of euphausiids and amphipods. Short-tailed shearwaters are most common in the central and northern Chukchi Sea from late August to late September. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987). This observation is consistent with those of Bailey (1948).

III.F.2.b(2)(c) Auklets. Parakeet (*Cyclorrhynchus psittacula*), least (*Aethia pusilla*), and crested (*A. cristatella*) auklets breed as far north as the Bering Strait (Sowls, Hatch, and Lensink, 1978) but move north into the Chukchi Sea, including much of the action area, from late August through early October. Based on limited data, crested auklets appear to be the most numerous auklet species in the Chukchi Sea during this period. In 1986, an anomalous year due to a large intrusion of Bering Sea water into the Chukchi Sea that likely affected zooplankton availability, crested auklets were abundant in the Chukchi Sea from late August until early October, probably numbering well over 100,000 (Divoky, 1987). The distribution in other years is probably less uniform with fewer birds, perhaps 100,000 auklets, when combining the three species.

III.F.2.b(3) High-Arctic-Associated Seabirds.

III.F.2.b(3)(a) Black Guillemot (Cepphus grylle). Roseneau and Herter (1984) estimated 500 breeding birds in the Chukchi Sea ranging from Cape Thompson northward. Black guillemots that breed on Cooper Island in the Beaufort Sea also make use of the Chukchi Sea in the vicinity of Point Barrow during the early part of the breeding season (Divoky, 1987). Despite the relatively small breeding population in Alaska (Chukchi and Beaufort seas have a combined total of fewer than 2,000 birds), the pelagic population in the Chukchi Sea is estimated to be around 70,000 (Divoky, 1987). It may be that the Alaskan breeding and non-breeding population combines with the small (~300) Russian Chukchi population and the large (~40,000) nonbreeding population of the East Siberian Sea to forage during the summer near the decomposing ice edge in the northern Chukchi Sea (Golovkin, 1984).

Black guillemots remain closely associated with sea ice throughout their lifetime where they feed extensively on arctic cod (*Boreogadus saida*) (Divoky, 1987). The largest breeding colony in the Beaufort Sea is on Cooper Island, where breeding occurs between late June and early September. These guillemots make frequent trips to the ice edge to forage on arctic cod, so in the Beaufort Sea they are common within their foraging range from Cooper Island. When the sea ice is beyond their foraging range, it appears that black guillemots switch prey to other fish species (Friends of Cooper Island, 2005).

III.F.2.b(3)(b) Ross' Gull (Rhodostethia rosea). These gulls are rare in the Beaufort Sea during summer, because most breed in coastal areas in the Russian Arctic. When present during summer in the Beaufort Sea, they typically are found in close association with the ice edge. In September and October, Ross' gulls are common migrants in the western Beaufort Sea, where they occur in greatest concentrations between Point Barrow and Tangent Point (near the eastern edge of Elson Lagoon) (Divoky et al., 1988). These few weeks in fall are the only time that Ross' gulls are visible nearshore in Alaska. Very few Ross' gulls have been seen in other areas of the Beaufort Sea. These birds do not overwinter in the Arctic Ocean as once thought, and many migrate south through the Chukchi Sea and pass through the Bering Strait to winter in the Bering Sea from St. Lawrence Island south along the Kamchatka Peninsula to the Sea of Okhotsk (Divoky et al., 1988).

III.F.2.b(3)(c) Ivory Gull (Pagophila eburnea). Ivory gulls are present in the Beaufort and Chukchi seas in limited numbers during fall migration to wintering areas in the northern Bering Sea and are uncommon to rare in pelagic waters during summer. Throughout their life cycle they are closely associated with the ice edge (Divoky, 1987).

III.F.2.b(3)(d) Arctic Tern (Sterna paradisaea). Divoky (1983) observed that arctic terns were rare in the pelagic waters of the Beaufort Sea. East of Barrow, arctic terns often concentrate while staging, presumably to feed on zooplankton. Most arctic terns left the Beaufort Sea by mid-September. While common in pelagic waters of the Pacific Ocean on their migration to and from the Southern Hemisphere, they likely follow a more coastal route out of the Chukchi Sea in the fall, as they are considered rare in pelagic waters of the Chukchi (Divoky, 1987).

III.F.2.b(4) Tundra-Breeding Migrants.

III.F.2.b(4)(a) Phalaropes. Both red (*Phalaropus fulicaria*) and red-necked phalaropes (*P. lobatus*) are common in the Chukchi Sea during the open-water periods. Phalaropes are common in pelagic waters as well as within a few meters of shore, where their distribution typically is tied to zooplankton abundance. Due to their reliance on zooplankton, their distribution is patchy, but because they are tied to a moving prey source they may be encountered throughout the Chukchi Sea in varying concentrations. Most phalaropes are in the Chukchi Sea between the Bering Strait and Point Barrow, and relatively few are found farther north. A minimum of 1 million phalaropes are in the Chukchi Sea during summer (Divoky, 1987).

III.F.2.b(4)(b) Jaegers. Pomarine jaegers (*Stercorarius pomarinus*), parasitic jaegers (*S. parasiticus*), and long-tailed jaegers *(S. longicaudus*) are common in the Chukchi Sea in summer until late September, when they move south to the Bering Sea. Jaeger densities at sea are thought to be higher in years when there is low breeding effort on the tundra. Divoky (1987) estimated 100,000 jaegers in the Chukchi Sea between late July and late August. Jaegers were dispersed throughout the Chukchi Sea, with no areas of obvious concentration. Jaegers are pelagic seabirds that only come to shore during breeding season.

III.F.2.b(4)(c) Glaucous Gull (Larus hyperboreus). While some glaucous gulls breed at coastal seabird colonies, most breed inland near freshwater (Divoky, 1987; Sowls, Hatch, and Lensink, 1978). Glaucous gulls were most common in the Chukchi Sea from late July to late September within 70 km of shore between Icy Cape and Barrow. Glaucous gulls typically occur in low densities in the Chukchi Sea, but commonly congregate at food sources (Divoky, 1987).

III.F.2.b(5) Waterfowl.

III.F.2.b(5)(a) Loons. Pacific loons (*Gavia pacifica*) are the most common loon species migrating along the Chukchi Sea coast, although red-throated (*G. stellata*) and yellow-billed (*G. adamsii*) loons are present in lesser numbers. Most loons migrate very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea to head towards the Bering Strait (Divoky, 1987). Most of the loon migration takes place in September and, although loons may stop to rest, they are most commonly observed in flight as they migrate to southern locations for the winter.

III.F.2.b(5)(b) Long-tailed Duck. (Clangula hyemalis). During the open-water period when marine seismic surveys are possible in the Beaufort Sea, long-tailed ducks are abundant in and near lagoons. In late June and early July, most male and nonbreeding female long-tailed ducks assemble in massive flocks in lagoons along the Beaufort Sea to molt, while a smaller number molt on large, freshwater lakes. They are flightless for a 3- to 4-week period through July and August, but the majority of birds remain in or adjacent to the lagoons as opposed to pelagic waters. The molt is an energetically costly time, and long-tailed ducks have abundant food resources in the shallow water lagoons (Flint et al., 2003). Breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in the fall (Johnson and Herter, 1989).

Long-tailed ducks are common in the Chukchi Sea after the first week of September until late October. Typical migration distances offshore for long-tailed ducks as well as other species are shown in Figure III.F-4. While most migrate within 45 km of shore (roughly along the 20-m isobath), infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987). Most long-tailed ducks molt in the lagoons along the Beaufort Sea coast, but they also molt in Kasegaluk Lagoon on the Chukchi Sea coast. During the molt, long-tailed ducks tend to stay in or near the lagoons, especially near passes between the lagoon and the sea (Johnson, Frost, and Lowry, 1992).

III.F.2.b(5)(c) Common Eider (Somateria mollissima). Beginning in late June, male common eiders begin moving towards molting areas in the Chukchi Sea. Most males are out of the Beaufort Sea by late August or early September, and most females were gone by late October or early November. When traveling west along the Beaufort Sea coast, approximately 90% of the common eiders migrate within 48 km of the coast; 7% migrate 13-16 km from shore, roughly along the 17- to 20-m isobath (Bartels, 1973) (Figure III.F-4). Similarly, Divoky (1983) observed most molt-migrant common eiders traveling westward along a narrow corridor within 5 km of the 20-m isobath (13-16 km offshore). Common molt areas in Alaskan waters in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne (Johnson and Herter, 1989). Most breeding female common eiders and their young begin to migrate to molt locations in late August and September, although large numbers of female common eiders were observed molting in the eastern Beaufort Sea in Canada near Cape Parry and Cape Bathurst (Johnson and Herter, 1989).

In July and August, most common eiders in the Chukchi Sea are molting males. When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 45 km from shore. After the molt is completed, some common eiders move offshore into pelagic waters, but the majority of eiders remain close to shore (Divoky, 1987). Adult female breeders migrate to molt locations in late August and September.

III.F.2.b(5)(d) King Eider (Somateria spectabilis). Phillips (2005), using satellite telemetry, determined that most king eiders spent more than 2 weeks staging offshore in the Beaufort Sea prior to migrating to molt locations in the Bering Sea. Females tended to stay for a longer period, possibly to replenish nutrient reserves after nesting. Molting king eiders may be encountered in the Beaufort Sea between late June and early September. Some king eiders remain in the Beaufort Sea until late fall, where they likely use remaining areas of open water (Johnson and Herter, 1989). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km offshore but, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km offshore (Phillips, 2005) (Figure III.F-4). Although king eiders migrate through the Chukchi Sea, specific observations on their movements are poorly understood. Divoky (1987) characterized the movements of all three species of *Somateria* as typically migrating offshore along the 20-m isobath until late September, when they become more common in pelagic waters.

III F.2.c. Impact Assessment.

III.F.2.c(1) Range of Potential Effects. Proposed seismic surveys could have a variety of potential impacts to marine birds from the physical presence and noise produced by vessels, sound produced by the seismic airguns, and the physical presence and noise produced by support aircraft. Marine birds could be exposed to petroleum products in the event of an accidental spill.

III.F.2.c(1)(a) Disturbances from Vessels, Seismic Airguns, and Support Aircraft.

Vessel Presence and Noise. How waterfowl and marine birds respond to disturbances can vary widely depending on the species, time of year, disturbance source, habituation, and other factors (Fox and Madsen, 1997). It seems that in some species of waterfowl, the distance at which disturbances will be tolerated varies depending on flock size, because larger flocks react at greater distances than smaller flocks (Madsen, 1985). There is an energetic cost to moving away from a disturbance as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Some sea-duck species (e.g., Steller's eider, long-tailed duck, and harlequin duck [*Histrionicus histrionicus*]) exhibit different responses to different size vessels near developed harbors on the Alaska Peninsula and eastern Aleutian Islands during the winter (U.S. Army Corps of Engineers, 2000a,b,c). These species appear to tolerate large, slow-moving commercial vessels passing through narrow channels but typically fly away when in visual distance of a fast-moving skiff. Skiffs running small outboard engines at high speed make a distinctive high-pitched sound, whereas large commercial vessels produce a lower rumble. As these sea ducks appear more tolerant of slow-moving skiffs, their reaction may be interpreted as incorporating aspects of vessel size, speed, and engine noise. It also could be that these species associate the small skiffs with hunters they encounter elsewhere in their range. Seismic-survey vessels would remain at least 3 mi offshore, so they would not come close to nesting areas for any waterfowl or marine birds. It is more likely that vessels might disturb waterfowl and marine bids that are foraging or resting at sea or, in the case of a few species, molting at sea.

The seismic-survey activities would not occur in nearshore waters where many marine birds are found. Mitigation measures also could reduce vessel and aircraft disturbance to marine birds, especially spectacled eiders molting in Ledyard Bay.

Seismic Airgun Noise. Seismic surveying with airgun arrays results in both vertical and horizontal sound propagation. Horizontal propagation is a relevant issue, because it is less likely that marine birds would be under the array. Although there is variation in attenuation rates depending on bottom slope and composition, sound from airgun arrays can be detected using hydrophones at ranges of 50-75 km in water 25-50 m deep (Richardson et al., 1995a).

Very few studies have assessed the effects of seismic surveys on marine birds and waterfowl. Stemp (1985) observed responses of northern fulmars, black-legged kittiwakes, and thick-billed murres to seismic activities in Davis Strait offshore of Baffin Island. The first 2 years of the study involved the use of explosives (dynamite gel or slurry explosives) and, therefore, are not relevant as use of underwater explosives is not a method being considered for proposed seismic surveys in the Beaufort and Chukchi seas. The final year of the study involved airguns, but the study locations were never in sight of colonies, feeding concentrations, or flightless murres. The results of this study did not indicate that seabirds were disturbed by seismic surveys using airguns. This conclusion was due in part to natural variation in abundance. Nevertheless, Stemp concluded that negative effects from seismic surveys were not anticipated as long as activities were conducted away from colonies, feeding concentrations, and flightless murres.

In the Beaufort Sea, Lacroix et al. (2003) investigated the effects of seismic surveys on molting long-tailed ducks. These ducks molt in and near coastal lagoons on the North Slope, primarily during August, during which time they are flightless for 3-4 weeks. The molt is an energetically costly period. Long-tailed ducks are small sea ducks with higher metabolic rates and lower capacity to store energy than larger ducks (Goudie and Ankney, 1986). Consequently, long-tailed ducks need to actively feed during the molt period because their energy reserves cannot sustain them during this period (Flint et al., 2003). Lacroix et al. (2003) stated there was no clear response by the ducks to seismic surveying, even when the seismic vessels were in visual range. However, there may be effects that were too subtle to be detected by this study. The presence of long-tailed ducks within several 2.5-km radii of the sound source was monitored, but it was not possible to determine short-distance movements in response to seismic activities. Diving behavior of long-tailed ducks also was monitored by radio-telemetry, because direct observations may have induced bias due to the presence of observers. Therefore, it is unclear whether changes in diving frequency were due to disturbance from seismic vessels or local abundance of prey items. For instance, ducks may dive more in response to disturbances from vessels or they may dive less to avoid underwater noises related to airguns. Further behavioral observations would be necessary to characterize the response of long-tailed ducks to seismic surveys, even though the Lacroix et al. (2003) study found no effect of seismic surveying activity on movements or diving behavior of long-tailed ducks.

Seismic airguns have the potential to alter the availability of marine bird prey. Research indicates that there are few effects on invertebrates from noise produced by airguns, unless the invertebrate is within a few feet of the source (Brand and Wilson, 1996; McCauly, 1994). Consequently, noises from seismic airguns are not likely to decrease the availability of invertebrate crustaceans, bivalves, or mollusks.

It is possible that seismic surveys might affect fish and invertebrates in proximity to the airgun array (see discussion in Section III.F.1 Fish/Fishery Resources and Essential Fish Habitat). However, the effects of seismic surveys on marine fish that might change their availability to marine birds have not been documented under field operating conditions (CDFO, 2004b). If forage fishes are displaced by airgun noise, birds feeding on those resources might be temporarily displaced and stop feeding within a few kilometers of the survey activities.

It is possible, during the course of normal feeding or escape behavior that some birds could be near enough to an airgun to be injured by a pulse. The threshold for physiological damage, namely to the auditory system, for marine birds is unknown. Although MMS has no information about the circumstances where this might occur, the reactions of birds to airgun noise suggest that a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury, if that were possible at all. A mitigation measure to “ramp-up,” which is a gradual increase in decibel level as the seismic activities begin, can allow diving birds to hear the start up of the seismic survey and help disperse them before harm occurs. During ongoing surveys, diving birds also are likely to hear the advance of the slow-moving survey vessel and associated airgun operations and move away. Mitigation measures to ramp up airguns for use and to document bird reactions to seismic-survey vessel activities may help further evaluate the potential for marine birds to be harmed by airgun noises.

Support Aircraft Noise. Aircraft operating at low altitudes may disturb birds that are in the path of the aircraft. There is an energetic cost to repeatedly moving away from aircraft disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Implementation of mitigation measures could reduce the magnitude and frequency of aircraft-related noise disturbances to eiders and murrelets.

III.F.2.c(1)(b) Collisions with Vessels and Aircraft. Migrating birds colliding into manmade structures has been well documented in the literature. Weather conditions such as storms associated with rain, snow, icing, and fog or low clouds at the time of the occurrences often are attributed as causal factors (Weir, 1976; Brown, 1993). Lighting of structures, which can be intensified by fog or rain, also has been identified as a factor (Avery, Springer, and Dailey, 1980; Brown, 1993; Jehl, 1993). Birds are attracted to the lights, become disoriented, and may collide with the light support structure (e.g., pole, tower, or vessel).

Vessel Strikes. Lights on fishing vessels at sea have been known to attract large numbers of seabirds during storms (Dick and Donaldson, 1978). Black (2005) reported a collision of about 900 birds, mostly a variety of petrel species and Antarctic prion, with a 75-m fishing trawler near South Georgia. The collisions took place over a 6-hour period at night, when visibility was less than 1 nautical mile (nmi) due to fog and rain. Of the 900 birds on deck, 215 were dead. Most of the remaining birds were released alive after being allowed to dry off in boxes stored in a protected area on deck. Waterfowl and shorebirds also have been documented as colliding with lighted structures and boats at sea (Schorger, 1952; Day, Kuletz, and Nigro, 2003).

Marine birds are at risk of collisions with seismic-survey vessels at night due to attraction and subsequent disorientation from high-intensity lights on ships. Sea ducks are vulnerable to collisions with seismic-survey vessels, primarily because they tend to fly low over the water. Johnson and Richardson (1982) documented that 88% of eiders migrating to molting areas along the Beaufort Sea coast flew below an estimated 10 m (32 ft) and more than 50% flew below 5 m (16 ft). Eiders (various species) leaving the North Slope travel day or night. Movement rates (birds/hour) did not differ between night and day, but movement rates and velocities were higher on nights with good visibility (Day et al., 2004).

Identification and avoidance of marine mammals is an important mitigation measure to prevent harmful impacts to marine mammals from seismic surveys. High-intensity lights are needed during the seismic surveys to help spot marine mammals during nighttime operations or when visibility is hampered by rain or fog. A mitigation measure to not use high-intensity lights when not needed can reduce the potential that marine birds would be attracted to and strike the seismic survey vessel.

Aircraft Strikes. Seismic-survey-support aircraft operating at low altitudes have the potential to flush birds into the path of the aircraft where a collision could occur. While such strikes are relatively rare, implementation of mitigation measures could further reduce the frequency of strike risk to marine birds.

III.F.2.c(1)(c) Petroleum Exposure. Coastal and marine birds could be affected by a survey-vessel accident resulting in a petroleum spill. However, the potential for a spill is low, given that the vessels will be operating at least 3 mi from shore and away from obstructions. In addition, seismic-survey operations generally try to stay at least 15 mi away from each other so that they do not interfere with each others' acoustic-generating system. During seismic surveys, vessels will be operating at about 4.5 kn, so speeds generally will be slow except for movements between survey areas. Seismic surveys need to be conducted in a relatively ice-free environment, so there is only a small chance of damage to survey vessels from ice.

Each streamer cable may contain 100-200 L of a paraffin-like, biodegradable fluid to provide buoyancy. Newer generation streamer cables are filled with foam and, if used, they would eliminate any risk of a spill presented by fluid-filled cables. Breaks in these cables are rare and typically only occur when currents whip cables around a structure, such as an oil platform. Seismic surveys in the Beaufort and Chukchi seas would be done in open water, far away from structures that would present a risk of entanglement and a spill.

If direct oiling of eiders and murrelets were to occur, despite being unlikely, it would likely result in loss of feather insulation and acute and chronic toxicity from ingestion and absorption. Oiled birds also could carry oil to nests where eggs and young could be oiled.

Both sexes of some marine birds incubate eggs and bring fish for their young. Lightly oiled birds could bring oil contamination back to their nest where eggs and young could be contaminated. Lightly oiled birds also could also bring contaminated food to the nest. Heavily oiled birds would be prevented from returning to the nest, resulting in the young dying of starvation.

According to oil-spill records, most accidental spills in Alaska happen in harbors or during groundings; consequently, a spill from a vessel on the high seas where pelagic murrelets are mostly found in the Chukchi Sea would be a rare occurrence. The MMS believes that the risk of incidents involving the release of oil and fuel from vessels during seismic-survey activities is likely to be small. This conclusion is based on the assumption that there would be no unauthorized discharges from the seismic vessel, such as the discharge of engine oil, etc. Therefore, any effects would be due to accidental discharges, such as a spill of fuel oil during a fuel transfer from a support vessel to a seismic vessel. The MMS assumes further that the operators would be cautious and vigilant during fuel transfers; for example, if a fuel hose broke, the fuel valves would be shut off quickly. Given that the risk of incidents likely is small and that the seismic surveys typically would be working more than 3 mi from shore, petroleum exposure is not addressed as a specific category below.

III.F.2.c(1)(d) Mitigation Measures. Several methods exist to reduce the potential negative impacts to marine birds. Implementation of the following measures would mitigate potential negative effects on threatened, endangered, and candidate and other marine and coastal birds during proposed seismic-survey activities within the Proposed Action Area:

Disturbance:

- No seismic activity, including re-supply vessels and other related traffic, will be permitted within the Ledyard Bay Critical Habitat Area (Figure III.F-2) after July 1 of each year, unless human health or safety dictates otherwise.

- Survey-support aircraft would avoid over-flights across the Ledyard Bay Critical Habitat Area below an altitude of 1,500 ft (450 m) after July 1 of each year, unless human health or safety dictates otherwise. In other coastal areas, seismic-survey-support aircraft should maintain at least 1,500 ft (450 m) over beaches, lagoons, and nearshore waters as much as possible.

Collisions with Vessels or Aircraft:

- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m bathymetric contour. High-intensity lights will be turned off in inclement weather when a vessel is not actively participating in seismic surveys, however, navigation lights, deck lights, and interior lights could remain on for safety.

- All bird-vessel collisions shall be documented. Minimum information will include species, date/time, location, weather, and vessel operational status when the strike occurred. If eiders or murrelets that are injured or killed through collision with survey vessels are recoverable, seismic survey personnel should recover them and immediately contact the Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, AK, at 907-456-0499 for instructions on the handling and disposal of the injured or dead bird(s).

- Ramping-up procedures will be used when initiating airgun operations.

The following impact assessments assume these mitigation measures would be fully implemented.

III.F.2.c(2) Impacts of Alternatives on Threatened and Endangered Species. The level of potential impact is based on the alternative selected.

Alternative 1. The no-action alternative would mean that spectacled and Steller's eiders and Kittlitz's murrelets in the Beaufort and Chukchi seas would not be exposed to disturbance and noise from seismic vessels and associated seismic activities.

Alternative 2. This alternative was deleted from further consideration and is not analyzed further.

Alternatives 3, 4, 5, 6, 7, and 8. These alternatives differ only in how they implement a marine mammal-exclusion zone. The marine mammal-exclusion zone is intended to prevent disturbing marine mammals within specified zones around the seismic-survey vessel. The zone is monitored using observers that are onboard and/or in aircraft. Aircraft or other vessels may be required if the exclusion zone is larger than onboard observers can monitor. Mitigation measures will reduce the impacts to coastal birds from aircraft used to monitor the exclusion zone.

Onboard observers would need the use of high-intensity lighting to maintain vigilance for marine mammals when the surveys are being conducted during periods of darkness or poor visibility (e.g., during rain or fog). Use of high-intensity lighting would be independent of the size of the exclusion zone, as these lights would be useful only in areas closest to the seismic-survey vessel. Mitigation measures will reduce the impacts to birds from high-intensity lighting.

Alternative 9: This alternative would have limited seismic activities to one geophysical exploration permit or authorized ancillary activity in each planning area each year. This alternative was deleted from further consideration and is not analyzed further.

II.F.2.c(2)(a) Spectacled Eider. The most likely effects of seismic surveying to spectacled eiders in the Beaufort Sea involve disturbance and collisions.

Disturbances. The potential for disturbance to spectacled eiders is limited to the brief period when females depart the tundra after nesting and enter the Beaufort Sea. A variety of tugs and barges already transit through the Beaufort and Chukchi seas to supply coastal communities and industries, so the presence of seismic-survey ships would represent a small incremental increase in disturbance from vessel traffic.

The most important issue with disturbance involves the collocation of seismic activities and molting spectacled eiders. Male and female spectacled eiders typically take from 1-2 weeks to move from breeding grounds on the North Slope to Ledyard Bay. This migration is believed to involve all breeding females as well as a portion of males, because some males that breed on the North Slope molt in Russian coastal waters. During the couple of weeks between breeding and molting, eiders are at sea, presumably replenishing energy reserves before the energetically demanding molt. During this migration, males typically migrate within 7 km of the coast and females stay within 17 km; the disparity in distance likely is a function of the extent of sea ice (Petersen, Larned, and Douglas, 1999). Due to the extent of sea ice, it is unlikely that seismic surveys would begin in the Beaufort Sea when males are passing through and, therefore, negative effects are unlikely. Females with broods might be encountered during seismic surveys occurring within 17 km of shore between late August and early September. During this migration, eiders are able to fly and move away from disturbances, though obviously at some energetic cost.

In the Chukchi Sea, spectacled eiders molt in Ledyard Bay, an area designated as critical habitat. Males and/or females are present in this area from early July through the middle of October or possibly later. Regardless of the degree of reliance on exogenous energy reserves during this energetically demanding period, spectacled eiders are common in this area and it is probable that energetic needs are a component of their molt-site selection. Spectacled eiders will either dive or fly in response to a disturbance. While present in Ledyard Bay, these eiders will molt and be flightless for a few weeks, so diving or displacing by running and flapping on the surface of the water are the only options to rapidly evacuate an area. There is an energetic cost in this behavior as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. The magnitude of the effects likely would depend on the frequency and timing of the disturbance. In September 1995, approximately 33,000 spectacled eiders were encountered in Ledyard Bay; most were located in a 37-km-diameter circle centered approximately 40 km offshore. Similar numbers and distributions were observed on other aerial surveys (Petersen, Larned, and Douglas, 1999). If seismic-survey lines were 500 m apart, as many as 74 transects would be needed to survey the Ledyard Bay molting area. With 3D surveys that acquire data using a racetrack pattern, these passes could be separated in time, as alternate lines could be surveyed at a fairly distant location before the vessel returns to the vicinity of the eiders. This actually may increase impacts to eiders, because it could result in repeated disturbances over a longer time period instead of a couple of days of intense local effort.

Seismic surveys in the Beaufort Sea near a coastal lagoon did not appear to affect the movements or diving behavior of molting long-tailed ducks, although the study design did not facilitate detection of more localized changes in distribution or diving behavior (Lacroix et al., 2003). It is unknown if spectacled eiders might respond in a similar manner. Long-tailed ducks molt in coastal lagoons protected by barrier islands, whereas spectacled eiders molt in pelagic waters far from shore. It is possible that the barrier islands add a measure of protection from underwater sounds, although most barrier islands in the Beaufort Sea provide a poor visual buffer, because they usually are less than a couple of meters above sea level.

Molting spectacled eiders in Norton Sound dove and resurfaced farther away in response to small skiffs. These eiders appeared more wary than other species of sea ducks to the presence of small boats (Larned, 2006, pers. comm.). Unlike many other species of sea ducks, spectacled eiders have minimal exposure to vessels during their lifecycle, as there is minimal exposure on the North Slope, and they winter in polynyas south of St. Lawrence Island in the Bering Sea. Accordingly, there is little opportunity for habituation to vessel disturbance. Mitigation measures would avoid or minimize vessel disturbance to spectacled eiders molting in the Ledyard Bay area.

Collisions. Eiders flying during low-visibility conditions of rain or fog can strike vessels. Spectacled eiders also often migrate at night. Eiders flying at night can become disoriented by high-intensity work lights and strike vessels. As day-length decreases during the late summer, eiders migrating to the molting area in darkness would be more likely to encounter vessels using high-intensity lights.

Mitigation measures for marine mammals likely necessitate the use of high-intensity lights at night and during inclement weather to search for marine mammals in the vessel path. Seismic surveys would cease when the marine mammal-exclusion zone could not be effectively monitored, but the high-intensity lights could remain on to search for marine mammals.

The risk of collisions with spectacled eiders is lowest beyond 60 km offshore, because females tend to travel within 60 km and males travel within 35 km. Within these distances from shore, the risk of collisions might increase, especially during poor visibility. The greatest risk of a vessel strike would exist if the seismic-survey vessel was using high-intensity lighting while transiting through areas of high spectacled eider density at night during fog or rain. Implementation of mitigation measures would reduce the risk of the seismic-survey vessel operating in eider-concentration areas.

Summary: Alternative 1, no action, would have the least potential negative effect on spectacled eiders. Alternatives 3-8 would have the same relative amount of potential effects on spectacled eiders, varying by the amount of monitoring for marine mammals. With the implementation of measures to mitigate impacts to marine and coastal birds, none of the alternatives are likely to adversely affect spectacled eiders in the project area.

III.F.2.c(2)(b) Steller's Eider. The most likely effects of seismic surveys to Steller's eiders in the Beaufort and Chukchi seas involve disturbance and collisions. Due to the extent of sea ice, it is unlikely that seismic surveys would begin in the Beaufort Sea when males are passing through, so impacts to Steller's eiders are unlikely. Males could be encountered in the Chukchi Sea in the summer and fall, and females might be encountered in both the Beaufort and Chukchi seas during the seismic-survey period.

Disturbances. The potential for disturbing Steller's eiders is limited to the brief period when females depart the tundra after nesting and move to the Beaufort Sea. Given that seismic surveys would not occur within 3 mi of shore and the limited distribution of Steller's eiders in the Beaufort Sea, effects are unlikely.

Steller's eiders spend a relatively small portion of their time in the Alaska Chukchi Sea. Spring migration already would be completed prior to seismic-survey activities, because the sea needs to be relatively ice free before surveys could begin. Eiders resting and foraging along the Chukchi Sea coast in Alaska could be disturbed by seismic-survey activities; however, because they molt in other areas of Alaska they would be well outside the action area during this energetically demanding period. Due to their low numbers in the Chukchi Sea and their tendency to occur within 2 km of shore, it is unlikely that there would be any significant adverse effects from disturbance.

Collisions. Steller's eiders flying during low-visibility conditions of rain or fog can strike vessels. Steller's eiders flying at night could be attracted to high-intensity lights on vessels, become disoriented, and strike the vessel. The numbers of Steller's eiders that might be affected probably are much lower than for spectacled eiders because of the lower abundance of Steller's eider on the North Slope and the fact that they do not molt or otherwise concentrate in the action area.

Summary: Alternative 1, no action, would have the least potential negative effect on Steller's eiders. Alternatives 3-8 would have the same relative amount of potential effects on Steller's eiders, varying by the amount of monitoring for marine mammals. With the implementation of measures to mitigate impacts to marine and coastal birds, none of the alternatives are likely to adversely affect Steller's eiders in the project area.

III.F.2.c(2)(c) Kittlitz's Murrelet. Limited data exist on breeding Kittlitz's murrelets in the action area. Breeding pairs in the Chukchi Sea are solitary and nested well inland on the tundra. They forage at sea during nesting and chick rearing, but their foraging distances during this period in the Chukchi Sea are unknown. In glaciated areas in Alaska, they typically forage within a few hundred meters of shore. In Chukotka and the Sea of Okhotsk, they typically forage 200-500 m offshore (Day, Kuletz, and Nigro, 1999). An estimated 15,000 Kittlitz's murrelets have been observed in the pelagic waters of the Chukchi Sea beginning in late August, but their presence is sporadic, suggesting there are additional factors that influence their distribution and that there is large interannual variation in abundance (Divoky, 1987). Wildlife observers under contract to a seismic exploration company voluntarily completed 68 10-minute ship-based surveys (Gould and Forsell, 1989) covering approximately 38 km^2 of open-water about 100 miles offshore in the Chukchi Sea between late-July and mid-August 2006. Preliminary review of these survey data indicated that only one "unidentified small dark auklet" (possibly a murrelet) was observed. Accordingly, disturbance effects from seismic survey and support vessels encountering birds at these at-sea densities are expected to be insignificant. Overall, the potential for murrelet disturbance from or collision with seismic-survey vessels or aircraft is small.

The effects of seismic surveys on marine fish that might increase or decrease their availability to marine birds have not been documented under field-operating conditions (CDFO, 2004b). If forage fishes are displaced by airgun noise, pelagic Kittlitz's murrelets might be temporarily displaced and stop feeding within a few kilometers of the survey activities.

Kittlitz's murrelets feed by diving to several meters or more. The murrelets also escape from boats by diving when the vessel is close. It is possible, during the course of normal feeding or escape behavior that a murrelet could be near enough to an airgun to be injured by a pulse. A mitigation measure to "ramp up" airgun noise when seismic surveys begin can help disperse birds before harm occurs. During ongoing surveys, murrelets also are likely to hear the advance of the slow-moving survey vessel and associated airgun operations and move away.

Wildlife observers under contract to an exploration company voluntarily made several voluntary observations regarding the reaction of birds, primarily murres, to the seismic survey vessel. These observations were made in open-water about 100 miles offshore in the Chukchi Sea between late-July and mid-August 2006. Preliminary review of these survey data indicated that murres tended to react to the source vessel when it was within 100 m. Most birds dove and most frequently surfaced at greater distances away from the vessel. A few birds used their wings to "paddle" away from the vessel and several others flew away. It was impossible to observe birds beyond abeam of the moving vessel or to ascertain if underwater movements were influenced by vessel or seismic airgun noise. These observations are inconclusive and it remains difficult to assume any diving birds, potentially including murrelets, would dive in close proximity of an active airgun array where they could be injured.

A mitigation measures to ramp-up the airguns at the beginning of a survey could allow diving birds in the seismic survey area an opportunity to move away from the sound source prior to any injury. Additional research or monitoring to document murrelet reactions to seismic-survey vessel activities could help evaluate the potential for marine birds to be harmed by airgun noises. Lacking this information, it is assumed any Kittlitz's murrelets in the seismic survey area would move away from the vessel and an active airgun array prior to injury from noise.

Summary: Alternative 1, no action, would have the least potential negative effect on Kittlitz'z murrelets. Alternatives 3-8 would have the same relative amount of potential effects on Kittlitz'z murrelets, varying by the amount of monitoring for marine mammals. With the implementation of measures to mitigate impacts to marine and coastal birds, none of the alternatives are likely to adversely affect Kittlitz's murrelets in the project area.

III.F.2.c(3) Impacts of Alternatives on Other Marine Birds. The range of potential effects of seismic surveys to other marine birds are summarized in the impact assessment section III.F.2.c(1) above.

III.F.2.c(3)(a) Seabirds.

Murres. Both species of murres could be disturbed by seismic surveys, primarily during the at-sea rearing period when juveniles and molting attendant males are unable to fly. During this period, these birds are distributed based on currents covering most of the Chukchi Sea. Data on their distribution during this period is based on telemetry data from Hatch et al. (2000). If bird distribution during the period of potential seismic surveys is similar to that of the telemetry studies in the mid 1990's, most murres would be outside the action area and would not be disturbed. Because distribution is based on prevailing currents, it is possible that the at-sea distribution will remain similar in future years.

Disturbance at the breeding colonies is unlikely, because survey vessels will not be operating closer than 3 mi offshore. Foraging bouts can range more than 100 km from shore, but the patchy prey distribution and transient nature of seismic surveys is unlikely to lead to disturbance. Furthermore, wildlife observers under contract to an exploration company voluntarily completed 68 10-minute ship-based surveys (Gould and Forsell 1989) in open-water about 100 miles offshore in the Chukchi Sea between late-July and mid-August 2006. Preliminary review of these survey data indicated that murres, as a group, were found at a density of approximately 0.7 birds/km^2. Disturbance effects from seismic survey and support vessels encountering birds at these at-sea densities are expected to be insignificant.

The chance of murres colliding with seismic-survey vessels is relatively low, because most murres should be out of the action area during the male molt and at-sea rearing period. The primary risk of collision occurs during the brief period when murres migrate south to the Bering Sea. Based on telemetry data (Hatch et al., 2000), most murres would not migrate through the action area.

Puffins. Seismic-survey vessels would remain at least 3 mi from shore, so there is little chance for disturbance of breeding colonies. Most puffins are located near Cape Lisburne in September, but this area represents only a small portion of the action area, and it is possible that this area already might be surveyed prior to September. If surveys were completed prior to September, there would be minimal risk of puffins colliding with the seismic-survey vessel.

Black-legged Kittiwake. Disturbance and risk of collision should be minimal to kittiwakes, as they are mobile (i.e., not molting) and wide ranging throughout the Chukchi Sea. There are no discernable areas of concentration that may increase the impact of disturbance or risk of collision. Most kittiwakes are out of the Chukchi Sea by late September.

Northern Fulmar. If distribution trends are similar to the 1980's, most fulmars would be south of the action area. Furthermore, most fulmars are present in the Chukchi Sea for only a few weeks at the end of summer; it is possible that all survey vessels would be working on survey areas farther north during that time to take advantage of the period of maximum ice retreat in the Beaufort Sea. Wildlife observers under contract to an exploration company voluntarily completed 68 10-minute ship-based surveys (Gould and Forsell 1989) in open-water about 100 miles offshore in the Chukchi Sea between late-July and mid-August 2006. Preliminary review of these survey data indicated that only 5 fulmars were observed in an area of about 38 km^2. Disturbance effects from seismic survey and support vessels encountering birds at these at-sea densities are expected to make the chance of large scale disturbance or collision minimal.

Short-tailed Shearwaters and Auklets. These species are considered together, because they occur in similar numbers and both forage on patchily distributed zooplankton in pelagic waters. The chance of disturbance is low, because their distribution is patchy and the disturbance is of short duration. A disturbance might lead to a temporary halt in feeding in one area or a switch to a new and possibly less-productive area.

The risk of collisions is a more relevant issue, as shearwaters and auklets are present in the Chukchi Sea until late September or early October. There are about 12 hours of darkness during this period, and seismic surveys could occur 24 hours a day. Large collisions involving crested auklets and lights on commercial-fishing vessels have been documented; Dick and Donaldson (1978) documented 1.5 metric tons of crested auklets striking and nearly capsizing a fishing vessel. Collisions are not documented for shearwaters, but these types of events typically are poorly documented. It appears most likely that large collisions occur when a combination of darkness, fog, rain, or snow exist and high-intensity lights are used on commercial vessels near large aggregations of certain species of seabirds. While there is no certainty that collisions would occur, the chance seems to be the greatest for auklets and, perhaps to a lesser extent, shearwaters in the Chukchi Sea during seismic surveys. Implementation of mitigation measures would reduce the likelihood of collisions.

Black Guillemot. These birds usually are closely associated with the ice edge, and the likelihood of disturbance or collisions is limited to a small portion of the action area. Seismic-survey vessels need to follow a specific course during the survey and, therefore, minimize surveys near the ice edge due to the presence of large sections of ice that could cause the vessel to alter course or damage seismic instruments. Accordingly, operations in areas likely to be inhabited by black guillemots are limited, and the chance for disturbance and collisions is minimal.

III.F.2.c(3)(b) Gulls and Terns. The likelihood of impacts from disturbance or collisions to Ross' gulls, ivory gulls, arctic terns, and glaucous gulls is minimal. Ross's gulls and ivory gulls are associated with ice and breed well outside the action area. They are present in the action area for a short period before migrating through the Chukchi Sea to overwintering locations. Arctic terns breed near the coast of both seas, but seismic vessels will be operating beyond 3 mi from shore; therefore, disturbance is unlikely. Terns migrate through the Chukchi Sea but are rarely observed in pelagic waters. Similarly, glaucous gulls typically are most abundant within 70 km of shore. Wildlife observers under contract to an exploration company voluntarily completed 68 10-minute ship-based surveys (Gould and Forsell 1989) in about 38 km^2 of open-water about 100 miles offshore in the Chukchi Sea between late-July and mid-August 2006. Preliminary review of these survey data indicated densities of Larids (jaegers, gulls, and kittiwakes) at 0.5 birds/km^2. Disturbance effects and collision potential from seismic survey and support vessels encountering birds at these at-sea densities are expected to be small.

III.F.2.c(3)(c) Phalaropes. Both species of phalaropes may be encountered in the Beaufort and Chukchi seas, especially during the postnesting period in late summer and fall. Phalaropes use habitat within a few meters of shore and also pelagic areas; their distribution is generally tied to patchy concentrations of zooplankton. Because seismic-survey vessels would remain at least 3 mi offshore, disturbance to or a collision with phalaropes nearshore is unlikely. In pelagic waters, disturbances may occur but their impact is likely to be minimal, due to the patchy distribution of prey and the transient and short-term nature of seismic surveys. Disturbed phalaropes might move to another prey patch or return to the same area after the disturbance passes. Collisions may occur, especially during inclement weather, but the likelihood of collisions is unknown. Lambert (1988) reported that red-necked phalaropes were attracted to lights on a ship in the Gulf of Guinea and reacted most strongly at night in inclement weather. There does not appear to be any other documented cases of collisions involving phalaropes, so the incidence of collisions may either be low or unreported.

III.F.2.c(3)(d) Jaegers. The chance of impacts to jaegers by disturbance or collision is minimal. Although they are present throughout the Chukchi Sea in the fall when there are several hours of darkness and frequent inclement weather, jaegers are not known to occur in high concentrations in any area. See recent density information under Gulls and Terns, above.

III.F.2.c(3)(e) Waterfowl.

Loons. In the Beaufort and Chukchi seas, loons typically migrate close to shore until they are south of Cape Lisburne, when they travel over pelagic waters on their migration to wintering areas. Impacts from disturbances or collisions are unlikely, because loons migrate nearshore in most of the action area, and seismic-survey vessels would remain 3 mi offshore. Potential mitigation measures are discussed below that might reduce the likelihood of collisions.

Long-Tailed Ducks. Impacts from disturbances or collisions are unlikely, because long-tailed ducks molt in lagoons on the coast of the Beaufort Sea. Seismic-survey vessels would remain 3 mi offshore during surveys. This distance is far greater than those encountered during a recent study on the effects of seismic surveys on long-tailed ducks in Beaufort Sea lagoons (Lacroix et al., 2003). There was no clear response by the ducks to seismic surveying, even when the seismic vessels were in visual range.

After molting, these birds move south following the Chukchi Sea coast and typically remain 45 km offshore along the 20-m isobath. Observations farther offshore are uncommon. The chance of disturbance is small due to the small portion of the action area within 45 km from the coast. Collisions are possible, especially in inclement weather. Implementation of mitigation measures would reduce the likelihood of collisions.

Common Eider. Impacts to common eiders likely would be similar to those described for spectacled eiders, although the implications of potential impacts probably are less significant. Common eiders molt near several locations along the Alaska Chukchi Sea coast including Point Lay, Icy Cape, and Cape Lisburne. Like spectacled eiders, their molt locations probably coincide with areas of high-density prey items. Disturbance at molt locations could impose additional stress during this energetically demanding period; the degree of stress would depend on the magnitude and frequency of disturbance. Implementation of mitigation measures would minimize the magnitude and frequency of disturbances to common eiders.

Collisions are possible, especially during nighttime when there is inclement weather. Most common eiders follow the 20-m isobath, which is ~45 km from shore in the Chukchi Sea and 13-16 km in the Beaufort Sea. Because most of the action area lies well beyond these distances form shore, eiders are at risk of collisions for a small portion of the surveys. Implementation of mitigation measures would reduce the likelihood of collisions.

King Eider. Impacts would be similar to common eiders in both the Beaufort and Chukchi seas, except that king eiders molt at locations in the Bering Sea. Migration distances from shore are similar, so the collision impacts are likely similar to common eiders. Implementation of mitigation measures would reduce the likelihood of collisions.

III.F.2.c(4) Summary of Effects. Potential negative effects of the proposed seismic-survey activities on coastal and marine birds can be summarized in categories of:

- Disturbance from the physical presence of vessels;
- Disturbance from noise by vessels, seismic airguns, and support aircraft;
- Collision with vessels or aircraft; and
- Direct and indirect results of petroleum product spills from vessels.

It would be difficult to quantify effects in terms of the number of marine birds potentially affected or areas of habitat potentially modified or lost, because the area of the proposed seismic surveys is very large and specific knowledge of marine bird distribution and density within the survey area is limited. Consequently, a summarization of effects will be in general terms that address the potential effects of prelease seismic activities on marine birds within the survey area.

III.F.2.c(4)(a) Disturbance from the Physical Presence of Vessels. Seismic-vessel activity is expected to have only temporary and localized disturbance effects on relatively small numbers of certain marine bird species that are distributed in low density over a large action area. Similarly, disturbance to pelagic species are expected to be minimal, because they are expected to move away from the slow-moving seismic vessel well in advance of the towed seismic- airgun array. Any displacement to these birds is expected to be dynamic and temporary. Information collected by onboard observers during seismic surveys conducted in the Chukchi Sea indicated that at-sea densities of birds are low. Preliminary review of these survey data indicated that no bird species/groups occurred at a density greater than 1 bird/km2. Murres, as a group, were found at the highest density, approximately 0.7 birds/km^2, followed by Larids (jaegers, gulls, and kittiwakes) at 0.5 birds/km^2. The only other birds noted were fulmars (n=5) and one "unidentified small dark auklet". Disturbance effects from seismic survey and support vessels encountering birds at these at-sea densities are expected to be insignificant.

An exception is potential disturbance to spectacled eiders in Ledyard Bay when they gather to molt. In Ledyard Bay, repeated disturbance of flightless eiders could move molting eiders near their energetic threshold and result in lower than desired fitness for winter survival in the Bering Sea. Implementation of mitigation measures would prevent or minimize vessel-related disturbances to spectacled eiders molting in the Ledyard Bay critical habitat area.

III.F.2.c(4)(b) Disturbance from Noise by Vessels, Seismic Airguns, and Support Aircraft. Slow-moving seismic vessels would be dispersed across the large action area. Seismic activities are dynamic and short term in nature. Implementation of mitigation measures largely would avoid and minimize disturbance impacts to marine birds in the action area from vessel, airgun, and aircraft noise.

III.F.2.c(4)(c) Collision with Vessels or Aircraft. Many seabirds can be attracted to lights and vessels in nearshore waters. A marine bird striking a vessel could be injured or killed. Potential mortality from being attracted to and colliding with seismic-survey vessels is more likely to occur inside the 20-m isobath, where the majority of seabirds and waterfowl are believed to migrate. An unknown number of seabirds and waterfowl are expected to occasionally be attracted to the lights of seismic vessels during the survey period, but implementation of mitigation measures would reduce the risk that birds fly into survey vessels. Similar measures outside the 20-m isobath could reduce impacts to more pelagic species. No birds were reported to have collided with seismic survey vessels during the 2006 season when these mitigation measures were in effect.

III.F.2.c(4)(d) Direct and Indirect Results of Petroleum Product Spills from Vessels. Direct effects of contact with oil are loss of insulation; death from hypothermia, exhaustion, or ingestion and absorption; transfer of toxicity to eggs and ducklings; and death of eggs and ducklings.

Indirect affects to marine birds could result from oil spilled when they are or are not present in the survey areas. Indirect effects might be contamination of food resources that would lessen the diversity, abundance, or caloric value of food resources. Indirect affects on food resources ultimately could affect nesting success and overwinter survival.

A spill in the vicinity of Ledyard Bay during the late June through mid-October molt period (Petersen, Larned, and Douglas, 1999) could affect large numbers of flightless spectacled eiders, resulting in significant harm to the Arctic Coastal Plain breeding population of spectacled eiders through potential stochastic effects.

Implementing best management practices would make the risk of vessel-related spills in the action area, including Ledyard Bay, very small.

Impact Summary: Alternative 1, no action, would have the least potential negative effect on spectacled eiders. Potential impacts from seismic-survey activities could affect small numbers of low-density marine bird species across a large area on a temporary basis each year. Alternatives 3-8 would have the same relative amount of potential effects on coastal and marine birds, varying by the amount of monitoring for marine mammals. With the implementation of measures to mitigate impacts to marine and coastal birds, none of the alternatives are likely to result in significant adverse impacts to birds in the project area. The voluntary collection of bird information during future seismic survey work would aid in verifying assumptions regarding the abundance and distribution of marine bird species' their behavioral reaction to seismic-survey activities.

III.F.3. Threatened and Endangered Species of Marine Mammals.

III.F.3.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, species analyzed under the 2006 Arctic seismic PEA (USDOI, MMS, 2006a), and species included under the NMFS June 16, 2006 biological opinion on Federal oil and gas leasing and exploration by MMS within the Alaskan Beaufort and Chukchi Seas (NMFS, 2006),, 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*)

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 previously contacted NMFS' protected resources staff regarding this communication, and the agencies will follow up with the hunter to see if additional information is available. MMS expects to keep NMFS updated on any additional information regarding the potential presence of right whales in the Chukchi Sea, and will follow NMFS' guidance regarding whether we should evaluate the potential for this species to be affected by the Proposed Action. MMS and NMFS 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 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 2 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 OCS Planning Areas. 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 NMFS June 2006 biological opinion (NMFS, 2006) and from our own review that the bowhead whale is the species most likely to be impacted by seismic-survey activities in the Beaufort Sea and Chukchi Sea OCS project 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.

III.F.3.b. Summary of Pertinent Information about Listed Species that Underlies our Analyses.

III.F.3.b(1) Bowhead Whales. There is one ESA-listed species under NMFS' jurisdiction, 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 seismic-survey activities. 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. 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 over-harvesting 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 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 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 the bowhead's 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 Planning Area, or adjacent areas to the south, are lacking.

III.F.3.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 probably is modified due to serious population reduction during commercial hunting. However, there is no indication that fin whales typically occur within the Chukchi Sea 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. 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 OCS Planning Area, or adjacent areas to the south.

III.F.3.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.

III.F.3.c. Bowhead Whale.

III.F.3.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, the environmental assessment for Lease Sale 195 (USDOI, MMS, 2004), the 2006 Arctic Seismic PEA (MMS, 2006a), the DEIS for Lease Sale 193 in the Chukchi Planning Area (MMS, 2006b), and the NMFS June 2006 biological opinion (NMFS, 2006). The information is also supplemented 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. We also incorporate by reference information provided in the 2006 Arctic Seismic PEA (MMS, 2006a) and NMFS June 2006 biological opinion (NMFS, 2006).

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). 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 USDOC 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) and the second meeting of this group was scheduled to be held in the 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; IWC, 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) and *Offshore Distances of Bowhead Whales (Balaena mysticetus) Observed during Fall in the Beaufort Sea, 1982-2000: An Alternative Interpretation* (Treacy et al., 2006). The *Final 2005 Alaska Marine Mammal Stock Assessment* (Angliss and Outlaw, 2005) for this stock remains the most recent finalized stock assessment available 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 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.

III.F.3.c(2) ESA Status of the Western Arctic Stock. 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; IWC, 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' 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]).

III.F.3.c(3) 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. 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 this writing (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 in the 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.

III.F.3.c(4) 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 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).

III.F.3.c(5) 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 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. 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 > 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.

III.F.3.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 seismic survey 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. latitude and south of 75° N. latitude (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.

III.F.3.c(6)(a) Winter and Other Use of the Bering Sea. Bowhead whales of the BCB Seas stock currently 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 (Dahlheim et al., 1980:Figure 1b, from Townsend, 1935).

III.F.3.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 (Dahlheim et al., 1980:Figure 1b, 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 (Mel'nikov, Zelensky, and Ainana, 1997:Figures 4 and 5).

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. (2004) found that cow/calf pairs 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 cm (5.5-7 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 Barrow from April to 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.

III.F.3.c(6)(c) Summer Migration. 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, 1995a). Eight bowheads were observed near Barrow on July 25, 1999, 2 at 71° 30' N. latitude, 155° 40'W. longitude to 155° 54' W. longitude from a helicopter during a search, and six at 71° 26' N. latitude, 156° 23' W. longitude 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.

Although records of bowhead sightings from 1975-1991 suggest that bowheads may occur along Alaska's northwestern coast in late summer, no one has yet established that these are "early-autumn migrants" or whales that have summered nearby (Moore et al., 1975). 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, 1995a). 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 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 in the Chukchi Sea during those surveys (Figure III.F-7), 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 and, 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; they are the best data 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) in the Chukchi Sea. Temporal and spatial patterns of distribution also may be modified. Conversely, earlier information may have inferred less variability in distribution than actually existed.

III.F.3.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). Inupiat 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 <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 km/hour) vary widely (Wartzog et al., 1990; Mate, Krutzikowsky, and Winsor, 2000). Much faster speeds (e.g., up to 9.8 ± 4.0 km/hour) 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/hour in ice-free waters. It traveled at an average speed of 3.7 km/hour in relatively ice-free waters and at an average speed of 2.7 km/hour 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/hour (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/hour. 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 (147°-150° W. longitude) migrate closer to shore in light and moderate ice years and farther offshore in heavy ice years, with median distances offshore of 30-40 km (19-25 mi) in both light and moderate ice years and 60-70 km (37-43 mi) in heavy ice years. Moore (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. An analysis of nineteen years of data under the MMS BWASP study also support findings that whales migrate further offshore in years of heavier sea-ice coverage (Treacy et al., 2006). 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; Treacy, 2000). Over a 19-year period (1982-2000), there were 15 years with some level of offshore seismic exploration and/or drilling activity and four 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, 2003a: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. 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 proposed 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, 1986a). 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, 1996a). 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).

III.F.3.c(6)(e) Known Use of the Beaufort Sea by Bowheads. Bowhead whales may occur in the portions of the Beaufort Sea project 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.

III.F.3.c(6)(f) Known Use of the Chukchi Sea by Bowhead Whales. The Chukchi Sea 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 Sea. 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 seas 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 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. 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.

III.F.3.c(7) Feeding Behavior. 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, 2001). 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 has also 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 the MMS Bowhead Whale Aerial Survey Program (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 Pt. 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' 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 et al. (2005:221) 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, an 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. Of the individual bowheads that traveled thought this portion of the Alaskan Beaufort Sea, some spent at least seven days.

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.

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. 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.

III.F.3.c(8) Summary. Available new information does not indicate that there has been any significant negative or other change in the population status of the BCB Seas bowhead whale population since MMS consulted with NMFS in 2003 regarding Beaufort Lease Sale 195 (USDOI, MMS, 2004), the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), or the June 2006 biological opinion on Federal oil and gas leasing and exploration by MMS within the Alaskan Beaufort and Chukchi Seas (NMFS, 2006a). 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 downlisting 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 June 2006 biological opinion (NMFS, 2006a). 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. We have taken available information into account in the update of our analyses of potential effects on this population.

III.F.3.d. Fin Whale.

III.F.3.d(1) Introduction. 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 or Beaufort OCS 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 stock assessment for 2005 available for this population (Angliss and Outlaw, 2005). 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.

III.F.3.d(2) ESA Status. 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, Silber, and Payne, 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.

III.F.3.d(3) Population Structure and Current Stock Definitions. The NMFS (Angliss and Outlaw, 2005) 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) 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).

III.F.3.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, fin whale abundance estimates were almost five times higher in the central 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). During sighting cruises in July-August 2001-2003 of coastal waters (up to 85 km offshore) between the Kenai Peninsula (150° W. longitude) to Amchitka Pass (178° W. longitude), fin whales were observed from east of Kodiak Island to Samalga pass (Zerbini et al., In prep., as cited in Angliss and Outlaw, 2005). 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).

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). 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: 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."

III.F.3.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."

III.F.3.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, Rice, and Breiwick, 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. latitude, 175° E.-180° E. longitude, plus 45 °N.-65° N. latitude, 180°-165° W. longitude) and the Gulf of Alaska Ground (also called the Northwest Coast Ground) (45° N.-55° N. latitude, 165° W.-160° W. longitude, 45° N.-60° N. latitude, 160° W.-134° W. longitude), and the Vancouver Ground (40° N.-55° N. latitude, 134° W.-125° W. longitude) (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).

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. latitude 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 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).

III.F.3.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, Fig. 40), 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. latitude, 168º44.8'W. longitude 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. latitude and east of the International Date Line, and the Alaskan Beaufort Sea from 157º 01' W. longitude east to 140º W. longitude and offshore to 72º N. (Ljungblad et al., 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 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.

III.F.3.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-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., 2000c). 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).

III.F.3.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.

III.F.3.d(7) 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).

III.F.3.e. Humpback Whale (Central and Western North Pacific Stocks).

III.F.3.e(1) Introduction. 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. We provide information about this species because of its potential occurrence in the southwestern Chukchi Sea.

The MMS provides extensive information about humpback whales and the potential for humpbacks to be affected by oil and gas activities in the EIS for the Cook Inlet OCS Lease Sales 191 and 199. Herein, we provide much of the same basic information about humpbacked whales. We have focused our attention on the use of this species of areas where they potentially could be exposed to seismic survey activities that may occur within the Chukchi and Beaufort Sea Planning Areas. 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 readers to the recently revised draft stock assessments for these two stocks (Angliss and Outlaw, 2005) for additional detailed information beyond the scope of this biological evaluation.

III.F.3.e(2) ESA Status. 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, 1991).

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 yards (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.

III.F.3.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. Based on the breakdown presented above, however, 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.

III.F.3.e(4) Past and Current Population Abundance in the North Pacific. The reliability of pre- and postexploration 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. 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 Wolman and another postexploitation 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: 356-1,523). 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.

III.F.3.e(5) Reproduction, Survival and Non-Human-Related Sources of Mortality. 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.

III.F.3.e(6) Migration, Distribution, and Habitat Use.

III.F.3.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 Pt. 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." Individuals tend not to move between feeding areas. Mizroch et al. (2004) summarized that, based on all sightings, <2% of all individuals sighted were observed in more than one feeding area.

III.F.3.e(6)(b) Use of the Beaufort and Chukchi Seas. 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 western North Pacific stock strikes reference to the Chukchi Sea. 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. latitude and east of the International Date Line, and the Alaskan Beaufort Sea from 157º 01' W. longitude east to 140º W. longitude and offshore to 72º N. latitude (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 project 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.

III.F.3.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.

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 to 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:Fig. 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 nautical miles (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.

III.F.3.e(7) Feeding Behavior. Humpbacks tend to feed on summer grounds and to not eat on winter grounds. 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.F.3.f. Impact Assessment Overview. In the following section, we discuss potential effects of 2D/3D seismic surveys on bowhead, fin, and humpback whale, but focusing principally on the bowhead whale.

Because this document takes a programmatic approach to understand potential effects of seismic surveys on these species, it is uncertain as to exactly where or how much seismic survey activity will occur (up until the limits defined under the Proposed Action described in Chapter 1). This PEIS provides best estimates about what levels and kinds of seismic survey activity may occur in 2007 and beyond. The mitigating measures outlined in Section IV and as may be imposed during the MMPA authorization process are intended to reduce the potential effects of seismic surveys conducted in the Arctic Ocean.

III.F.3.f(1) Principles and Assumptions Underlying Analyses of Potential Effects.

1. Potential effects of anthropogenic noise on females with calves, on newborn calves, on all dependent calves, 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 their 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 increase 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 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 and the ability of the calf to maintain needed contact with the mother during its period of dependency (i.e., period of maternal care) is critical to the continued recovery and the long-term viability of the population. In providing guidance on the evaluation of whether acoustic 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....

The greatest potential for effects to calves would occur if seismic operations resulted in the reduction in nursing by calves shortly after they are born (in the spring). By the summer, calves appear to have developed a thick blubber layer (William Koski, personal communication). To avoid effects at this critical spring to early summer stage, the Proposed Action and Alternatives all require that seismic operations not commence before July 1 in areas where bowhead mothers and calves might be present.

In general, available evidence indicates that bowhead mothers will rarely separate from their calves and remain within a body length of each other. The only exception to this appears to be during summer and fall when mothers are feeding; during feeding bouts at that time of year, the mother will leave the calf at the surface for periods up to an hour or more (William Koski, personal communication). Anecdotal observations of bowhead whales have not shown seismic operations to cause cow-calves to separate or abandon each other (Reeves, et al. 1984; Richardson et al 1986, 1987; Koski and Johnson 1987; Richardson 1999). In addition, other research scientists (John Richardson, William Koski, and Bernd Wursig, personal communications) confirmed they have often observed bowhead mothers and calves exposed to noise from seismic survey operations or other oil and gas activities in the Arctic Ocean, and have seen no indication that this ever causes a cow to separate from or abandon its calf. In confirmation, Wartzok et al (1989) reported two observations of bowhead cows and calves separated by a few hundred meters quickly rejoined each other when a ship approached them. In fact, any disturbance to cows causes them to join and remain with their calves. Similar findings have been reported for humpback whales exposed to man-caused activities (Phillip Clapham, personnal communication).
Although separation of mother/calf pairs caused by operation of the seismic source does not appear to be likely there is a potential for it to occur during vessel approaches and/or if operations were to occur while a mother was feeding below the surface. In addition, although the mother/calf pair may not separate, it is unknown whether they experience unobservable effects (e.g., increased stress levels) from the presence of seismic operations or if their persistence in maintaining close contact will result in displacing them from preferred habitats.

Although the potential for separation of bowhead whale mother/calf pairs appears low, NMFS and MMS acknowledge that the unequivocal determination of how ~~on~~ baleen (or other cetacean) calves, especially newborn calves, or females attending calves are affected by sound exposure is difficult. Absent certainty however, but based on the best available scientific information on potential effects on baleen calves and females with calves, we can draw on more general conclusions from the following marine mammalian literature in order to assess potential effects:

- Young (1991) calculated safe distances for several marine animals from underwater explosions of various sizes, given a blast depth of 61 m (200 ft. For a 22.7 kg (50 lb) explosive weight, the safe distance for a porpoise calf at the surface in open water was estimated to be about 468 m (1,537 ft). The calculation of a safe distance for an adult porpoise under the same conditions was 352 m (1,154 ft) and for a 6 m (20-ft) whale was 298 m (978 ft). Although the study was based on an acoustic source of a different nature than seismic, results did show that the potential for effects to cetacean calves from acoustic exposure was greater than that of adults.

- In a 2002 study of dolphins in the Eastern Tropical Pacific, NOAA found that chronic stress from fisheries activities may lead to reduced foraging efficiency, reduced breeding or calving success, and/or decreased immune function (NOAA, 2002).

- Available data also indicate that female mammals with young (e.g., Bergerud, 1974), including female baleen whales (e.g., Tilt, 1985; Bauer, Mobley, and Herman, 1993; McCauley et al., 2000; NRC, 2003), show a heightened response to noise and disturbance, including seismic sources, 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).

- Gray whale cow-calf pairs are more sensitive than other age or sex classes to disturbance by whale-watching boats (Tilt, 1985) and humpback groups containing at least one calf are more sensitive to vessel traffic than are groups without calves (Bauer et al., 1993).

When all of this information is considered in concert with data indicating potential extreme longevity of bowheads and thus the potential for repeated exposures throughout a whale's life to seismic survey and other noise (see below and cumulative section), we believe that a precautionary approach to development and possible implementation of additional mitigation and monitoring measures is warranted to: (1) further reduce the potential for adverse impacts to this segment of the bowhead whale population, (2) ensure that the seismic activity will not have more than a negligible impact on the bowhead whale stock, (3) ensure that takings are limited to non-serious injury (i.e., not having a potential for mortality) and harassment and (4) ensure that takings are at the lowest level practicable, as required by MMPA section 101(a)(5)(D)(ii).

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. McCauley et al. (2000:698) recommended that management decisions distinguish between whales that are in a "…key habitat type" 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." To the extent that information exists, we have highlighted potential effects that could impact the use of areas used for calving, feeding, resting, and breeding by large numbers of whales. We also have 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. An individual bowhead may experience multiple disturbance effects from the Proposed Action 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. Many bowheads already may have been exposed to multiple anthropogenic sources of loud noise (see cumulative analysis section).

4. Uncertainty should be acknowledged explicitly, because it may point to areas that may need further monitoring and consideration of adaptive management. The species of whales under consideration in this section are large endangered baleen whales, with the BCB stock of bowhead whales most likely to be exposed to activities under the Proposed Action. This stock 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. Although the Proposed Action provides a limit of six 2D/3D permits or authorized ancillary activities per planning area, there are still multiple sources of uncertainty in our analyses. These include, but are not limited to, uncertainty at the programmatic stage about the specifics of potential seismic surveys (where seismic surveys will occur; how many surveys will occur concurrently; how much noise will be produced by the firing of airguns; what the exact shape of related activities, such as support vessel type and activity will be); uncertainty about the potential adverse effects of noise on baleen whales, especially repeated exposure to loud noise; uncertainty about 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. While some sources of uncertainty cannot be reduced (*e.g.*, the potential effects of long-term exposure to elevated noise levels or the general presence of exploration activities in key areas, synergistic interactions with sound exposure and other stressors such as increased toxic load), we can reduce overall uncertainty about potential impacts on baleen whales through requirements for monitoring coupled with an adaptive management approach whereby mitigations are tailored to conditions that are discovered through monitoring (Sec. III.F.3.g).

5. Where there is uncertainty on the status of the affected population relative to the species and other important characteristics of the population, the analyses should be protective. While t ~~T~~he BCB Seas stock of bowhead whale is the only stock of bowheads that is considered to be robust and well on its way to recovery from depletion due to commercial whaling, questions raised by scientists regarding its population structure (see III.F.3.c(3)) require a cautious approach to the analyses and the shaping of the action. It is currently not clear whether one or more population stocks are being impacted by the proposed action. If more than a single population is affected it is unclear what these stock sizes are and whether they may be affected disproportionately to the overall BCB Seas population. Thus, the population that could be exposed to the Proposed Action is important to the long-term viability of the species as a whole.

6. The bowhead's association with ice and its dependence on the spring lead and polynya system make it difficult to extrapolate about the potential adverse impacts of seismic noise, or other loud noise, that could affect whales within these systems. 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. Additional consideration is therefore needed in assessing the potential for impacts within their relatively constrained migratory routes.

7. The effect of subsistence hunting on the BCB Seas stock of bowheads throughout most of its range needs to be considered in evaluating the potential effects of the Proposed Action on this species. Refugia between areas where bowheads are hunted, and times between periods when bowheads are hunted may have more significance to bowheads than they would if the species was not hunted. The fact that they are hunted also may heighten their response to anthropogenic acoustic disturbance, at least in some instances.

8. Current status of the population is informative about potential response to the Proposed Action. Based on available information, the BCB Seas 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 any direct mortality on baleen whales from the Proposed Action but acknowledge that mortality could occur (e.g., through vessel strikes). 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 the population's resilience at least to the level of disturbance and take that have occurred within the past 20 years.

Mitigation measures, which are outlined in Section IV, would reduce the potential for adverse effects from activities under the Proposed Action. We assume that monitoring and mitigation measures will be in place in both the Beaufort and Chukchi Sea Planning Areas. NMFS may require mitigation, monitoring, and reporting measures within any MMPA authorizations it grants for seismic surveys considered under this PEIS. Through the NEPA and/or MMPA review and comment provisions, NMFS through could identify mitigation and monitoring measures other than those specified and described in this PEIS. In general, MMPA authorizations and their mitigation and monitoring measures are granted to ensure there is a "negligible impact" on marine mammals and no "unmitigable adverse impacts" to subsistence activities. (For definitions of these terms, see NMFS website at http://wwww.nmfs.noaa.gov/pr/glossary.htm).

III.F.3.f(2) Potential Pathways of Impact from Seismic Surveys. During seismic surveys, endangered whales could potentially be adversely affected by noise and disturbance from the seismic sound sources, seismic vessel, related support ships, boats, and icebreakers, and from aircraft supporting the ship or conducting required monitoring. Additionally, endangered whales conceivably could be struck by ships or boats during seismic surveys. Small fuel spills could also occur. Any or all of these factors may affect ESA-protected whales in and/or near the Chukchi or Beaufort Sea Planning Areas during oil and gas exploration seismic survey activities.

III.F.3.f(3) Potential Effects of Noise and Disturbance from Proposed Seismic Surveys. During seismic surveys under the Proposed Action, noise can be transmitted through the air, sea ice, and through marine waters from a variety of sources including, but not limited to, the seismic sources themselves that purposely release sound into the water, icebreakers, other ship and boat transit, high-resolution seismic surveys, and helicopter and fixed-winged aircraft traffic. One of the greatest concerns associated with the impacts of oil and gas exploration and development on marine mammals has to do with potential adverse impacts of noise on their ability to function normally and on their health. Because of the importance of this issue, we provide two background sections. The first provides very general information relevant to understanding acoustics in the marine environment. The second provides general background about potential types of adverse 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 seismic-survey-related sounds and disturbance in the Chukchi and Beaufort Sea Planning Areas. We then review specific studies about the potential impacts on these species.

III.F.3.f(4) 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 seismic surveying on marine mammals has to do with potential impacts of noise on their ability to function normally and on their health. Background information on noise in the marine environment and on the marine acoustic environment is provided in Section III.B.

In this section, we provide background about potential adverse effects of impacts of OCS oil- and gas-related noise and disturbance. 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, source, 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 (e.g., 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., Tyack, 1998; Wartzok and Ketten, 1999; NRC, 2003, 2005). The scientific community generally agrees that hearing is an important sense used by cetaceans (for example see Richardson et al., 1995a; NRC, 2003, 2005; Natural 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. NMFS summarized that a habitat concern for all whales, and especially for baleen whales, is the increasing anthropogenic contribution to ambient noise in the world's oceans (Carretta et al., 2001).

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., 1995a; 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); NRDC (1999, 2005); IWC (2004a); MMS (2006a); MMS (2006b); and MMS (2004). 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. The Marine Mammal Commission (MMC) convened an Advisory Committee on Acoustic Impacts on Marine Mammals which produced 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 from caucuses available on their website at www.mmc.gov).

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.

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 (but see Finneran et al., 2005). We acknowledge that evaluation of total energy could change our analyses. At present, we do not have the data necessary to make such a determination. The 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 ambient 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 future years, we can only incorporate recommendations from the NRC (2005) qualitatively.

Marine mammals use calls to communicate and probably listen to natural sounds to obtain information important for detecting open water, navigating, and avoiding predators. 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., 1995a; Kraus et al., 1997; NRC, 2003; 2005) in ways ranging from subtle behavioral and physiological impacts to serious injury and death.

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 (e.g., NRC, 2005; McCauley et al., 2000; Richardson et al., 1995a). 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 protective approach in our analyses and base conclusions about potential impacts on potential effects on the most sensitive members of a population. In addition, supported by recent transmission measurements in the Chucki and Beaufort seas, we make assumptions that sound will travel the maximums observed in this area and other oceans, rather than minimums.

While there is some general information available, evaluation of the impacts of sound exposure on marine mammal species, particularly on cetaceans, is hampered by 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. 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 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 potential impacts on baleen whales generally are based on assumptions (i.e., based on inner ear anatomy and vocal behavior) about their hearing rather than actual studies of their hearing (Richardson et al., 1995a; Gordon et al., 1998; Ketten, 1998; Wartzok and Ketten, 1999)). 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 kilohertz (kHz), but the frequency range in bowhead songs can approach 4,000 Hertz (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 likely as sensitive to frequencies below 1 kHz kHz as nominal natural ambient noise in this frequency band will allow (e.g., Clark and Ellison, 2004). They can also likely but can hear sounds up to a considerably higher but unknown frequency. Most of the anthropogenic 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, (i.e., below 20 Hz) sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales may extend to 20 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 Hz. 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 such as 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 Hz or higher. This statement refers solely to the 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., 1995a; Wartzok and Ketten, 1999). Based on suspected differences in hearing sensitivity discussed in Richardson et al. (1995a), MMS and NMFS believe that it is likely that baleen whales (more sensitive at low frequencies) and pinnipeds (more sensitive at mid frequencies) are more likely to be affected or harmed by direct acoustic impact from low to mid-sonic range devices than odontocetes (more sensitive at high frequencies). 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 however 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 (NRC, 2003). Whales and other marine mammals 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.

III.F.3.f(4)(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 to 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, 2005). 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 (TTS) if the individual recovers its pre-exposure sensitivity of hearing over time, or a permanent threshold shift (PTS) 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, as well as the characteristics of the noise source (e.g., amplitude, frequency, duration).

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 (e.g., for orientation, prey finding, or predator detection), as well as impair the mammal's ability to hear other important sounds such as sounds of predators, conspecifics (i.e., of the same species), other species (e.g., sounds of breaching), or approaching vessels.

Most experiments have looked at the characteristics (*e.g.*, sound pressure amplitude, frequency, duration) of sounds at which temporary threshold shift and permanent threshold shift occurred. 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 (e.g., 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.

PTS are less species dependent and more dependent on the length of time the peak pressure lasts, ~~and the~~ signal rise time, "sharpness" (or "kurtosis") of the signal and other variables (e.g., Ward, 1997. 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 PTS in humans. Presumably the same could occur in other species, such as marine mammals. 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) and Ridgway and Carder (1993) note that there is evidence of age-related hearing loss in marine mammals.

.Long-term adverse 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, and data gathered on odontocetes and pinnipeds is minimal. As noted previously, the assumption is made that the area of greatest hearing sensitivity are at frequencies known to be used for intraspecific communication. 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 errs on the side of caution, 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. Lacking more detailed knowledge of hearing capabilities of these large whales, a cautious analysis is prudent.

III.F.3.f(4)(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.

III.F.3.f(4)(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). Southall et al. (2000) provides a comparison of underwater masking, including the frequency-specificity, across all marine mammals. 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, critical natural behaviors could be disrupted and harm could 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). Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Lesage et al (1999) demonstrate that belugas also avoid signal masking by modification of its vocalizations.

III.F.3.f(4)(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 and the sound source. 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 precautionary 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 making the implicit assumptions that sound may travel the maximum distances recorded (as verified by measurements made in 2006), rather than minimum distances and that whales engaged in a particular activity may respond at the maximum, not the minimum, distances observed in studies to date. These assumptions may overestimate potential effect in many cases. Because at least some of the airgun arrays being proposed for use in the Chukchi and Beaufort Planning Areas may have greater total output than those in previous studies, we also potentially may underestimate impact in some cases.

III.F.3.f(5) Potential Exposure to Seismic-Survey Activities in the Proposed Action Area. 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 Planning 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 Seas where seismic surveys could occur 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 above, neither fin whales nor humpback whales are expected to appear at any time of the year within either the Chukchi or Beaufort Sea Planning Areas. Available evidence indicates these two species do not typically breed, calve, feed, rest, or migrate through such areas. They appear seasonally however, in coastal waters of the southwestern Chukchi Sea, adjacent to the Chukchi Peninsula. 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.

III.F.3.f(5)(a) Noise and Disturbance from Seismic Surveys. Sound from seismic exploration is a potential source of disturbance to bowhead whales and other cetaceans in and near areas where the surveys may occur. Marine seismic operations use an acoustic sound source called an airgun to produce a burst of underwater sound from the release of compressed air, which forms a bubble that rapidly expands and then contracts. Typically, the rapid release of compressed air is used to produce an impulsive acoustic signal that is directed downward through the seabed. 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.

Animals, including bowhead whales, sensitive to either low-frequency or high-frequency sounds may be affected. 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) and Goold and Fish (1998) also found significant levels of energy from airguns across the bandwidth up to 22 kHz.

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). 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. (1995a) for pulsed sounds. 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) 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 the seabed in determining sound propagation.

Received levels within a few kilometers typically exceed 160 dB re 1 µPa rms (Richardson et al., 1995a), depending on water depth, bottom type, ice cover, etc. 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 farther under some conditions. 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).

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). 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 2 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."

Regarding exposure of whales to seismic surveys, it is important to note that ~~noise~~ sounds from a seismic survey is not stationary and is not a single event. The duration of exploration in a given area can continue for varied lengths of time, from days to months, with the area covered depending on the interests and needs of the explorer. The seismic survey activity, including airgun firing, vessel traffic and related activities may concentrate activity in a few hundred square kilometers for upward of a month (McCauley et al., 2000:695).

III.F.3.f(5)(b) Timing of Potential Exposure to Noise and Disturbance from Active Seismic Surveys. In the Proposed Action under consideration, based on industry interest and the size of Lease Sale 193 area, interest expressed by industry in future lease sales in the Chukchi and Beaufort seas, we 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 any potential mitigation measures. This includes a measure that prohibits seismic operations in the Chukchi Sea spring lead system until July 1, unless authorized by NMFS (and NMFS is not proposing to have any MMPA authorizations valid for the Chukchi Sea open-water period prior to July 1) , to provide bowhead mothers and calves additional protection. Further temporal/spatial/operational restrictions may be implemented for bowheads and/or other marine mammals under Alternative 8 and also through the MMPA authorization process for the seismic surveys considered under this PEIS

Marine 2D/3D seismic surveys in the Beaufort Sea Planning Area likely would be feasible only in the months of August, September, and October. It is likely that the 2D/3D seismic surveys would be subject to conditions to eliminate or mitigate seismic-survey impacts during times of, and in areas subject to, subsistence harvests. Seismic surveys are likely to occur after the subsistence harvest is over or in areas where bowhead subsistence hunting does not occur. There is, however, uncertainty regarding bowhead use of the Alaskan Beaufort Sea during the summer months. Bowheads are typically observed in the Beaufort Sea until freezeup occurs. As required by both MMS under the permitting process and by NMFS under the MMPA authorization process, 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 survey 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 NMFS is not proposing to have any MMPA authorizations valid for the Chukchi Sea open-water period prior to July 1) and could occur into November. (However, Alternative 8 includes no surveying in the Chukchi after September 25 or until monitoring shows the majority of whales have moved through the operations area.) The total period of seismic surveys is likely to be considerably longer in the Chukchi Sea than in the Beaufort Sea.

III.F.3.f(6) Potential Effects from Seismic Surveys. Because high-energy and impulsive sounds can cause hearing damage and behavioral reactions, there is considerable concern about the potential impacts of airguns on marine organisms. Sound from seismic surveys potentially could have negative impacts on marine mammals within or near the program areas. Because of the distance sound can travel through water, marine mammals in regions of the Beaufort Sea and Chukchi Sea that are near to the areas of seismic surveys, or that are connected to the area of exploration by a relatively unimpeded sound travel path, also could be affected by the sound. The Proposed Action alternatives and the mitigation measures outlined in Sections II and IV are designed to avoid Level A takes (injury) of marine mammals and to varying degrees limit the potential for Level B takes (harassment). The mitigation measures described herein and any imposed through the MMPA authorization process would further reduce the potential for causing possible adverse effects, such as harassment. Therefore, although injuries directly from seismic survey noise are not expected to occur because of the mitigation measures and because of bowhead whales avoiding active seismic vessels, there remains a limited potential for injury from strikes by seismic-survey-related vessels.

The low-frequency noise (generally below 200 Hz) produced by seismic airguns are more likely to disturb baleen whales, which communicate at frequencies mostly below 3 kHz. Thus, their communications are more likely to overlap with those low frequencies than are the communications of beluga whales or small odontocetes in the areas of the survey. However, because high-frequency noise also is still produced, marine mammals that are sensitive to high frequencies also can be affected.

The next few paragraphs provide a brief discussion of characteristics of the surveys relevant to whales and provide information from a number of studies on the effects of noise from seismic operations on bowhead whales, and where appropriate, other baleen whales.

III.F.3.f(6)(a) Potential Effects of High-Resolution Site-Clearance Seismic Surveys on Endangered Whales. High-resolution site-clearance surveys are described in detail in Section I.E.3. Because high-resolution seismic surveys produce less energy and sound would be less likely to travel as far as sound from 2D/3D surveys, these activities are not as likely to have significant effects on endangered whales. A primary concern with respect to high-resolution surveys is the potential for these activities to add to noise and disturbance from 2D/3D seismic activities, and to cause local impacts within a specific area if numbers of bowheads are present, migrating and/or feeding. 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 areas. The use of mitigation measures outlined in Sections II and IV is expected to reduce the potential for adverse effects from multiple seismic surveys in the biologically high-value areas.

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 Würsig (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 1 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 these activities are of shorter duration and have a smaller zone of influence, we believe it unlikely they would result in a significant effect on bowhead whales.

III.F.3.f(6)(b) Potential Effects of 2D/3D Seismic Surveys on Endangered Whales. Marine 2D/3D seismic survey operations are described in detail in Section I.E.1and 2.

Recent data are available regarding measured versus modeled noise level radii associated with different seismic arrays in shallow and very deep water (Tolstoy et al., 2004) that indicate some 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 Planning Areas, as depicted in Map 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 also might vary from those determined during previous seismic activities in these two planning areas. We summarize the information available about noise levels at distances 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).

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. The studies involving the response of bowheads to 3D seismic surveys in which a large enough area was monitored both prior to, and following, initiation of the surveys to determine potential effects are most relevant to evaluating the potential effects of the Proposed Action.

Because of the importance of the issue of potential noise disturbance of bowhead whales, we provide considerable detail on these studies below. We preface this section with an important point: 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. Madsen et al. (2006) found that received levels from airguns varied based on the animal's (sperm whales) range and depth from the source and that a single air gun firing exposed the animal to multiple sound pulses. Thus, the fact that results from different studies of bowhead response to oil and gas-related sound have varied is not surprising. 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 (Ljungblad et al., 1998; Richardson, Würsig, and Greene, 1986). In general, many of the seismic surveys conducted during the 1980's were 2D seismic surveys that covered fairly large areas in a wide variety of areas. 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 smaller areas in relatively nearshore area.

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. Methodological problems with this early study preclude us from drawing conclusions about potential 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 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 (4.7 mi) 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.

Based on early data, Richardson and Malme (1993) concluded that collectively, scientific studies showed that most bowheads usually show strong avoidance response when an operating seismic vessel approaches within 6-8 km (3.8-5.0 mi). Based on those early data, they believed that strong avoidance occurred when received levels of seismic noise are 150-180 dB re 1 μPa (Richardson and Malme, 1993). 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. Strong seismic pulses were often 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. As noted above, seismic pulses can be detectable 100 km (62.2 mi) or more away and in some habitats, have been detected at distances from the source more than ten times that distance.

The North Slope Borough (NSB) believes that many of the early studies were different from the real-world situation, and various and important limitations of these studies have been pointed out. Most early 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. NMFS and MMS note that many early studies were observational and involved opportunistic sightings of whales in the vicinity of seismic operations. These 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.

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 OCB 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 MMPA 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. 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 (USDOI, MMS, 2003a).

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 1980’s 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-survey activities in the 1980’s were 2D, whereas the recent seismic activities were 3D OBC.

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 1980's 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 survey 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.

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 560-1500 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 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 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 echosounders. 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. NMFS recommended criterion that exposure of whales to impulse sound not exceed 180 dB re 1µPa 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/hour) or all seismic operations combined (0.44 bowheads/hour). 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 broad-scale 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, 1995a) 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 also are 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., 1995a; McCauley et al., 2000; Gordon et al., 1998, 2004). Gordon et al. (1998:Sec. 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:Sec. 6.12). Therefore, 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).

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 generalized response of migrating humpback whales to a three-dimensional 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 behavior 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 cow/calf pairs 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 noise levels at which response was detectable were 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 program area could have their movement and feeding behavior affected by noise associated with seismic exploration. The most likely to be impacted are cow/calf pairs. This potential impact would be seasonal, since humpbacks are not common in these areas during the winter.

Conclusions about Potential Effects of 2D/3D Seismic. Scientific studies and traditional knowledge presented above about the potential effect of 2D/3D seismic surveys on bowheads indicate that bowhead response to 2D/3D seismic surveys varies, sometimes considerably. It is not entirely clear which factor(s) explain differences in response in all cases. However there appears to be a consensus that migratory bowheads may avoid an active seismic source at 20-30 km in some circumstances and deflection may start from even further (35 km). Because data on other whales and other mammals indicates that females with calves may show even stronger avoidance (e.g.,McCauley et al., 2000), and since it is often unclear what behavior a whale was engaged in, we assume most bowhead whale 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. The 2D/3D seismic surveys may occur within multiple areas of the evaluation area, or there may be clustering of activities within more specific areas, for the entire open water period. We assume that seismic operators will be actively shooting as much of the open water period as is feasible.

If bowhead whales, especially cow/calf pairs or large aggregations, avoided feeding or resting areas due to seismic-survey activities, there could be disruption of important biological behaviors of bowhead whales in that area. Our primary concern is for potential effects on calf survival and female reproduction. Given the state of the science on bowhead whales, it may be difficult to determine if exclusion from feeding and/or resting areas could result in lower calf survival, lower future reproduction, or reduced growth. Likewise, we cannot determine with certainty the potential energetic significance of exclusion of cow/calf pairs from resting areas, which could be significant if not mitigated.

Under the Proposed Action, it is likely that one to six seismic surveys would occur anytime during the open water season, and bowheads may occupy some or all of these waters for much of this period. Because large aggregations have been observed in early September in some years in areas in the Alaskan Beaufort Sea, it is not clear if these whales (which have in some instances included a high proportion of cow/calf pairs) migrated west early, never migrated to feeding areas in the Canadian Beaufort Sea, or came in after summering in the Chukchi Sea. It is clear that some areas are used by larger numbers of whales on a regular basis, such as areas off of Dease Inlet and Smith Bay, Cape Halkett, and the areas near Brownlow Point (see Figure III.F-6).

Mitigation measures required in recent seismic surveys were designed primarily to reduce the potential for adverse effects on bowhead whale hearing and adverse effects on subsistence hunting of bowheads. Bowheads typically remain in portions of the Alaska Beaufort Sea after hunting in those areas is over. While their use of the northeastern Chukchi Sea in the summer and autumn is unclear, bowhead whales utilize areas in periods and locations when and where there is no hunting. As up to six surveys may occur in each planning area yearly and individual bowheads could potentially be exposed to 2D, 3D and high resolution surveys as they move through each planning area (potentially up to 12), we cannot conclude with certainty that there would not be exclusion or avoidance of bowhead whales from feeding, resting or migratory areas. In addition, we cannot say with certainty that these exclusions, if they occur, would not result in significant impacts, as defined under the NEPA significance criteria (Section III.E), and/or affect their survival. With this in mind, we have identified mitigation measures that reduce the potential for these type of effects (exclusion or avoidance of these areas) to occur and applied these to all Alternatives 3-9 (see Sections II and IV). The alternatives, to varying degrees, also contain additional measures to reduce the potential for these types of effects (i.e., large exclusion zones, time/area closures). Also, any MMPA authorizations would need to meet a determination that, among other things, the seismic survey(s) would only result in a negligible impact to whales. This provides an additional level of protection to help avoid effects of exclusion and avoidance. Although the potential for significant impacts, as defined under the NEPA significance criteria (Section III.E), exists particularly given the likelihood of increased seismic surveys that may run concurrently and potential for repeated exposures during critical behaviors, required mitigation and monitoring measures have been proposed and analyzed to reduce the level of impacts.

III.F.3.f(7) Effects of Noise from Icebreakers. If seismic-survey vessels are attended by icebreakers (serving as support vessels), additional disturbance and noise could be introduced by the icebreaker. Based on models in earlier studies, Miles, Malme and Richardson (1987) predicted that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km (1.24-15.53 mi). 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.

Table 6.5 in Richardson et al. (1995a) provided source levels for icebreaker noise. For example, they note that noise levels from the M/S *Voima* in open water at 50-60% power had broadband noise levels of 177 dB re 1 µPa-m whereas the source level when icebreaking at full power was 190 dB re 1 µPa-m.

Response distances of bowheads to icebreakers are expected to vary, depending on the size, engine power, and mechanical characteristics of the icebreaker, vessel activities, sound-propagation conditions, the types of individuals exposed, and the activities they are engaged in when exposed. 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. They pointed out that the source level of an actual icebreaker is much higher than that of the projectors (projecting recorded sound) used in their study (median difference 34 dB over the frequency range 40-6,300 Hz). Over the two-season period, they observed a difference in the estimated numbers of bowheads seen near the ice camp when the projects were quiet (approximately 158 bowheads in 116 groups) versus when icebreaker sounds were being transmitted into the water (an estimated 93 bowheads in 80 groups). Some but not all, 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 and a minority of whales apparently diverted at a lower sound-to-noise ratio.

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. For example, infrasounds that may be associated with icebreakers were not adequately represented in playback transmissions. Bowhead whales likely hear or can detect infrasounds (Richardson et al., 1995b).

Richardson et al. (1995b:322) summarized that:

> 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. (1995b:xxi) stated that:

> If bowheads react to an actual icebreaker at source to noise and RL values similar to those found during this study, they might commonly react at distances up to 10-50 km from the actual icebreaker, depending on many variables. Predicted reaction distances around an actual icebreaker far exceed those around an actual drillsite...because of (a) the high source levels of icebreakers and (b) the better propagation of sound from an icebreaker operating in water depths 40+ m than from a bottom-founded platform in shallower water.

Richardson et al. (1995b) stated that predicted response distances for bowheads would be highly variable around an actual icebreaker. They predicted that detectable effects on behavior and movements for "typical traveling bowheads" extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km. They noted that given the factors influencing reaction distances and the observed reactions to playbacks of icebreaker noise "Predicted reaction distances for bowheads around an icebreaker like the *Robert Lemeur* vary from as little as ~2 km to as much as 95 km."

Richardson et al. (1995b:xxii) 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 bowheads visible in the open water of nearshore lead systems during spring migration east of Pt. Barrow. Reaction distances around an *actual icebreaker* like *Robert Lemeur* are predicted to be much greater, commonly on the order of 10-50 km. Effects of an actual icebreaker on migrating bowheads, especially mothers and calves, could be biologically significant.

The highest potential for avoidance would probably occur if both seismic surveys and icebreaking occur within an area in which a high level of use by bowheads is also occurring. Concerns also 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. As specified above and in the mitigation measures of Sections II and IV, MMS will not permit seismic surveys in the spring lead system until July 1 and NMFS is not proposing to have any MMPA authorizations valid for the Chukchi Sea open-water period prior to July 1.

III.F.3.f(8) Effects from Other Vessel Traffic Associated with Seismic Surveys. 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 <1 km (<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 six seismic surveys in each of the two planning areas, there could potentially be up to 12 additional support vessels, some of which could 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 moving from one site to another would be more disturbing to whales than vessels idling or maintaining their position. Bowheads probably would adjust their individual swimming paths to avoid approaching within several to several dozen kilometers. Vessel activities associated with seismic surveys are not expected to disrupt the bowhead migration but may cause avoidance of certain areas. Small deflections in individual bowhead-swimming paths are not expected to be significant in any individuals but a reduction in use of possible bowhead-feeding areas near exploration units may result in adverse effects. 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 extensive and too thick for seismic-survey ships and supply vessels to operate in. Because MMS does not intend to authorize seismic-survey activities in the spring lead system until July 1 and NMFS is not proposing to have any MMPA authorizations valid for the Chukchi Sea open-water period prior to July 1, 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 cumulative effects section of this PEIS, available information indicates that current rates of vessel strikes of bowheads are low. Available data do not indicate that ship strikes of bowheads by seismic-survey-related vessels are a significant source of injury or mortality.

III.F.3.f (9) Effects from Aircraft Traffic. 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 depending upon several factors, including the depth of the animal.

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) (Richardson et al. (1995a). At altitudes below 150 m (500 ft), some bowheads 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 (500 ft) 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. The majority of bowheads, however, 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 (500 ft) ranged from 117-120 dB re 1µPa 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 (Richardson et al. (1995a). 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) (Richardson et al. (1995a). 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. From the following study, it is assumed that the behavioral 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 cow/calf pairs. 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. Potential effects on bowheads from aircraft are relatively easily avoided by flight practices requiring fixed winged flights above 1,~~0~~500 feet and avoidance by helicopters of areas where bowheads are aggregated.

III.F.3.f(10) Areas and Situations Where Potential Impacts are Likely to be Greater than Typical. Bowheads are not randomly distributed throughout the two planning 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’ 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. We depict counts from the aerial surveys in the Beaufort Sea on Figure III.F-6. This figure clearly shows areas of relatively high use by bowheads, and thus, areas where effects from the proposed seismic surveys are likely to be greater than typical. Figure III.F-7 depicts counts in the Chukchi Sea. It is important to note that the Chukchi Sea data are not recent (1979-1991) and thus should not be interpreted as indicating current patterns of bowhead use of the Chukchi Sea. While it is clear that seismic activity may overlap with bowhead use of the Chukchi Sea during fall migration, we are uncertain about the likely extent of overlap between seismic activity and bowhead whales in the summer. During fall migration, available, but dated, data indicate that overlap is likely to be greatest in the main migratory pathways, one heading nearly directly to the Bering Strait, and the other heading west from Barrow towards Wrangell Island (see Figure III.F-5).

It is clear that if 2D/3D seismic surveys impacted areas of the spring lead and polynya system during the spring migration, impacts could potentially be 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 the potential of affecting the whales including females with newborn calves. We do not expect this to occur however, because MMS will preclude seismic operators from conducting activities prior to July 1. 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) sufficient open water may not be present for open-water seismic surveys, and (3) MMS will not permit surveys in the lead system until July 1 and NMFS is not proposing to have any MMPA authorizations valid for the Chukchi Sea open-water period prior to July 1.

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 cow/calf pairs, are more likely to occur in the Beaufort Sea (Figure III.F-6). 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 III.F-6 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. 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 of bowheads were present, and particularly if multiple 2D/3D seismic surveys occurred concurrently in these areas, large numbers (potentially hundreds) of bowheads could be disturbed by the survey activity or could be prevented from accessing important habitat areas during the period in which the surveys were occurring. As we explain in the description of the Proposed Action, 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. Data do indicate however, 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. The mitigation measures outlined in Section IV and as may be imposed during the MMPA authorization process are designed to avoid Level A takes (injury) and limit the potential for Level B takes (harassment) to ensure a negligible impact on marine mammals, including bowhead whales.

Considering only seismic activity, and ignoring other potential human uses of an area, we considered a scenario where up to four seismic vessels in a given area were interested in collecting seismic data from the same general area (see Figures III.F-10 and III.F-11). This scenario does not include any avoidance of support vessels, attraction of prey that might be in the area, sizes of the areas being surveyed, turning requirements for the vessels, or the fact that, unless the vessels all moved in tandem, this area would be larger if the vessels moved further apart. The scenario does provide an opportunity for obtaining a simplistic area of avoidance under the following assumptions: (1) the seismic vessels are no more distant from each other than the minimum separation of 15 mi that MMS requires; and (2) most bowhead whales may 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 Assocs. and LGL Ltd., 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. 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, Würsig, and Greene, 1986; Richardson et al., 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. However, information also exists which documents bowhead whales occurring near operating near seismic survey vessels (Reeves et al., 1984; Richardson et al., 1986, 1987; Brueggeman et al., 1990) and near controlled tests with single airguns and airgun arrays (Richardson et al., 1986; Ljunblad et al., 1988) with no observed effects. Given these assumptions, an instantaneous area being avoided by bowheads in all directions could be as high as 112-132 km x 40-60 km. On Figures III.F-10 and III.F-11, 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 an idea of the potential extent of avoidance in different areas if the assumptions, as discussed above, held. If the area of seismic activity and the avoidance rectangle were offshore of where the whales wanted to be, but not so far offshore that the avoidance rectangle did not reach coastal waters, the seismic vessels might form a "seismic fence" through which few whales would cross. MMS and NMFS believe i~~I~~t is likely most of the whales would not make use of the areas inshore of the "seismic fence," and instead move seaward of the seismic activity. If seismic surveying is being conducted in relatively nearshore blocks (e.g., within 20-30 km of wherever the bowheads' most shoreward-migratory pathway would be), seaward movement could be constrained by the presence of offshore ice. The mitigation measures outlined in Sections II and IV and those that could be included through the MMPA authorization process are designed to limit the potential for seismic surveys to adversely affect the bowhead whales and the subsistence hunt. The MMS and NMFS can restrict operations if additive synergistic effects occur from simultaneous seismic surveys that might hinder the whales' migration.

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 (as potentially in Alternative 8), 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 may also 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 are also 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. 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 cow/calf pairs remain in the Chukchi Sea. The second situation for possibly larger than typical impacts 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. Because recent data are not available on which to evaluate current habitat use by season or area in the Chukchi Sea, the mitigation measures in Section IV should provide additional environmental protection to large numbers of feeding whales and cow/calf pairs by further reducing potential adverse effects.

III.F.3.f(11) Summary of Noise Effects Associated with Seismic Surveys. Our primary concern is for potential effects on bowhead whales, especially cow/calf pairs, newborn and other calves, and females in particular during migration and concentrated feeding periods. If females are unaccompanied by calves, they cannot be distinguished from males. If seismic surveys resulted in the exclusion of large numbers of these classes of individuals from feeding areas, or if calves were exposed to loud sounds from seismic surveys, we cannot rule out the potential for affecting biologically important behaviors. We believe the potential for such effects can be greatly reduced or avoided through careful application of mitigation measures as outlined in Section IV and as may be imposed during the MMPA authorization process.

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 to the noise should not be interpreted as clear indication that they are, or are not, 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 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 (12.4 mi). 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 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. 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, it is possible that disturbance to bowhead whales would be greater than if seismic was the only source of sound. 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 1000 feet. 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 significant. 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 MMS previously (USDOI, MMS, 2003a and 2006a) concluded that these disturbances or avoidance factors were unlikely to be significant, the anticipated level of activity under this Proposed Action is greater than in 2003 and 2006 but less than the activities in the late 1970's and 1980's. 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 (Davis, 1987).

III.F.3.f(12) Effects from Small Oil Spills Associated with Seismic Surveys. Large oil spills are not expected during the course of exploration. Small 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 or potentially permanent 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's) from water and could thereby serve as a conduit for the transfer of PAC's 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 PAC's 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 provide extensive review and discussion of potential impacts of oil spills on endangered whales in our Biological Evaluation of Potential Effects of Oil and Gas Activities in the Chukchi Sea and Beaufort Sea Program Areas on Bowhead, Fin and Humpback Whales. This document is provided on our website at http://www.mms.gov/alaska.

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 large amount of oil and related cleanup-vessel activity. Individual bowhead whales potentially could 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.

III.F.3.f(13) Evaluation of the Context and Intensity of the Proposed Action Relative to Bowhead Whales.

The following criteria for determining significance under NEPA are believed relevant to bowhead whales

III.F.3.f(13)(a) Unique Characteristics of the Geographic Area. We provide detailed information about the affected environment and bowhead whales in Section III. The affected environment in which this activity could have occurred included areas within the spring migratory pathway of the bowhead whale in the Chukchi and Beaufort seas; bowhead calving areas; the fall migratory pathway of the bowhead; and spring, summer, and fall bowhead feeding grounds. Mating can occur within the Beaufort and Chukchi seas area, but most mating probably occurs in the Bering Sea.

We have attempted to reduce substantially the potential for there to be any significant effects on bowhead calving by building into the base action a ban on the conduct of seismic surveys within the spring lead system until July 1. Thus, seismic surveys will not be permitted by MMS to begin operations until July 1 and NMFS is proposing to prohibit any takings under MMPA authorizations for the Chukchi Sea open-water period prior to July 1. While some calving may occur after this date, available data indicate that most of the calving has occurred before that time. This ban also should significantly reduce the possibility of dispersal or disruption of whales that are feeding within the spring lead system in the Chukchi Sea.

Thus, because of these mitigation measures, the spring lead system with in the Chukchi Sea until July 1 is removed from the affected environment in which this action could now occur.

Where data are available and sufficient, we have attempted to identify other areas where aggregations of bowheads are known to occur and where feeding aggregations repeatedly have been observed. We have summarized information that is available about the timing of habitat use.

Where analyses identified areas where effects to bowheads potentially could be significant, we have identified monitoring and mitigation measures to reduce the potential for such impacts (see Sections II and IV).

III.F.3.f(13)(b) Degree of Controversy. There is lack of agreement and controversy exists within the scientific and stakeholder communities about the potential effects of noise on baleen whales, including bowhead whales. This was demonstrated recently by summaries provided in the NRC (2005) and by the lack of consensus amongst participants in the Marine Mammal Commission's Sound Advisory Panel (USDOI, MMS, 2006c). We have considered and incorporated recommendations from the NRC (2005) in our analyses and our conclusions about the potential significance of effects. Perhaps more importantly, our analyses are protective in that we have attempted to err on the side of overestimating potential effects rather than underestimating, and then building in mitigation measures to reduce such potential effects.

III.F.3.f(13)(c) Degree of Highly Uncertain Effects or Unique or Unknown Risks. As discussed in the affected environment section and summarized in the effects of the Proposed Action section, there are limited recent data and, hence, uncertainty, on the current use of the Chukchi Sea by bowhead whales after the primary spring migration period (until approximately June 15 in most years). There is some, but less uncertainty, about bowhead use of the Beaufort Sea for feeding during the summer before September 1. There is remaining uncertainty about the importance of feeding areas within the Alaska Beaufort Sea, especially the western Alaskan Beaufort Sea, to the bowhead population as a whole and, more specifically, to certain segments of the population. While it is clear that there is considerable inter-annual variability in the use of the Beaufort Sea for feeding by bowheads, the factors underlying such variability are not entirely clear. More importantly, the importance of the areas to segments of the population and to the population as a whole during years when large aggregations are observed feeding is unclear. There also is uncertainty about the potential effects of such disturbance from single vessel and multiple seismic vessel operating concurrently to the health of females and young calves and to the next year's reproductive potential of adult females. There is uncertainty about the effects of sound on the hearing of mysticete whales, particularly very young calves. In our analyses, we acknowledge this uncertainty and, based on the precautionary approach that NMFS takes in order to conform to the MMPA requirement to protect marine mammals, where ~~it~~ uncertainty exists, we have designed mitigation measures aimed at reducing impacts to ensure that takings are negligible to the affected stock and are at the lowest level practicable. These mitigation measures would also reduce concern regarding both uncertainty and the potential for there to be adverse effects on bowhead whales, especially cow/calf pairs.

III.F.3.f(13)(d) Precedent-Setting Effects. This PEIS evaluates the potential effects of seismic-survey activities that could occur during open water seasons in the Beaufort and Chukchi Sea Planning Areas. Regarding bowhead whales, there is extensive history and regulatory and procedural structure to evaluate the possible effects of seismic-survey noise on bowhead whales. In addition, multiple vessel seismic surveys have been analyzed in the past for the Arctic (MMS, 2006) and the Gulf of Mexico (MMS, 2004). For this reason, we do not believe that actions taken under the Proposed Action for 2007 and beyond are likely to be precedent setting in this or any other planning areas or with any other species..

III.F.3.f(13)(e) Cumulative Effects. There are potential cumulative effects of noise on bowhead whales. For this reason, we have addressed these potential effects in the cumulative effects section of this document (Section III.H).

III.F.3.f(13)(f) Violations of Federal, State, or Local Environmental Law. If seismic surveys were conducted without authorization under the MMPA, violations of the MMPA and the ESA could result. The Proposed Action and the further considered Alternatives 3 through 8 all require that operators obtain MMPA authorization prior to the commencement of survey activity authorized under MMS permits. For this reason, we can rule out violations of the MMPA and ESA.

III.F.3.f(14) Conclusions about Potential Effects of Seismic Surveys on Bowhead Whales. Available information indicates that bowhead whales are responsive, in some cases highly responsive, to anthropogenic noise in their environment. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source, and the reasons for this variability are not fully understood. In other species of mammals, including cetaceans, females with young are more responsive to noise and human disturbance than other segments of the population (McCauley et al., 2000).

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 levels and the exact characteristics of that activity (e.g., airgun source levels, array configuration and placement in the water column; context (e.g., feeding versus migrating whales); 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 within a relatively large distance than some other species, because they are hunted annually; some individual may have been exposed to both commercial and subsistence hunting over the course of many years and, thus, many individuals may have a strong negative association with human noise (i.e., sensitization).

Bowhead whales that may be exposed to 2D/3D seismic surveys most likely would exhibit avoidance of such operations, and in so doing, avoid the potential for any harm to their hearing from the noise. However, data indicate that fall migrating bowheads can 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 20-30 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 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. 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 (e.g., between hunting areas) bowheads have during their autumn migration and other use of the Beaufort Sea.

If seismic operations overlap in time, the zone of seismic exclusion or influence across both planning areas could potentially be quite large (see Figures III.F-10 and III.F-11), 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 could result in avoidance of feeding areas, resting (including nursing) areas, or calving areas by large numbers of females with calves or females over a period of many weeks. This can be especially important if cow/calf pairs are not able to readily use other similar areas without a costly expenditure of energy. Avoidance of critical areas by bowheads, particularly females with calves, potentially could lead to population-level consequences. These consequences would be of particular concern if such areas included those used for feeding or resting by large numbers of individuals or by cow/calf pairs.

We acknowledge that we are not certain what the potential effects could be on calf survival or growth and female reproduction could be if multiple seismic surveys and other noise sources occurred within an area that was frequently used for feeding by large numbers of bowhead whales. If seismic surveys were not mitigated, or are insufficiently mitigated, effects that are biologically significant could result if seismic surveys cause avoidance of feeding areas, resting areas, or calving areas by females with calves, females, or aggregations of whales that likely contain reproductive-aged females over a period of many weeks. The impact likely would be related to the importance of the food source to the component of the population that would have used it, had not the disturbance caused them to avoid or leave 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 (e.g., between hunting areas) bowheads 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 detectable, long-term population-level 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, it is important to note that sublethal impacts on health (such as reduced hearing or increased stress) could not be detected in this population. Effects on reproduction or survival would not be detectable, unless the level of effects was great enough to be detected given the error around population estimation. The rates of population increase do not indicate any sublethal effects (if they occurred) resulted in a detectable effect on this population's recovery.

NMFS and MMS believe that 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 adverse effects can be reduced thorough careful shaping of the action through the implementation of sufficient monitoring coupled with adaptive management (where the mitigation~~s~~ measures required are dependent on what is discovered during monitoring).

In the Beaufort Sea, depending on the restrictions agreed to in a Plan of Cooperation or similar agreement (e.g., Conflict Avoidance Agreement), it is likely that 2D/3D seismic surveys will be conditioned to protect subsistence harvests. For example, seismic surveys in the central Beaufort Sea conducted during the open-water season could be limited to areas west of Cross Island after September 1 under the provisions of the Conflict Avoidance Agreement between the operator and subsistence whalers, and this would greatly reduce impacts on bowhead whales for the period of the restriction. Similar agreements between the operator and subsistence whalers are likely to be established for any seismic surveys proposed near Kaktovik and Barrow.

We acknowledge a greater level of 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 Sea during the late autumn, careful monitoring and mitigation will be necessary to avoid impacting large numbers of individuals. We propose marine mammal monitoring to address this uncertainty (see Section IV). Coupled with adaptive management that implements mitigation packages dependent on what is encountered during monitoring will ensure to the greatest extent practicable that impacts to bowhead and other species will not be more than negligible.

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

Icebreaker response distances vary. Predictions from some models indicate that bowhead whales likely would respond to the sound of the attending icebreakers at distances of 2-25 km or greater, even much greater, 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.

Under the Proposed Action, 2D and 3D seismic survey vessels will be attended by support vessels. 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. Operations with icebreakers attending could cause a greater zone of avoidance than seismic vessels without icebreakers, especially if active ice management is occurring. The predicted distances at which bowheads would be expected to avoid icebreakers are highly variable, but range up to 95 km, with reaction distances predicted (Richardson et al., 1995b) to commonly be on the order of 10-50 km.

Seismic surveys also may result 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 sometimes are conspicuous if the aircraft is below 300 m (984 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 related to seismic surveys occur, depending on the location, bowheads in some areas may be repeatedly exposed to aircraft noise. Potential effects could be nearly eliminated by the mitigation in Section IV that specifies that flight altitude must be high enough to avoid disturbance. If seismic-survey and aircraft-traffic 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.

Available information does not indicate any long-term population-level 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, it is important to note that sublethal impacts on health (such as reduced hearing or increased stress) or low-level effects on reproduction and survival were not scientifically detectable in this population. Data are insufficient to determine the extent of behavioral, including habitat use, effects that may have occurred during this time period. Data do indicate that this population continued to recover during the 1980's but are insufficient to determine if the rate of recovery was affected by seismic surveys. There has been no documented evidence that noise from previous OCS operations has hindered the overall migration of bowhead whales. Because bowheads respond behaviorally to loud noise by swimming away from certain sounds, 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.

Overall, up to six surveys may occur in each planning area yearly and individual bowheads could be exposed to 2D, 3D and high resolution surveys as they move through each planning area (potentially up to

12 surveys). We cannot however, conclude with certainty that there would not be exclusion or avoidance of bowhead whales from important feeding, resting or migratory areas. In addition, we cannot say with certainty that these exclusions, if they occur, would not result in significant impacts, as defined under the NEPA significance criteria (Section III.E), and/or affect their survival. With this in mind, we have identified mitigation that reduces the potential for these type of effects (exclusion or avoidance of these areas) to occur and applied these to all Alternatives 3-8 (see Sections II and IV). The alternatives, to varying degrees, also contain additional measures to reduce the potential for these types of effects (i.e., large exclusion zones, time/area closures). Also, any MMPA authorizations would, among other things, need to meet a determination that the survey(s) would only result in a negligible impact to whales. This provides an additional level to help avoid effects of exclusion and avoidance. So, although the potential for significant impacts, as defined under the NEPA significance criteria (Section III.E), exists considering the higher level of activity, especially concurrent surveys, and the potential for repeated exposures during critical behaviors, required mitigation and monitoring measures would be implemented to reduce the potential for significant effects to occur.

III.F.3.f(15) Potential Effects of Seismic Survey-Related Noise and Disturbance on Fin and Humpback Whales. 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-producing activities in the Beaufort or Chukchi seas evaluation areas. We acknowledge that there no current data are 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.

Based on available information, it is unlikely that there would be any major effect of noise and disturbance associated with oil and gas activities in the Chukchi Sea Planning Area on humpback whales or fin 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. Because 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 on 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 detection occurs at all and causes any response, are most likely to be short term and related to minor behavioral changes, if any, and to be of negligible impact to the population. The most likely potential effect, if the humpback 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 also might be exposed to the seismic-survey vessels or to the support vessels as the boats 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 nm of Alaska. Vessels (with some exemptions) transiting near humpbacks also are required to adhere to a "slow, safe speed" requirement to prevent disturbance that could adversely affect humpbacks.

For the reasons given above, we conclude 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 the distance they are expected to be from such activities. We acknowledge that recent data confirming the use of these two species in areas near the Chukchi Sea Planning Area are lacking. If humpback whales and fin whales were present, available data indicate that humpback whales are likely to be more responsive to seismic-survey noise than fin whales, and behavior disturbance could occur as with bowhead whales. We reiterate that available information indicates neither of these is likely to be present within the area where seismic surveys may occur.

III.F.3.g. Mitigation Measures for Bowhead Whales. As pointed out by the Federal Caucus Finding of the Marine Mammal Commission Sound Advisory Panel (Marine Mammal Commission, 2006:B-12): "Improving mitigation depends upon the ability to understand the effect that is being mitigated…Efforts to monitor the effectiveness of these" mitigation "techniques and develop a better system are warranted."

To achieve effective mitigation of potential effects of seismic surveys on bowhead whales, and to avoid the potential for adverse effects on bowhead calves and reproductive-aged females, effective monitoring and adaptive management would be required. Effective pre-seismic-surveying monitoring surveys would be necessary in both the Beaufort and the Chukchi Sea to reduce uncertainty about how many and what type of bowheads might be exposed to noise and disturbance associated with seismic surveys and to form a basis for deciding whether ramp up could be initiated and what decibel-level exclusion zone or operational restrictions are warranted. This is particularly the case in the Chukchi Sea, where recent data are insufficient to determine current bowhead-habitat use sufficient to evaluate potential impacts. Thus, pre-seismic–survey monitoring could be required by the operator to determine the distribution and abundance and type of bowhead whales present in the areas in which the seismic survey will occur. Such monitoring surveys would be conducted using protocol approved by NMFS and would determine whether seismic operations can be initiated and the size of the exclusion zone or operational restrictions to be implemented.

Section IV describes mitigation measures to further reduce potential adverse impacts to bowhead whales and other marine mammals. Given the lack of scientific certainty in some areas, this PEIS adopts a protective approach in assessing potential impacts to the endangered bowhead whales, bowhead whale cow/calf pairs, and large aggregations of feeding mysticete whales.

III.F.3.h. Impact Assessment of Alternatives. The following analysis provides a comparison of the relative levels of protection to threatened and endangered marine mammals found in the Proposed Action area under the various alternatives, using the significance criteria for endangered whales defined in Section III.E.2.

III.F.3.h(1) Alternative 1. The no-action alternative (no seismic survey permits issued for geophysical exploration activities) would not expose marine mammals in the project area to noise associated with seismic surveys and their associated support vessels (air and sea) and therefore, no adverse impacts would be expected on bowhead whales.

III.F.3.h(2) Alternatives 3 through 8. Alternatives 3 through 8 are similar but have varying levels of protection for marine mammals. This variation in protection primarily is in the noise level set as the shut-down criteria and monitoring that is required to effectively monitor the noise-level radii, or shut-down/exclusion zone as well as any temporal/spatial/operational restrictions imposed (Alternative 3, 120-dB safety zone; Alternative 4, 160-dB safety zone; Alternative 5, 120/160-dB safety zones; Alternative 6, 180/190-dB exclusion zone; Alternative 7, 120/160/180/190-dB safety and exclusion zones; and Alternative 8, 160/180/190-dB safety and exclusion zones and temporal/spatial/operational restrictions).

While all alternatives other than the No-Action Alternative meet the objectives of this environmental analysis, they also could adversely affect bowhead whales and other marine mammals, principally through incidental harassment due to exposure to seismic survey noise. Although the MMPA authorization(s) would not authorize Level A (potential to injure) harassment takes of marine mammals, it would authorize potential behavioral harassment of marine mammals (i.e., Level B harassment). Harassment likely would be most important if feeding aggregations of whales, or cow/calf pairs of bowhead whales, are affected. As stated earlier, we cannot conclude with certainty that the Proposed Action would not result in exclusion or avoidance of bowhead whales from feeding, resting or migratory areas. In addition, we cannot say with certainty that these exclusions, if they occur, would not result in significant impacts, as defined under the NEPA significance criteria (Section III.E), and/or affect their survival. However, Alternatives 3 through 8 include mitigation and monitoring measures that would reduce the potential for significant impacts, as defined under the NEPA significance criteria (Section III.E). Further protection from potential adverse effects would also be reduced through granting of MMPA authorizations (which again must meet a determination of negligible impact to marine mammals) and the mitigations included in these authorizations.

Alternatives 3 through 8 would all prohibit seismic surveys in the spring lead system and thereby reduce the potential for adverse effects of seismic surveys on bowhead calving, cow/calf pairs, and newborn calves. The effect of seismic surveys on these components of the population is uncertain, and avoidance of their exposure is the most effective way to reduce the potential for an adverse effect on these bowheads (and the subsistence hunt of bowheads).

Variability in the size and configuration of the airgun arrays, water depth, and bottom properties all can influence the noise-level radii, which is expected to vary from one location to another and between different seismic operations. Therefore, field verification is included as a mitigation measure for all Alternatives 3 through 8 to verify the actual noise-level radii. As noted in the non-endangered marine mammal section (III.F.4), these shut-down or safety zones may be as large as 30 km for the 120-dB zones and as small as 100 m for the 190-dB zones, depending on the size and energy output of the airgun array and environmental conditions. It is likely that aerial, vessel or passive acoustic monitoring will be required to monitor these zones. If these methods are not effective, then additional mitigation measures may be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis). For example, it may be necessary to exclude seismic surveys from areas that historical data indicate could have high use during the open-water season by bowhead whales, unless survey data or monitoring can demonstrate that bowhead females and cow/calf pairs will not be excluded from areas of potentially high importance to them. Although the MMPA process could impose any of these additional temporal/spatial/operational restrictions, Alternative 8 provides a heavier emphasis of their use compared to Alternatives 3 through 7.

Alternatives 3 through 8 provide monitoring requirements meant for observers to visually monitor the safety and exclusion zones, regardless of size, and be able to call for a shut down if marine mammals enter the zones. The ability of observers to effectively monitor the zones, and be able to call for a shut down if bowheads enter the zones, is critical to the success of the protective measures described in Alternatives 3 through 8, although it is generally not possible to observe all bowheads within a zone, especially during foggy weather or at night. Additional monitoring techniques, such as aerial surveys, vessel-based systems, or passive acoustics, could enhance the ability to detect bowhead whales and other marine mammals in larger safety zones. (However, Alternative 8 may be able to address difficulties in monitoring larger safety zones by instead closing areas of higher bowhead concentration to seismic survey activities.

Evidence shows that bowhead whales and other cetaceans can react behaviorally in the presence of aircraft. The mitigation measures imposed under Alternatives 3 through 8 all would require that aircraft be flown no lower than 1,000 ft, a level that limits the potential for reactions from marine mammals. Therefore, the use of aerial overflights in monitoring would not be expected to add additional impacts to bowhead whales. The same is true for passive acoustic monitoring where observers simply “listen” for evidence of whale noise. Vessel-based monitoring may impose a degree of additional disturbance, but it would be considered less than what would occur for seismic activity should whales not be monitored but present in the exclusion zone.

The differences among Alternatives 3 through 8 revolve around the amount of protection afforded to whales through the mitigation included within each alternative. We reiterate the assessments made in the non-threatened and endangered marine mammal section (III.F.4). Alternatives with larger safety zones (i.e., Alternatives 3, 4, 5 and 7) would provide a greater level of protection than the 180/190-dB exclusion zone specified in Alternative 6. In addition, Alternative 8 includes a larger safety zone of 160-dB and also adds temporal/spatial/operational restrictions that would close areas or reduce activity in areas of higher bowhead presence.

Each 180/190-dB exclusion zone in Alternatives 3 through 8 would require boat-based visual monitoring (i.e., all observers are scanning areas from the vessel as far as visually possible with appropriate equipment). The additional monitoring techniques (e.g. aerial or vessel-based surveys, acoustic monitoring) that may be necessary for Alternatives 3, 4, 5, 7, and 8 could be costly to implement because the larger zones associated with the 120-dB isopleth, in theory, would provide a much larger and more difficult area to monitor then the smaller zones (160-dB isopleth and 180/190-dB isopleth). However, smaller zones are less effective in limiting impacts to cetaceans than larger zones because larger zones associated with Alternatives 3, 5 and 7 would by definition require further distance of operating seismic survey vessels from cetaceans than Alternatives 4 and 6. The temporal/spatial/operational restrictions in Alternative 8 may provide an equal or greater level of protection than Alternatives 3 (120-dB), 5 (120/160-dB) and 7 (120/160/180/190-dB) and a certain greater level of protection than Alternatives 4 (160-dB) and 6 (180/190-dB). Additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis) should monitoring measures prove ineffective.

III.F.4. Other Marine Mammals.

There are 11 species of marine mammals that occur in the Beaufort and Chukchi Sea Planning Areas that are not listed as endangered or threatened under the ESA. They are:

Pinnipeds
- Ringed seal (*Phoca hispida*)
- Spotted seal (*Phoca largha*)
- Ribbon seal (*Phoca fasciata*)
- Bearded seal (*Erignathus barbatus*)
- Pacific walrus (*Odobenus rosmarus divergens*)

Cetaceans
- Beluga whale *(Delphinapterus leucas)*
- Killer whale *(Orcinus orca)*
- Minke whale *(Balaenoptera acutorostrata)*
- Harbor porpoise *(Phocoena phocoena)*
- Gray whale *(Eschrichtius robusta)*

Marine Fissipeds
- Polar bear *(Ursus maritimus)*

There are no State-listed marine mammal species of special concern within the Proposed Action area.

III.F.4.a. Pinnipeds.

Five species of pinnipeds are associated with sea ice in Alaskan waters: Pacific walrus and four species of phocid seals (bearded, ribbon, ringed, and spotted). All five species haul out on sea ice to rest, give birth, and molt, and they all perform seasonal migrations in conjunction with the seasonal advance and retreat of ice (Fay, 1974). Ribbon and spotted seals are thought to prefer the loose ice of the "ice front," whereas ringed seals, bearded seals, and walruses are thought to prefer more interior pack ice, when available (Fay, 1974; Burns, Shapiro, and Fay, 1981; Simpkins et al., 2003). Little is known about the biology or population dynamics of ice seals, and they have received little attention compared with other Bering/Chukchi Sea species known to be in decline. Accurate population estimates for ice seals are not available and are not easily attainable due to their wide distribution and problems associated with research in remote, ice-covered waters (Quakenbush and Sheffield, 2006). Although little is known about the population status of ice seals and walrus, there is cause for concern. Sea ice is changing in thickness, persistence, and distribution (Sec. III.A.4, Sea Ice), and evidence indicates that oceanographic conditions have been changing (Sec. III.A.3, Oceanography), which suggests that changes in the ecosystem may be occurring as well (Quakenbush and Sheffield, 2006).

III.F.4.a(1) Ringed Seal.

Ringed seals have a circumpolar distribution from approximately 35° N. latitude to the North Pole, and occur in all seas of the Arctic Ocean (King, 1983). Ringed seals are year-round residents in the Chukchi and Beaufort seas, and are the most common and widespread seal species in the area. They are closely associated with ice. They have the unique ability to maintain breathing holes in thick ice and, therefore, are able to exploit the ice-covered parts of the Arctic during winter when most other marine mammals have migrated south (Rosing-Asvid, 2006). In winter and spring, the highest densities of ringed seals are found on stable, shorefast ice. In summer, ringed seals often occur along the receding ice edges or farther north in the pack ice. Ringed seals seem to prefer icefloes >48 m in diameter and often are found in the interior pack ice, where sea-ice concentrations exceed 90% (Simpkins et al. 2003). Ringed seal densities in the Beaufort Sea are greatest in water with >80% ice cover (Stirling, Kingsley, and Calvert, 1981) and depths between 5 and 35 m (Frost et al., 2004). Densities also are highest on relatively flat ice and near the fast-ice edge, declining both shoreward and seaward of that edge (Frost et al., 2004). Ringed seal densities historically have been substantially lower in the western than the eastern part of the Beaufort Sea (Burns and Kelly, 1982; Kelly, 1988). The lower densities to the west appear to be related to very shallow water depths in much of the area between the shore and barrier islands. Surveys flown from 1996-1999 indicate that the highest density of seals along the central Beaufort Sea coast in Alaska occurred from approximately Kaktovik west to Brownlow Point (Frost et al., 2004). This may be due to the fact that relative productivity, as measure by zooplankton biomass, is approximately four times greater there than the average biomass in other areas of the eastern Beaufort Sea (Frost et al., 2004).

In early summer, the highest densities of ringed seals in the Chukchi Sea are found in nearshore fast and pack ice (Bengston et al., 2005). This also appears to be true in the Beaufort Sea, based on incidental sightings of seals during aerials surveys for bowhead whales (USDOI, MMS, 2005this should be a BWASP cite). During summer, ringed seals are found dispersed throughout open-water areas, although in some regions they move into coastal areas (Smith, 1987; Harwood and Stirling, 1992). In the late summer and early fall, ringed seals often aggregate in open-water areas where primary productivity is thought to be high (Harwood and Stirling, 1992).

No reliable estimate for the size of the Alaska ringed seal stock is available (Angliss and Outlaw, 2005), although past estimates ranged from 1.0 million to 3.6 million (Frost et al., 1988). Ringed seal numbers are considerably higher in the Bering and Chukchi seas, particularly during winter and early spring (71 *FR* 9783). Recent work by Bengston et al. (2005) reported an estimated abundance of as many as 252,488 ringed seals in the eastern Chukchi Sea. Frost and Lowry (1981) estimated 80,000 ringed seals in the Beaufort Sea during summer and 40,000 during winter, although some authors (Amstrup, 1995) estimated the Beaufort Sea population at four times these numbers. Few, if any, seals inhabit ice-covered waters shallower than 3 m due to water freezing to the bottom and/or poor prey availability caused by the limited amount of ice-free water (71 *FR* 9785). Frost et al. (2002) reported that population trend analyses in the central Beaufort Sea suggested a substantial decline of 31% in observed ringed seal densities from 1980-1987 to 1996-1999. However, this apparent decline may have been due to a difference in the timing of surveys rather than an actual decline in abundance (Frost et al., 2002). Spatial and temporal comparisons typically rest on the assumption that the proportion of animals visible is constant from survey to survey. However, Frost et al. (2004) cautioned against comparing survey results because of the marked between-year variation in density estimates common for ringed seal surveys. This likely is due to the timing of the surveys relative to ice conditions and the progress of the seals' annual molt (Frost et al., 2004). In fact, Kelly (2005) found that aerial surveys can underestimate ringed seal densities by factors of >13, because the proportion of seals visible during survey periods can change rapidly from day to day. Therefore, comparisons of ringed seal densities between regions and between years based on aerial surveys should account for the proportion of the population visible during each survey (i.e., appropriate correction factors should be used) (Kelly, 2005). Ringed seals are not listed as "depleted" under the MMPA, and the Alaska stock of ringed seals is not classified as a strategic stock by the NMFS.

Ringed seals give birth from mid-March through April to a single pup, which they nurse for 5-8 weeks (Hammil et al., 1991; Lydersen and Hammill, 1993). Pupping and nursing occur in subnivean lairs constructed on either landfast or drifting pack ice, during which time they are hunted by polar bears (Stirling and Archibald, 1977; Smith, 1980). Mating occurs shortly after pupping (~ 4 weeks), and the female delays implantation of the embryo until later in the summer (July-August).

Ringed seals feed on a variety of fish and invertebrates. Diet depends on the prey availability, depth of water, and distance from shore. In Alaskan waters, the primary prey of ringed seals is arctic cod, saffron cod, shrimps, amphipods, and euphausiids (Kelly, 1988; Reeves, Stewart, and Leatherwood, 1992).

Reproductive rates for ringed, spotted, and ribbon seals are capable of approaching 95% annually (Smith, 1973; Burns, 1981; Quakenbush and Sheffield, 2006). However, current reproductive rates appear to be lower than the maximum recorded for each species. For example, 69% of female ringed seals sampled in the Bering and Chukchi Seas between 2000 and 2005 were pregnant (Quakenbush and Sheffield, 2006). Similarly, ringed seals in the eastern Beaufort Sea exhibited reduced reproductive output and reduced body condition between 2003 and 2005. Local fishers in the eastern Beaufort Sea suggest that the downturn in seal body condition is related to decreased marine productivity in the area, as evidenced by recent reductions in fishing opportunities for arctic cod in the same areas that seals hunt (Harwood, 2005). Reduced arctic cod numbers probably also are a factor in reduced seal reproductive output, as successful ovulation is directly correlated with body condition (Harwood, 2005).

Ringed seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The Alaska Department of Fish and Game (ADF&G) maintains a subsistence harvest database and, as of August 2000, the mean estimate of ringed seals taken annually is 9,567 (ADF&G, 2000).

III.F.4.a(2) Spotted Seal.

Spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay, 1977). They are common in the coastal Alaskan waters in ice-free seasons. They migrate south from the Chukchi Sea and into the Bering Sea in October-November (Lowry et al., 1998). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring, moving to coastal habitats after the retreat of the sea ice (Shaughnessy and Fay, 1977; Simpkins et al., 2003). Spotted seals are not known to use the Beaufort Sea in the winter. Spotted seals are closely related to, and often mistaken for, Pacific harbor seals (*Phoca vitulina richardsi*). The two species often are seen together and are partially sympatric in the southern Bering Sea (Quakenbush, 1988).

No reliable estimate for the size of the Alaska spotted seal stock is available (Angliss and Outlaw, 2005). An early estimate of the size of the world population of spotted seals was 370,000-420,000, and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000-250,000 animals (Bigg, 1981). Using telemetry data, the ADF&G corrected 1992 survey results producing a rough estimate of 59,214 animals (Rugh et al., 1993) for western Alaska and the Bering Sea. Spotted seals are not listed as “depleted” under the MMPA. The Alaska stock of spotted seals is not classified by NMFS as a strategic stock.

During spring when pupping, breeding, and molting occur, spotted seals inhabit the southern margin of the sea ice in the Bering Sea (Quakenbush, 1988; Rugh, Shelden, and Withrow, 1997). Of eight known breeding areas, three occur in the Bering Sea (Angliss and Outlaw, 2005). Pupping occurs on ice in April-May, and pups are weaned within 3-4 weeks. Adult spotted seals often are seen on the ice in female-pup or male-female pairs, or in male-female-pup triads. Mating occurs around the time the pups are weaned and mating pairs are monogamous for the breeding season. During the summer and fall, spotted seals are found primarily in the Bering and Chukchi seas but some range into the Beaufort Sea (Rugh, Shelden, and Withrow, 1997; Lowry et al., 1998) from July until September. In total, there probably are only a few dozen spotted seals along the coast of the central Beaufort Sea during summer and early fall (Richardson, 2000). At this time of year, spotted seals haul out on land part of the time but also spend extended periods at sea. The seals commonly are seen in bays, lagoons, and estuaries, but they also range far offshore to 72° N. latitude (Shaughnessy and Fay, 1977). Spotted seals are rarely seen on the pack ice during the summer, except when the ice is very near shore.

Adult spotted seal principal foods are schooling fishes, although the total array of foods is quite varied. In the Arctic, their diet is similar to that of ringed seals, including a variety of fishes such as arctic and saffrocod, and also shrimp, and euphausiids (Kato, 1982; Quakenbush, 1988; Reeves, Stewart, and Leatherwood, 1992). Within their geographic range they are known to eat sand lance, sculpins, flatfishes, and cephalopods (mainly octopus). The juvenile diet is primarily crustaceans (shrimp).

Spotted seals are an important subsistence species for Alaskan Native hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions (Lowry, 1984). The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. From 1966-1976, an average of about 2,400 spotted seals was taken annually (Lowry, 1984). The ADF&G maintains a subsistence-harvest database that indicates that at least 5,265 spotted seals are taken annually for subsistence use (ADF&G, 2000).

III.F.4.a(3) Ribbon Seal.

Ribbon seals inhabit the North Pacific Ocean and the adjacent fringes of the Arctic Ocean. In Alaska, they range northward from Bristol Bay in the Bering Sea and into the Chukchi and western Beaufort seas. They are found in the open sea, on pack ice, and rarely on shorefast ice (Kelly, 1988). As the ice recedes in May to mid-July, they move farther north in the Bering Sea, hauling out on the receding ice edge and remnant ice (Burns, Shapiro, and Fay, 1981). Seal distribution throughout the rest of the year is largely unknown; however, information suggests that many ribbon seals migrate into the Chukchi Sea for the summer months (Kelly, 1988).

Females give birth anytime from early April to about mid-May, with pupping occurring on pack ice. Nursing lasts from 3-4 weeks, during which time a pup's weight more than doubles. Mating occurs about the time pups are weaned. After weaning, pups spend a great deal of time on the ice, achieving proficiency at diving and feeding. Ribbon seals dive as deep as 200 m in search of food. They eat a variety of different foods, but their main prey is fish; they also are known to consume eelpouts, capelin, pricklebacks, arctic cod, saffron cod, herring, and sand lance. Foods other than fishes include cephalopods (primarily squids), shrimps, mysids, and crabs.

No reliable estimate for the size of the Alaska ribbon seal stock is available (Angliss and Outlaw, 2005). Burns (1981) estimated the Bering Sea population at 90,000-100,000. Ribbon seals are not listed as "depleted" under the MMPA. The Alaska stock of spotted seals is not classified by NMFS as a strategic stock.

Ribbon seals occasionally are harvested by Alaskan Native hunters, although subsistence-harvest levels are low. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The ADF&G maintains a subsistence harvest database, and the mean estimate of ribbon seals taken annually is 193 (Angliss and Outlaw, 2005).

III.F.4.a(4) Bearded Seal.

Bearded seals are the largest of the northern phocids, and have a circumpolar distribution ranging from the Arctic Ocean down into the western Pacific (Burns, 1981). In Alaskan waters, bearded seals occur over the continental shelves of the Bering, Chukchi, and Beaufort seas (Burns, 1981). Bearded seals predominantly are benthic feeders (Burns, 1981), feeding on a variety of invertebrates (crabs, shrimp, clams, and snails) and other food organisms, including arctic and saffron cod, flounders, sculpins, and octopuses (Kelly 1988; Reeves, Stewart, and Leatherwood, 1992). Bearded seals also feed on ice-associated organisms when they are present, allowing them to live in areas with water depths considerably deeper than 200 m. In some areas, bearded seals are associated with the ice year-round; however, they usually move shoreward into open-water areas when pack ice retreats. During the open-water period, bearded seals occur mainly in relatively shallow areas, preferring areas no deeper than 200 m (Harwood et al., 2005; USDOI, MMS, 2005see prev. comment).

No reliable estimate for the size of the Alaska bearded seal stock currently is available (Angliss and Outlaw, 2005). Bengtson et al. (2005) conducted surveys in the eastern Chukchi Sea but could not estimate abundance from their data. Early estimates of the Bering-Chukchi seas population range from 250,000-300,000 (Burns, 1981). Bearded seals are not listed as "depleted" under the MMPA. The Alaska stock of bearded seals is not classified by NMFS as a strategic stock.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly, 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. From mid-April to June, as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait. During summer, the most favorable bearded seal habitat is found in the central and northern Chukchi Sea, where they are found near the widely fragmented margin of the pack ice; they also are found in nearshore areas of the central and western Beaufort Sea during summer. Suitable habitat is more limited in the Beaufort Sea where the continental shelf is narrower and the pack-ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding. In the Beaufort

Sea, bearded seals rarely use coastal haulouts. Females pup in April-May, bearing a single pup. Breeding occurs within a few weeks after the pup is weaned, and implantation is delayed until July.

Bearded seals are an important subsistence species for Alaskan Native hunters. The number of seals taken annually varies considerably between years due to ice and wind conditions, which impact hunter access to seals. The ADF&G maintains a database, and the mean estimate of bearded seals taken annually is 6,788 (ADF&G, 2000).

III.F.4.a(5) Pacific Walrus.

No reliable estimate is currently available for the size of the Alaskan stock of Pacific walrus (Angliss and Outlaw, 2005). However, available evidence indicates that the population is likely in decline (Kelly, Quakenbush, and Taras, 1999; Kochnev, 2004).

Pacific walruses range throughout the shallow continental shelf waters of the Bering and Chukchi seas, where their distribution is closely linked with the seasonal distribution of the pack ice. Walruses are migratory, moving south with the advancing ice in autumn and north as the ice recedes in spring (Fay, 1981). Walruses generally are found in waters <200 m deep along the pack ice margin where ice concentrations are <80% (Fay 1982; Fay and Burns, 1988). The juxtaposition of broken ice over relatively shallow continental shelf waters is important to them for resting between feeding bouts, particularly for females with dependent young which may not be capable of deep diving or long term exposure to the frigid water.

Walruses are extremely social and gregarious animals, and spend approximately one-third of their time hauled out onto land or ice, usually in close physical contact with one another. Walruses rely on sea ice as a substrate for resting and giving birth (Angliss and Outlaw, 2005) and generally require ice thicknesses of 50 cm or more to support their weight (USDOI, FWS, pers. commun.). Pacific walruses are segregated by gender for much of the year as they migrate over vast areas of the Bering and Chukchi Seas (Fay, 1982). The shallow Chukchi Sea and eastern Siberian Sea serve as the main feeding grounds for the bulk of the Pacific walrus population in the summer and autumn (Kochnev, 2004). During the summer months the majority of the subadults, females, and calves move into the Chukchi Sea. In contrast, adult males generally abandon the sea ice in spring for coastal haulouts in Bristol Bay and Gulf of Anadyr (Jay and Hills, 2005). The Chukchi Sea west of Barrow is the northeastern extent of the main summer range of the walrus; few are seen farther east in the Beaufort Sea (e.g., Harwood et al., 2005). Those observed in the Beaufort Sea are typically lone individuals.

Walruses specialize in feeding on benthic macro-invertebrates and prefer to forage in areas <80 m deep (Fay, 1982). In Bristol Bay, 98% of satellite locations of tagged walruses were in water depths ≤60 m (Jay and Hills, 2005). Walruses most commonly feed on bivalve mollusks (clams), but they also will feed on other benthic invertebrates (e.g., snails, shrimp, crabs, worms). Some walrus have been reported to prey on marine birds and small seals.

Walruses are long-lived animals with low rates of reproduction. Females reach sexual maturity at 4-9 years of age, and give birth to one calf every 2 or more years. Although males become fertile at 5-7 years of age, they do not reach full competitive maturity until age 15-16. Some walrus may live to age 35-40, and remain fertile until relatively late in life. In winter, Pacific walruses inhabit the pack ice of the Bering Sea. Breeding occurs between January and March, and implantation is delayed until June-July. Gestation lasts 11 months, and calving occurs on the sea ice in April-May approximately 15 months after mating. Calves are not weaned for 2 years or more after birth (Fay, 1982). By May as the pack ice loosens, adult females and dependent young move northward into the Chukchi Sea. In summer, these walrus tend to concentrate in areas of unconsolidated pack ice within 100 km of the leading edge of the pack ice in the Chukchi Sea. By July, large groups of up to several thousand walruses can be found along the edge of the pack ice between Icy Cape and Point Barrow. When suitable pack ice is not available, walruses will haul out to rest on land, preferring sites sheltered from wind and surf. Traditional haulout sites in the eastern Chukchi Sea include Cape Thompson, Cape Lisburne, and Icy Cape. By August, depending on the retreat of the pack ice, walruses are found farther offshore, with principal concentrations to the northwest of Barrow. By

September, the edge of the pack ice generally retreats to about 71° N. latitude, although it may retreat as far as 76° N. latitude in some years. In October, as the pack ice advances, large herds begin moving back down to the Bering Sea.

Recent trends in seasonal sea-ice break-up have resulted in seasonal sea-ice retreating over deep Arctic Ocean waters beyond the continental shelves. This trend poses adaptive challenges for the walrus population (Tynan and DeMaster, 1997). Females with calves are not normally observed in deep Arctic basin waters due to the depth of the water and resultant inaccessibility of food there; thus, the recent observations of nine motherless calves stranded on ice floes in deep waters off of northwest Alaska are troubling (Cooper et al., 2006). Considering that walrus calves are dependent on maternal care for 2 years or more before they are able to forage for themselves, this observation of abandoned calves may have implications for the Pacific walrus population (Cooper et al., 2006). These calves may have been abandoned by their mothers due to lack of food, and the authors speculate that much higher numbers than the 9 observed may have been present in their study area.

In fall, migrating walruses often have to cross large distances of open water between the leading ice edge and haulout sites where they can rest on shore (Kochnev, 2004). According to Charles Johnson, Executive Director of the Alaska Nanuuq Commission, walrus herds have begun hauling out in great numbers along the north coast of Chukotka within the last 5 years (Johnson, pers. commun.). In 2002, walruses hauled out at an unusual place on the north coast of Chukotka, between Cape Schmidt and the Native village of Vankarem. Walruses had never been reported hauling out there before, yet this time they formed a large coastal rookery (Ovsyanikov, 2003). Up to 125,000 walruses have been estimated to use coastal haulouts on Wrangel Island in the Russian Arctic (Kochnev, 2004), and from 10-13 walrus-haulout sites now occur annually in summer and autumn on the Arctic coast of Chukotka. During autumns of minimal ice, walruses are relegated to these sites, which limits their feeding opportunities and likely results in great energy loss prior to winter. This is because walruses tend to use ice haulouts when they are available over shallow waters, because the constantly moving ice provides easy access to undepleted food resources. When ice retreats far to the north in autumn, walrus are forced to use crowded terrestrial haulouts. Under these conditions, competition for food resources within their foraging range of the haulout can be fierce. Prey abundance within foraging range can be depleted, resulting in poor body condition. The large number of lean walruses at coastal haulouts in the fall attests to this fact.

The high density of animals in many haulouts creates additional stress on tired and hungry animals. The level of mortality at haulouts on Wrangel Island and the Arctic coast of Chukotka is estimated to be 3-6 times higher than at summer haulouts in the Bering Sea (Kochnev, 2004). Because the majority of haulouts on the Chukotka coast are near native villages, they also are susceptible to human harvest. Polar and brown bears also prey on walruses at haulouts. For these reasons, all the haulouts of the Arctic coast of Chukotka are characterized by a high disturbance level, which results in stressed animals and mortalities due to predation and stampedes. During ice-free years, killer whales appear more frequently and also take a toll on walruses. In addition, the absence of ice increases the severity of autumn storms, which can induce further stress, and result in mortalities and the separation of mother/calf pairs (USDOI, FWS, 2005b). This may be one of the reasons for observed low pup survival in recent years (Kelly, Quakenbush, and Taras, 1999; Kochnev, 2004). Furthermore, weakened animals are more susceptible to diseases; in recent years, for example, ulcers observed on harvested and captured walruses have been linked to bacterial infections of unknown etiology (Kochnev, 2004). Repetition of such conditions over the last decade likely have resulted in increased mortalities among juveniles and weakened adult walruses and may be the major cause of apparent population declines (Kochnev, 2004). On the American side of the Chukchi, walrus-haulout sites are relatively rare (Kochnev, In prep.), although in recent years, Cape Lisburne has seen regular walrus use in the late summer (USDOI, FWS, pers. comm.).

Over the past decade, the numbers of walruses at coastal haulouts in Bristol Bay, along the coast of Kamchatka, and in the Bering Strait and Gulf of Anadyr have steadily declined, which may indicate a declining walrus population (Smirnov et al., 2004). According to Smirnov et al. (2004) and others, it is increasingly clear that efforts must be made to improve the protection and monitoring of the Pacific walruses' most vulnerable habitats, their coastal haulouts.

No reliable estimate for the size of the Alaska Pacific walrus stock is available (Angliss and Outlaw, 2005). Estimates of the Pacific walrus population suggest a minimum of 200,000 animals were necessary to withstand the levels of commercial harvest, which occurred in the 18th and 19th centuries (Fay, 1982). The population size has never been known with certainty; however, the most recent survey estimate was approximately 201,039 animals (Gilbert et al., 1992). In 2006 the FWS, in collaboration with USGS and Russian scientists from GiproRybFlot and ChukotTINRO, conducted a rangewide survey of the Pacific walrus population. The primary goal of the survey was to estimate the size of the Pacific walrus population across its spring range, which is the ice-covered continental shelf of the Bering Sea. Walruses were counted using a combination of aerial thermal imagery and photography. The final population estimate will be developed cooperatively by U.S. and Russian scientists, and results are expected in late 2007.

Pacific walruses are not listed as “depleted” under the MMPA, nor is the Alaska stock of Pacific walrus classified by NMFS as a strategic stock.

The Pacific walrus is an important subsistence species for Alaskan Native hunters. The number of walruses taken annually has varied over the years, with recent harvest levels much lower than historic highs. Based on harvest data from Alaska and Chukotka in the years 2001-2005, mean harvest mortality levels are estimated at 5,458 animals per year (USDOI, FWS, 2006b).

III.F.4.b. Cetaceans.

III.F.4.b(1) Beluga Whale.

Beluga whales are found throughout the arctic and subarctic waters of the Northern Hemisphere. They inhabit seasonally ice-covered waters and are closely associated with open leads and polynyas in ice-covered regions (Hazard, 1988). In summer months, they migrate to warmer coastal estuaries, bays, and rivers (Finley, 1982). In Alaska there are five recognized stocks: (1) Eastern Chukchi Sea; (2) Beaufort Sea; (3) Cook Inlet; (4) Bristol Bay; and (5) Eastern Bering Sea (O’Corry-Crowe et al., 1997). Within the Proposed Action area, only the Beaufort Sea stock and eastern Chukchi Sea stocks are present. During June, July, and part of August it is likely that the ranges of the two stocks do not overlap much (Suydam et al., 2005). However, based on recent telemetry studies on eastern Chukchi belugas, it is likely that members from both stocks occur in similar places and at similar times during the fall migration, although the significance of this is unknown (Suydam et al., 2005).

Pod structure in beluga groups appears to be along matrilineal lines, with males forming separate aggregations. Small groups often are observed traveling or resting together. Females calve in the May-July, when herds are in their summer areas. Calves typically are weaned at 2 years of age. Mating occurs in the early spring (March-April).

Beluga whales of both stocks winter in the Bering Sea and summer in the Beaufort and Chukchi Seas, migrating around western and northern Alaska in the spring lead system in April and May (Richard, Martin, and Orr, 2001; Angliss and Outlaw, 2005). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al., 1984; Ljungblad, Moore, and Van Schoik, 1984; Richardson et al., 1995a). Most belugas move into shallow coastal or estuarine waters during at least a portion of the summer (Caron and Smith, 1990; Frost and Lowry, 1990). These areas of summer concentration are consistent from year to year, and the waters are usually brackish and relatively warm (Suydam et al., 2005). Eastern Chukchi belugas move into coastal areas along Kotzebue Sound and Kasegaluk Lagoon in late June and remain there until mid to late July (Suydam et al., 2001; Suydam et al., 2005). Subsistence hunting occurs on this stock during their time in these waters. The absence of significant stomach contents in belugas killed suggests that feeding is not the major reason for their presence near Kasegaluk Lagoon during this time (Suydam et al., 2005). Some of the largest gravel beds in the Chukchi Sea occur in Kasegaluk Lagoon and research suggests these areas are likely used for molting (Frost, Lowry, and Carroll, 1993). The low saline content and warmer water exiting the lagoons may facilitate the molting process (Suydam et al., 2005). After leaving coastal areas, it is believed the animals move northeastward and spend the remainder of the summer in the northern Chukchi and western Beaufort seas.

During the late summer and autumn, most belugas migrate far offshore near the pack-ice front (Frost et al., 1988; Hazard, 1988; Clarke, Moore, and Johnson, 1993; Miller, Elliott, and Richardson, 1998). During the remainder of the summer, beluga whales also can be found in large aggregations further offshore and associated with deeper slope water. Recent research suggests that belugas are not necessarily limited by heavy ice cover (>90%) during this time and are able to travel great distances in short time periods (Suydam et al., 2005). Whales may remain in pods for weeks or months or may move as much as 700 km apart and converge again later (Suydam et al., 2001). From satellite-tagged animals, it appears that all belugas that move north of 75° N. latitude are males, whereas females remain at or near the shelf break throughout summer and early fall (Suydam et al., 2005). Belugas of all ages and both sexes prefer water deeper than 200 m along and beyond the continental shelf break. Moore (2000) and Moore et al. (2000) suggest that beluga whales select deeper slope water independent of ice cover.

The main fall-migration corridor of beluga whales is ~100+ km north of the Beaufort Sea coast. During that time, belugas can be found in large groups exceeding 500 animals (Lowry et al., 1993). In the eastern Beaufort Sea, the westward fall migration begins in late August to mid-September (Treacy, 1994; Richard et al., 1997, 1998, 2001). Movements of tagged belugas indicate that the western Chukchi Sea is an autumn migratory destination, with many whales moving into Russian waters near Wrangel Island between mid-September and early October. They remain near Wrangel Island for weeks before moving south into the Bering Sea (Richard, Martin, and Orr, 2001). These whales often number into the hundreds and occasionally remain in certain areas near Wrangel Island for periods of up to a month, possibly to feed (Richard et al., 1998, 2001).

Winter food habits of belugas are largely unknown; however, during summer they feed on a variety of schooling and anadromous fishes that are sequentially abundant in coastal zones. Principal species eaten include arctic and saffron cods, herring, capelin, smelt, salmon, flatfishes, char, whitefish, and sculpins (Frost and Lowry, 1990; Richard, Martin, and Orr, 2001). Octopus, squid, shrimps, crabs, and clams are eaten occasionally. Most feeding is done over the continental shelf and in nearshore estuaries and river mouths. In the shallow waters of Alaska, most feeding dives are probably to depths of 20-100 ft (6-30 m) and last 2-5 minutes. Belugas generally are associated with ice and relatively deep water throughout the summer and autumn, which may reflect their preference for feeding on ice-associated arctic cod (Moore et al., 2000). Late-summer distribution and fall-migration patterns are poorly known, wintering areas are effectively unknown, and areas that are particularly important for feeding have not been identified (Suydam et al., 2005).

NMFS has set the minimum population estimate for the Beaufort Sea beluga whale stock at 32,453 and the eastern Chukchi Sea stock at 3,710 (Angliss and Outlaw, 2005). Of the five beluga whale stocks, only the Cook Inlet stock is listed as “depleted” under the MMPA (Angliss and Outlaw, 2005). Neither the Beaufort Sea nor the eastern Chukchi Sea stocks are listed as “depleted” or classified as a strategic stock under the MMPA.

Beluga whales from both stocks are an important subsistence resource for Alaskan Native hunters. For the eastern Chukchi Sea stock, annual subsistence take averaged 65 animals from 1999-2003. Annual subsistence take for the Beaufort Sea stock averaged 53 animals for the same period (Angliss and Outlaw, 2005). Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska (Suydam et al., 2001).

III.F.4.b(2) Killer Whale.

Killer whales are found in all oceans and seas of the world and are common in temperate waters; however, they also frequent tropical and polar waters. The greatest abundance is thought to occur within 800 km of major continents (Mitchell, 1975). Along the west coast of North America, killer whales occur along the entire Alaskan coast (Braham and Dahlheim, 1982). This includes the Chukchi Sea, into the Bering Sea, along the Aleutian Islands, the Gulf of Alaska, and into southeast Alaska.

Killer whales in Alaska are composed of two stocks: the eastern north Pacific resident stock and the eastern north Pacific transient stock. Population abundance for the transient stock includes animals from British Columbia (trans-boundary) and is estimated at a minimum of 346 individuals. The resident stock also is a trans-boundary stock, including animals from British Columbia. Population estimates for this stock are estimated at a minimum of 723 individuals. Only the AT1 pod of killer whales, occurring primarily in Prince William Sound and the Kenai Fjords region, is listed as "depleted" under the MMPA and designated by NMFS as a strategic stock (Angliss and Outlaw, 2005). Killer whales occurring in the Beaufort and Chukchi are not listed as "depleted" under the MMPA or classified by NMFS as a strategic stock.

Killer whales travel through the Bering Strait in the spring as the pack ice retreats and can be found in the Beaufort and Chukchi seas until fall, when the ice advances. Killer whales travel in close-knit matrilineal groups and appear to follow the distribution of their prey. Calving occurs in the late fall to spring. Killer whales are opportunistic feeders and will prey on a variety of prey items including marine mammals, fish, and squid.

Killer whales are not harvested as a subsistence species by Alaskan Native hunters.

III.F.4.b(3) Minke Whale.

In the North Pacific, minke whales range into the Bering and Chukchi seas south to the equator (Leatherwood et al., 1982). Minke whales are not considered to range into the Beaufort Sea. There are two stocks that occur within U.S. waters: (1) Alaska stock; and (2) California/Washington/Oregon stock (Angliss and Outlaw, 2005). In Alaska, minke whales are believed to be migratory in contrast to whales from the Washington/Oregon/California stock that establish inland coastal home ranges (Dorsey et al., 1990).

There are no reliable estimates for the Alaska stock of minke whales. A provisional estimate was made for the Bering Sea of 810 individuals; however, this is not used for the Alaska stock because the entire stock's range was not surveyed. Minke whales are not listed as "depleted" under the MMPA or classified by NMFS as a strategic stock.

Minke whales are known to penetrate loose ice in summer. Aerial surveys suggest that minke whales are associated with the 100-m contour in upper slope waters (Moore et al., 2000). They are either solitary or found in small groups, but they can occur in large aggregations associated with concentrations of prey in the higher latitudes. Calving occurs during the winter months at the lower latitudes. Minke whales feed on both fish (e.g., herring, sand lance) as well as on invertebrates (e.g., euphasiids, copepods).

Minke whales are rarely used as a subsistence species by Alaskan Natives, but some takes have occurred. Annual subsistence takes average zero in recent history (Angliss and Outlaw, 2005).

III.F.4.b(4) Harbor Porpoise.

The harbor porpoise inhabits shallow, coastal areas in temperate, subarctic, and arctic waters of the Northern Hemisphere (Read, 1999). In the North Pacific, harbor porpoises range from Point Barrow, Alaska to Point Conception, California (Gaskin, 1984). In Alaska, three separate stocks have been recommended, although there is insufficient biological data to support their designation at this time. The southeast Alaska stock, the Bering Sea stock, and the Gulf of Alaska stock have been identified based on arbitrarily set geographic boundaries (Angliss and Outlaw, 2005). The Bering Sea stock is the only stock expected to be present in the action area.

Minimum population estimate for the Bering Sea stock of harbor porpoises is 39,328 (Angliss and Outlaw, 2005). The Bering Sea stock of harbor porpoise is not listed as "depleted" under the MMPA or classified by NMFS as a strategic stock.

Harbor porpoises occur mainly in shelf areas (Read, 1999), diving to depths of at least 220 m and staying submerged for more than 5 minutes (Harwood and Wilson, 2001). Harbor porpoises typically occur in small groups of only a few individuals (Read, 1999); however, they can be observed in larger aggregations during feeding or migration. Calving occurs during spring-early summer, and calves are weaned within a year. Harbor porpoises feed on a variety of small, schooling fish and cephalopods (Read, 1999).

Harbor porpoises are not taken by Alaskan Native hunters for subsistence.

III.F.4.b(5) Gray Whale.

Gray whales formerly inhabited both the North Atlantic and North Pacific oceans; however, they are believed to have become extinct in the Atlantic by the early 1700's. There are two stocks recognized in the North Pacific: the eastern north Pacific stock, which lives along the west coast of North America; and the western north Pacific stock, which lives along the coast of eastern Asia (Angliss and Lodge, 2005).

During the summer months, eastern north Pacific gray whales and their calves feed in the northern Bering and Chukchi seas (Tomilin, 1957; Rice and Wolman, 1971; Braham, 1984; Nerini, 1984). Gray whales prefer areas of little or no ice cover (<5%) (Moore and DeMaster, 1997). They are a coastal species, spending most of their time in waters <60 m deep. In mid-October, the whales begin their migration to the west coast of Baja California and the east coast of the Gulf of California to breed and calve (Swartz and Jones, 1981; Jones and Swartz, 1984). The northbound migration starts in mid-February and continues through May (Rice, 1984). Calves are weaned during the feeding season at approximately 6 to 8 months of age (Bradford et al., 2006). The long migration to northern waters is undertaken in order to feed in a location where food is sufficiently abundant that nearly an entire year's energy requirements can be harvested in about 6 months (Highsmith and Coyle, 1992).

Killer whale predation on gray whales has been well documented. Weller et al. (2002) recorded that at least 33% of identified western gray whales had visible killer whale tooth rakes on their bodies, indicating that they are subject to killer whale predation in some portion of their range.

Gray whales feed by sucking sediment from the seafloor. Their primary prey is amphipods, although other food items are ingested. It is believed that gray whales are expanding their feeding areas in Arctic Alaska as their population expands. Although gray whales probably feed opportunistically throughout their range, they return annually to primary feeding areas in the northern Bering Sea and Chukchi Sea (Moore and Clarke, 2002), particularly north of St. Lawrence Island and in the Chirikov Basin (Moore et al., 2000). The northeastern-most recurring known gray whale feeding area is in the Chukchi Sea southwest of Barrow (Clarke, Moore, and Ljungblad, 1989). During aerial surveys in the Alaskan Chukchi and Beaufort Seas in 1982-1991, gray whales were associated with virtually the same habitat throughout the summer and the autumn (38 m depth and <7% ice cover) (Moore and DeMaster, 1997). Gray whale feeding habits in the northern Chukchi Sea appear limited to shoal and coastal waters and their selection of such habitat is greatest in the summer (Moore et al., 2000). It is likely that shallow coastal and offshore-shoal areas provide habitat rich in gray whale prey, and their association with offshore shoals in the northern Chukchi Sea may indicate that these are important feeding areas for the expanding population (Moore and DeMaster, 1997; Moore et al., 2000). Because shallow shoals and coastal areas provide habitat rich in gray whale prey, there is little reason for whales to abandon it prior to beginning their southbound migration.

Only a small number of gray whales enter the Beaufort Sea east of Point Barrow, although in recent years, ice conditions around Barrow have become lighter and gray whales may have become more common there. For example, Moore et al. (2006) reported that Native hunters have noticed increasing numbers of gray whales near Barrow in late summer and autumn, which may indicate a northward shift in their distribution. Gray whale calls also were recorded northeast of Barrow each month from October 2003 through May 2004, indicating that some whales overwintered in the Beaufort Sea and did not migrate to California as expected (Moore et al., 2004). This extended occurrence of gray whales in the Beaufort Sea complements observations of feeding whales moving north from the Bering Sea to the Chukchi Sea in summer (Moore, Grebmeier, and Davies, 2003), and may be indicative of marine ecosystem changes occurring in the North Pacific (Grebmeier et al., 2006). For example, Moore, Grebmeier, and Davies (2003) suggested that gray whale use of the Chirikov Basin has decreased, likely as a result of the combined effects of changing currents and a dramatic downturn in amphipod productivity, perhaps due to overgrazing by whales. Arctic amphipod communities may be quite sensitive to increased predation by the expanding gray whale population, due to their long generation times and low growth rates (Highsmith and Coyle, 1992). Fine scale indices of whale abundance were associated with the highest biomass of one particular amphipod-dominated faunal group, suggesting strong prey selection, perhaps indicative of these being a key prey species (Moore, Grebmeier, and Davies, 2003). However, gray whales' unique capacity to forage by suctioning dense mats of amphipods from the sea floor coupled with the temporal and spatial breadth of prey species' distribution confounds a comprehensive assessment of prey availability (Moore et al., 2001).

Gray whales were commercially hunted during the 19th and 20th centuries, which reduced the eastern north Pacific population to perhaps as few as 1,000-2,000 whales (Moore et al., 2001). The latest abundance estimate (2001/02) for the eastern north Pacific stock is 18,178 individuals (Rugh et al., 2005). NMFS has provided a minimum population estimate of 17,752 (Angliss and Lodge, 2005). Abundance estimates were 29,758 whales in 1997/98 and 19,448 in 2000/01 (Rugh et al., 2005). Wade and Perryman (2002) calculated gray whale carrying capacity (*K*) from abundance data with a 90% credibility interval of 19,830 to 28,740, suggesting that the population is essentially at *K*. Declining abundance estimates may be the first clear indication that the gray whale population is responding to environmental limitations. It is anticipated that abundance estimates will rise and fall in the future as the population finds a balance with the carrying-capacity of the environment (Rugh et al., 2005). Federal protection under the ESA for gray whales was removed in 1994, and further evaluation determined that the stock was neither in danger of extinction nor likely to become endangered in the foreseeable future (Rugh et al., 1999). The eastern North Pacific stock is not designated as depleted under the MMPA nor considered a strategic stock by NMFS.

Gray whales are taken by both Alaskan and Russian subsistence hunters; however, most of the harvest is done by the Russians. The only reported takes in Alaska in the last decade occurred in 1995, when Alaskan Natives harvested two animals (IWC, 1997). In 1997, the IWC implemented an annual cap of 140 gray whales to be taken by Russia and the U.S.. Annual subsistence take averaged 122 whales from 1999-2003 (Angliss and Lodge, 2005). The Makah Indian Tribe in Washington State is authorized to take four gray whales from this stock each year, but the last reported harvest was one animal in 1999 (IWC, 2001).

III.F.4.c. Marine Fissipeds – Polar Bear.

According to the FWS, the status of polar bears worldwide is declining as a result of climate changes, loss of ice habitat, and unregulated hunting pressures (USDOI, FWS, 2005c).

On February 16, 2005, the Centers for Biological Diversity (CBD) petitioned the FWS to list the polar bear as a threatened species under the Endangered Species Act due to global warming and the melting of their sea ice habitat (CBD, 2005). In June 2005, the IUCN/SSG (World Conservation Union/Species Survival Commission) Polar Bear Specialist Group (PBSG) concluded that the IUCN Red List classification of the polar bear should be upgraded from Least Concern to Vulnerable based on the likelihood of an overall decline in the size of the total world polar bear population by more than 30% within the next 35-50 years. The principle reason for this projected decline is "climatic warming and its consequent negative effects on the sea ice habitat of polar bears" (IUCN/PBSG Polar Bear Specialist Group, 2005). On February 7, 2006, the 90-day finding by the FWS determined that the CBD petition contained sufficient information indicating that listing polar bears as threatened may be warranted. Therefore, the FWS is currently conducting a 12-month status review of the species to determine whether listing is warranted; if that finding is positive, the FWS will publish a proposed rule to list the species.

Polar bears are the apical predators of the Arctic marine ecosystem (Amstrup, 2003) and are specialized predators of phocid seals in ice-covered waters (Derocher, Lunn, and Stirling, 2004). Polar bears have a circumpolar distribution throughout the Northern Hemisphere and the global population was last estimated at 21,500-25,000 (Lunn, Schliebe, and Born, 2002). There are two polar bear stocks recognized in Alaska: the southern Beaufort Sea stock (SBS) and the Chukchi/Bering Seas stock (CBS); though there is considerable overlap between the two in the western Beaufort /eastern Chukchi Seas (Amstrup et al., 2005). The SBS population ranges from the Baillie Islands, Canada west to Point Hope, Alaska and is subject to harvest from both countries. On an annual basis, more than 90% of the bears in the SBS subpopulation occur between the Colville River in Alaska and the Mackenzie River in Canada (Cronin et al., 2006). Similarly, more than 90% of the bears in the CBS subpopulation occur west of Cape Lisburne (Cronin et al., 2006). The CBS stock ranges from Point Barrow, Alaska west to the Eastern Siberian Sea. These two populations overlap between Point Hope and Point Barrow, Alaska, centered near Point Lay (Amstrup, 1995).

Polar bears are a classic *K*-selected species, meaning they have delayed maturation, small litter sizes, and high adult survival rates (Bunnell and Tait, 1981). Because polar bears exist in relatively small populations and have low reproductive rates, populations may be detrimentally impacted by even small reductions in their numbers (Amstrup, 2000). Their low reproductive rate requires that there must be a high rate of survival to maintain population levels (Amstrup, 2003). Mating occurs from March to May, followed by a delayed implantation in the autumn (Ramsay and Stirling, 1988). In any given year, 30-60% of the available adult females do not breed or are not impregnated (Taylor et al., 1987). Females give birth the following December or January to one to three cubs, which remain with their mother until they are at least 2 years of age (Harington, 1968; Jefferson, Leatherwood, and Webber, 1993). Females will not rebreed until they separate from their cubs. In the Beaufort Sea, female polar bears usually do not breed for the first time until they are 5 years of age (Lentfer and Hensel, 1980), which means that they give birth for the first time at age 6. The maximum reproductive age for polar bears is unknown, but is likely well into their 20's (Amstrup, 2003). The average reproductive interval for a polar bear is 3-4 years, and a female may produce 8-10 cubs in her lifetime, of which only 50-60 percent will survive (Amstrup, 2003). A complete reproductive cycle is energetically expensive for female polar bears. When nutritionally stressed, female polar bears can forgo reproduction rather than risk their own survival (Amstrup, 2003). This is possible because implantation of the fertilized egg is delayed till autumn; hence, a malnourished female unable to sustain a pregnancy can terminate the process by aborting or resorbing the fetus (Amstrup, 2003).

In northern Alaska, pregnant females enter maternity dens by late November. These dens typically are located in snow drifts in coastal areas, stable parts of the offshore pack ice, or on landfast ice (Amstrup and Garner, 1994). Newborn polar bears are among the most undeveloped of placental mammals; therefore, undisturbed maternal dens are critical in protecting them from the rigors of the arctic winter for the first 2 months of life (Amstrup, 2000). The highest density of land dens in Alaska occur along the coastal barrier islands of the eastern Beaufort Sea and within the Arctic National Wildlife Refuge (Amstrup and Garner, 1994). Protecting these core maternity denning areas is of critical importance to the long term conservation of polar bears.

Polar bears usually forage in areas where there are high concentrations of ringed seals, as these are their primary prey (Stirling and McEwan, 1975; Larsen, 1985), although bearded seals, walruses, and beluga whales also are taken opportunistically (Amstrup and DeMaster, 1988). Polar bears are almost completely carnivorous, although they will feed opportunistically on a variety of foods including carrion, bird eggs, and vegetation (Smith, 1985; Smith and Hill, 1996; Derocher, Wiig, and Bangjord, 2000). Polar bears prefer shallow-water areas, perhaps reflecting similar preferences by their primary prey, ringed seals, as well as the higher productivity in these areas (Durner et al., 2004). In spring, polar bears in the Beaufort Sea overwhelmingly prefer regions with ice concentrations >90% and composed of icefloes 2-10 km in diameter (Durner et al., 2004). In summer, bears in the Beaufort Sea select habitats with a high proportion of old ice, which takes them far from the coast as the ice melts. In fact, 75% of bear locations in the summer occur on sea ice in waters >350 m deep, which places them outside the areas of greatest prey abundance. This is because ringed seals tend to aggregate in open-water areas in the late summer and early fall, where primary productivity is thought to be high (Harwood and Stirling, 1992), thus placing them well out of reach of polar bears summering on the pack ice. The distribution of seals and the habitat-selection pattern by bears in the Beaufort Sea suggests that most polar bears do not feed extensively during summer (Durner et al., 2004), which is supported by reports of the seasonal activity levels of polar bears. Amstrup, Durner, and McDonald (2000) showed that polar bears in the Beaufort Sea have their lowest level of movements in September, which correlates with the period when the sea ice has carried polar bears beyond the preferred habitat of seals. Conversely, 75% of bear observations in winter occurred in waters <130 m deep. During winter, polar bears prefer the lead system at the shear zone between the shorefast ice and the active offshore ice. This narrow zone of moving ice parallels the coastline and creates openings that are used by seals. Thus, polar bears in winter use a relatively small area of the Beaufort Sea where prey are most abundant and accessible (Durner et al., 2004). Consequently, changes in the extent and type of this ice cover are expected to affect the distributions and foraging success of polar bears (Tynan and DeMaster, 1997).

Polynyas, or areas of open water surrounded by ice, are another habitat type that is extremely important to polar bears (Stirling, 1997). Polynyas are areas of increased productivity at all trophic levels in arctic waters, particularly where they occur over continental shelves, and are often the sites of marine mammal and bird concentrations. The increased biological productivity around polynas likely is the key factor in their ecological significance. Polynyas vary in size and shape and may be caused by wind, tidal fluctuations, currents, upwellings, or a combination of these factors (Stirling, 1997).

The polar bear's preferred habitat is the annual ice over the continental shelf and inter-island archipelagos that encircle the polar basin (Derocher, Lunn, and Stirling, 2004). Recent research has indicated that the total sea ice extent has declined over the last few decades, particularly in both near shore areas and in the amount of multiyear ice in the polar basin (Parkinson and Cavalieri, 2002; Comiso, 2002a,b). Polar bears and ringed seals depend on sea ice for their life functions, and reductions in the extent and persistence of ice in the Beaufort and Chukchi seas almost certainly would have negative effects on their populations (USDOI, FWS, 1995). Climate change already has affected polar bears in Western Hudson Bay (WHB) in Canada, where they hunt ringed seals on the sea ice from November to July and spend the open-water season fasting onshore. In a long term study, Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in bears with a trend toward earlier breakup of sea ice in recent years. The earlier breakup shortens the bears' feeding season and increases the length of their fasting season. Because ringed seals often give birth to and care for their pups on stable shorefast ice, changes in the extent and stability of shorefast ice and/or the timing of breakup could reduce their productivity. This is important, because the most critical factor affecting the reproductive success, condition, and survival of polar bears is the availability of ringed seal pups from approximately mid-April till breakup (Stirling and Lunn, 1997). As a result of the close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). In fact, a new analysis of the Western Hudson Bay polar bear subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN/PBSG Polar Bear Specialist Group, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with earlier sea-ice breakup.

The reduction in summer ice cover also might affect polar bears in other ways. For example, the Sale 195 EA explained that reductions in sea-ice coverage would adversely affect the availability of pinnipeds as prey for polar bears (USDOI, MMS, 2004:Appendix I, Sec. I.2.e(1)). Also, summer sea-ice reduction would affect the severity of storm events along the coast of Alaska, with consequent effects on polar bears. When the ice cover is reduced, particularly during late summer, the available open-water surface increases, and waves are able to grow in height. For example, rough weather prevented scouting about one-third of the time that whaling crews were on Cross Island during 2001 (Galginaitis and Funk, 2004:24) and about half of the time during 2003 (Galginaitis and Funk, 2005:18). The unusually rough water that restricted the scouting for whales might have been related to changes in the summer sea-ice cover during recent years. Long-term data sets indicate substantial reductions in both the extent and thickness of the arctic sea-ice cover during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005). Wave heights in the Beaufort Sea typically range from 1.5 m during summer to 2.5 m during fall, though maximum wave heights of 7-7.5 m are expected (Brower et al., 1988). In fact, a late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). Such large waves would undoubtedly induce energetic stress, or worse, in any swimming bears unfortunate enough to be caught in them.

Polar bears are excellent swimmers and swim while actively hunting, while moving between hunting areas, and while moving between sea ice and terrestrial habitats. In June, 2005, USGS researchers identified a female polar bear which apparently swam for over 557 km from Norton Sound back to the retreating pack ice in the Chukchi Sea northwest of Wainwright (Amstrup et al., 2006). Swimming is believed to be more energetically costly than walking, which helps explain why bears will often abandon the melting sea ice in favor of land when ice concentrations drop below 50% (Derocher, Lunn, and Stirling, 2004). Polar bears also can become energetically stressed when the pack ice retreats and carries them to deeper waters beyond the productive continental shelf zone. These bears eventually may choose to swim for shore, where annual food resources such as subsistence-harvested whale carcasses can be found along the coast. Despite being strong swimmers, energetically stressed bears are susceptible to misfortune on such long-distance swims. For example, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004. They estimated that at least 27 bears may have died as a result of this one storm, and attributed this phenomenon to longer open water periods and reduced sea ice cover. If such events are recurrent, they could easily rise to the level of a significant impact upon polar bear populations, especially considering that current human removals are already believed to be at or above maximum sustainable levels.

Additionally, polar bear use of coastal areas during the fall open-water period has increased in recent years (Kochnev et al., 2003; Schliebe et al., 2005). In fact, nearshore densities of polar bears can be two to five times greater in autumn than in summer (Durner and Amstrup, 2000). For example, aerial surveys flown in September and October from 2000-2005 have revealed that 53% of the bears observed along the coast have been females with cubs, and that 71% of all bears observed were within a 30-km radius of the village of Kaktovik, on the edge of the ANWR (USDOI, FWS, pers. comm.). Congregations of more than 60 polar bears and as many as 12 brown bears have been observed feeding on whale carcasses near Kaktovik in recent years during the fall open-water period (Miller, Schliebe, and Proffitt, 2006), and as many as 140 polar bears have been observed at walrus haul-out sites on Wrangel Island and the north coast of Chukotka (Kochnev, 2002; Kochnev et al., 2003). These observed changes in polar bear distribution have been correlated with the distance to the pack ice at that time of year. The farther from shore the leading edge of the pack ice is, the more bears are observed onshore in fall (Kochnev et al., 2003; Ovsyanikov, 2003; Schliebe et al., 2005; Kochnev, in prep.).

Climate change also may help explain why coastal communities in Western Hudson Bay have experienced increased bear-human conflicts prior to freezeup each fall. With earlier sea ice breakup, polar bears are forced ashore earlier, in poorer nutritional condition, and remain without access to seals for a longer time. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to encroach on human settlements in search of alternative food sources and come into conflict with humans. Thus, the increase in polar bear-human interactions in Western Hudson Bay probably reflects an increase in nutritionally stressed bears searching for food (Amstrup et al., 2006). Similar effects may be expected to occur in Alaska if climate change continues.

Sport hunting for polar bears has been banned in Alaska since 1972, although bears are still taken for subsistence and handicrafts by Alaskan Natives. In 1988, the Inuvialuit Game Council from Canada and the North Slope Borough from Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea, a voluntary agreement that limited the total harvest from the SBS population to within sustainable levels (Brower et al., 2002). The stipulations contained in this voluntary agreement actually are more stringent than those contained in the MMPA. Sustainable quotas under the agreement are set at 80 bears per year, no more than 27 of which may be female. This quota is believed to be at or near sustainable levels. Recent harvest levels (2000-2005) from the SBS stock averaged 37 individuals in the U.S. and 25 individuals in Canada, for an average harvest of 62 bears per year, well within the agreement's quotas (USDOI, FWS, unpublished data). For the same period, reported U.S. harvest levels of the CBS stock averaged 41 bears, while average Russian harvests of the CBS stock are believed to be much higher (Ovsyanikov, 2003; USDOI, FWS, 2003; USDOI, FWS, unpublished data).

Compared to harvest levels from the 1980's, Alaskan Native subsistence harvests of polar bears have declined substantially in the Chukchi Sea over the last decade. This decline may be due to a declining polar bear population that provides fewer animals for harvest, changing environmental conditions, changing demographics among hunters resulting in decreased hunter effort, or a combination of these factors (USDOI, FWS, 2003).

When environmental factors result in minimal ice conditions, it may affect polar bear-hunting success. In these situations, walrus haulouts become important feeding resources during autumn. The abundance and predictable nature of walrus haul outs contributes to recurrent aggregations of polar bears at these sites. Considering the regular nature of such aggregations, they likely play an important role in habitat use patterns of individual bears and their progeny (Kochnev, In prep).

Over the last 15 years, when the ice edge retreated far to the north of Wrangel Island, walruses formed large haulouts on Somnitel'naya Spit and Cape Blossom on Wrangel Island, where panic stampedes caused mortality from crushing of between 24 and 104 walruses/year. The walrus carcasses, in turn, attract coastal aggregations of bears that usually peak in the second half of October (Kochnev, in prep). Bears appear near walrus rookeries on Wrangel Island in early August, which is about a month prior to when walruses arrive (Kochnev, 2002). The maximum number of bears coming ashore on Wrangel Island most frequently occurs in late October, with an average of 50 bears , and a maximum of 140 bears (Kochnev, 2002). Bear densities can approach 69 bears per square kilometer. The total mass of dead walruses available (from predation and stampede deaths) averages 27 tons per season. This is the most important resource for bears on the island in autumn and early winter (Kochnev, 2002). The correlation between bear numbers and increased distance to the pack ice during the autumn indicates that the magnitude of bear concentrations on land depends on the Chukchi and East Siberian sea-ice condition (Kochnev, In prep). The position of Wrangel Island, an isolated land mass at high latitudes in the Chukchi Sea, contributes to observed use patterns by walruses and polar bears ((Kochnev, in prep).

According to Nikita Ovsyanikov, deputy director and senior research scientist of the Wrangel Island Nature Reserve, the summer and fall of 2002 were particularly bad for polar bears in the Chukchi Sea. Due to poor ice conditions, many polar bears hunting near Wrangel Island were forced ashore in "starving" condition. During such open-sea situations seals, the polar bears main prey, become unavailable and bears are forced to turn to walruses for sustenance. However, walruses did not haul out on Wrangel Island in autumn 2002 as they usually do; as a consequence, the stranded bears suffered a high mortality rate (Ovsyanikov, 2003). Due to ice patterns and prevailing winds, many walruses and a relatively large number of polar bears land on the north coast of Chukotka during late summer and autumn. Many walruses die in stampedes, which may be caused by Native hunters that, in turn, provides scavenging opportunities for stranded bears (Ovsyanikov, 2003) and brings them into close proximity to Native villages. As a result, the illegal harvest of polar bears on the Chukotka coast was higher in 2002 than during any previous years, with approximately twice the usual illegal take. Experts estimate that the illegal polar bear take in Chukotka in 2002 was between 250 and 300 animals (Ovsyanikov, 2003). The recent illegal polar bear take in Chukotka has little to do with traditional subsistence; rather, it appears to be purely for illegal commercial use (Ovsyanikov, 2003). This level of mortality is not sustainable, and highlights the peril that the CBS polar bear stock is currently in. The fact that more bears are visiting the northern coast of Chukotka does not reflect an increase in the number of polar bears, but rather the growing impact on bears from the reduced sea ice cover in the summer and autumn (Ovsyanikov, 2003).

In the last 10-15 years, the number of observations of polar bears feeding on marine mammal carcasses along the coast has increased (Kochnev et al., 2003). Such aggregations have occurred repeatedly (Kochnev, in prep). Bear concentrations form on the coast as early as late summer, depending on patterns of ice breakup, and the bears generally concentrate at walrus haulout sites (Kochnev, In prep). In recent years, as many as 50 bears congregated on Kolyuchin Island between August and November (Kochnev et al., 2003; Kochnev, In prep), and from 7-20 bears concentrated in five other areas along the north coast of Chukotka (Kochnev, In prep). In Chukotka, bears appear in great numbers along the coast near the Native village of Vankarem in October and November. These bears frequently come into the village while moving along the coast, where they are attracted by the smell of native harvested walrus meat. Hunters say that as many as 10 bears a day can enter the village (Kochnev et al., 2003).

From 10-13 walrus-haulout sites occur annually in the summer and autumn on the arctic coast of Chukotka. In addition, not less than seven to eight beach-cast whales occur annually (Kochnev, In prep). From 1999 through 2004, bears continued forming large aggregations on the coast of Wrangel Island, although walrus numbers and mortality rates at haulout sites decreased (Kochnev, In prep). On the American side of the Chukchi, walrus haulout sites are very rare (Kochnev, In prep).

A reliable estimate for the CBS stock of polar bears, which ranges into the southern Beaufort Sea, does not exist, and its current status is in question. In 2002, the IUCN/SSG Polar Bear Specialist Group estimated the size of the CBS population at 2000+ bears, though the certainty of this estimate was considered poor (Lunn, Schliebe, and Born, 2002). Russia prohibited polar bear hunting in 1956 in response to perceived population declines; however, both sport and subsistence harvest continued in Alaska until 1972. During the 1960's, hunters took an average of 189 bears per year from the CBS population, an unsustainable rate of harvest that likely caused significant population declines. With the passage of the MMPA in 1972, which prohibited sport hunting of marine mammals, the average annual Alaska harvest in the Chukchi Sea dropped to 67 bears per year. However, with the collapse of the Soviet empire in 1991, levels of illegal harvest dramatically increased in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). While the magnitude of the Russian harvest from the CBS is not precisely known, some estimates place it as high as 400 bears per year, although the figure is more likely between 100 and 250 bears per year. Models run by the FWS indicate that this level of harvest of the CBS population is most likely unsustainable, and that an average annual harvest of 180 bears (4.5% of the starting population) could potentially reduce the population by 50% within 18 years (USDOI, FWS, 2003). The FWS calculations were based on a starting population of 4,000 bears, which is believed to fairly characterize a healthy CBS population. This simulated harvest level is similar to the estimated U.S./Russia annual harvest for the period 1992-2006, as well as to the unsustainable harvest levels experienced in Alaska in the 1960's, indicating that the CBS stock of polar bears may well be in decline due to overharvest. Because of the unknown rate of illegal take currently taking place, in 2006 the IUCN/SSG Polar Bear Specialist Group designated the status of the CBS stock as "declining" from its previous estimate of 2000+ animals (IUCN/SSG Polar Bear Specialist Group, 2006).

In 2001, the SBS population was estimated at ~1,800 individuals and was thought to be increasing (Lunn, Schliebe, and Born, 2002). The most recent population growth rate for the SBS population was estimated at 2.4% annually based on data from 1982 through 1992, though the population growth rate is believed to have slowed or stabilized since 1992. However, recent information suggests that the SBS polar bear population may be smaller than previously estimated. In May 2006, USGS researchers stated that:

> High recapture rates during capture/recapture studies in 2005 and 2006 suggest that the number of polar bears in the Beaufort Sea region may be smaller than previously estimated. Final analyses of these new population data will not be completed until early in 2007, but preliminary evaluations of ongoing data collection suggest that conservative management is warranted until final estimates are calculated (S. C. Amstrup and E. V. Regehr, pers. comm. is this part of the quote?).

Neither the SBS nor the CBS stock is listed as "depleted" under the MMPA. The SBS is assumed to be within optimum sustainable population levels, although new information puts that assumption in question (USDOI, FWS: http://alaska.fws.gov/fisheries/mmm/polarbear/reports.htm). The SBS is currently designated a "non-strategic stock" by the FWS. Due to the lack of information concerning the CBS population, and due to the high levels of illegal harvest, the IUCN/SSG Polar Bear Specialist Group has designated it as "declining."

III.F.4.d. Impact Assessment. Under the MMPA, it is illegal to take a marine mammal (i.e., harass, hunt, capture, or kill, or attempt to do so) unless prior authorization is obtained but only for activities allowed under the Act. "Harassment" has been further defined under the MMPA to include: "any act of pursuit, torment, or annoyance which: (1) Level A Harassment - has the potential to injure a marine mammal or marine mammal stock in the wild; or (2) Level B Harassment - has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption or behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The current levels under the MMPA used by NMFS to set standards for Level A and Level B harassment caused by impulse noises, such as from seismic surveys, include: (1) Level A Harassment (injury) at 180 dB for cetaceans and 190 dB for pinnipeds, and (2) Level B harassment (behavioral disturbance) at 160 dB for marine mammals. Pacific walrus are managed by the FWS, which recently implemented a Level A harassment threshold for walrus of 180 dB (USDOI, FWS, 2005). These criteria often are coupled with existing data (e.g., Tolstoy et al., 2004) to determine exclusion or safety zones or safety radii on a case-by-case basis based on water depths and airgun configurations. Field verification will be required to determine appropriate safety radii for the Proposed Action.

The marine mammals discussed in this section are exposed to a wide variety of activities, such as subsistence hunting; vessel movements and associated activities; aircraft; commercial fishing; climate change; and oil- and gas-related exploration, development, and production activities (see Section III.H Cumulative Impact Analysis). In general, possible effects from seismic activities include tolerance, masking of natural sounds, behavioral disturbance, auditory impacts (e.g., temporary and permanent threshold shifts (PTS)), other physiological effects (Richardson et al., 1995a), and indirect effects associated with altered prey availability (Gordon et al., 2004). Seismic surveys, either alone or in combination with other factors, could have subtle, chronic effects such as: excluding marine mammals from important habitats (e.g., feeding, resting or molting areas) at significant times, interfering with their migrations and movements, contributing to habitat degradation, disrupting biologically significant behaviors, and causing increased levels of stress (Gordon et al., 2004).

There is no direct information on the extent to which seismic pulses mask biologically significant sounds for marine mammals. However, species such as baleen whales and phocids are believed to be low frequency specialists, and thus more susceptible to masking by low frequency noise, such as seismic (Gordon et al., 2004). Since it is likely that being able to detect biologically significant signals is important to marine mammals' viability, it is reasonable to assume that any reduction in this ability could have deleterious effects on marine mammals over very substantial distances (Gordon et al., 2004).

Behavioral impacts appear to be affected by the animal's sex and reproductive status, age, auditory sensitivity, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the sound previously and any associations it may have made with that sound (e.g., Olesiuk et al., 1995; Richardson et al., 1995a: Kraus et al., 1997; NRC, 2003, 2005). For example, a mother nursing her young might be expected to be more likely to show avoidance behavior than a male guarding a breeding territory.

Seismic activities do have the potential to substantially harass and injure marine mammals by the sounds they generate although appropriate mitigation measures can avoid injury and limit the potential for behavioral disturbance. (See Section III.F.3 for a detailed discussion of seismic sound and the potential biological impacts of seismic exploration on marine mammals and Section IV for a list of mitigation measures for seismic survey activities considered under this PEIS.) It is more difficult to scientifically determine whether population level effects can result from long-term behavioral disturbance caused by seismic survey activity. The degree of impact of noise on biologically significant behavior was studied by the National Research Council's Committee on Characterizing Biologically Significant Marine Mammal Behavior. The Committee concluded that it is unknown how or when responses of marine mammals to anthropogenic sound levels become biologically significant effects (NRC, 2005). In addition, a Federal Advisory Committee on Acoustic Impacts on Marine Mammals was convened by the Marine Mammal Commission in 2003-2005 to review and evaluate impacts of anthropogenic sound on marine mammals, identify areas of scientific agreement, and prioritize research and management needs. Although the committee was unable to reach an overall consensus on these issues, several findings from the Committee's Federal Caucus report are relevant here: (1) there has been no scientific link between exposure to sound and adverse effects on a marine mammal population; (2) studies to assess population-level effects are lacking and needed; and (3) population level impacts are not immediately detectable.

Given the current state of knowledge, it is not possible to reach firm conclusions on the potential for seismic pulses to cause threshold shifts or hearing damage in marine mammals. It has been experimentally shown that threshold changes can be induced in both odontocetes and pinnipeds by exposure to intense short tones and sounds of moderate intensity for extended periods (Gordon et al., 2004). Exposures to single short pulses have not induced threshold shifts, though it is difficult to extrapolate from these findings to a typical seismic survey, where animals will receive many pulses over the course of an exposure. There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. Direct impacts causing injury (Level A) from the seismic surveys likely would occur if animals entered the 190-dB zone immediately surrounding the sound source. A marine mammal within a radius of 100 m around a typical array of operating airguns might be exposed to a few seismic pulses with levels of >205 dB, and possibly more pulses if the animals moved with the seismic vessel. Although it is unlikely that airgun operations during most seismic surveys would cause PTS in marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals. The risk that seismic sources can cause hearing damage to marine mammals cannot be dismissed as negligible (Gordon et al., 2004), although with appropriate mitigation measures in place (e.g., marine mammal observers and shutdown procedures), the probability of seismic-survey-generated injuries should be mitigated.

The need to rely on indirect methods of assessing the environmental impact of human activity on marine mammals is a recurring problem (Inglis and Gust, 2003). Impact assessments for cetaceans typically emphasize immediate behavioral responses to human activities (Samuels and Bejder, 2004), the biological relevance of which is rarely known (Corkeron, 2004). Studies evaluating the effects of human activity on wildlife typically emphasize short-term behavioral responses, from which it is difficult to infer biological significance or to formulate plans to mitigate harmful impacts (Bejder et al., 2006). Furthermore, monitoring plans typically emphasize readily obtainable, short-term behavioral measures that can be directly related to disturbance factors (Bejder et al., 2006). However, it is rarely known in what ways short-term responses translate to longer-term changes in reproduction, survival, or population size (Gill et al., 2001; Beale and Monaghan, 2004a), and it is seldom possible to infer biological significance based on short-term behavioral observations.

Because cetaceans are long-lived and elusive animals, it is very challenging to assess the potential long-term effects of anthropogenic activities on them (Williams, Lusseau, and Hammond, 2006). Clearly, linking short-term behavioral responses to long-term population level impacts presents difficulties, a fact that can lead to the false, or at least premature, conclusion that human activities have no biologically significant effects on the species in question (Williams, Lusseau, and Hammond, 2006). There are indications that repeated short-term avoidance tactics can lead to long-term impacts at the population level, either through displacement from important habitats (Morton and Symonds, 2002; Lusseau, 2005; Bejder et al., 2006), which can reduce the fitness of targeted populations, or via physiological constraints at the individual level, which may lead to decreased reproductive output (Lusseau, 2003b). For a food-limited population, energetics may provide the causal link between demonstrable short-term behavioral responses and difficult-to-detect population level impacts (Williams, Lusseau, and Hammond, 2006). Therefore, the relationship between an animal's response to disturbance and their underlying sensitivity is not straightforward (Gill et al., 2001; Beale and Monaghan, 2004a,b). Equating lack of response with indifference may be incorrect; those animals least likely to exhibit avoidance responses may simply be those that can least afford to demonstrate their sensitivity, namely those in poorest body condition (Beale and Monaghan, 2004b). Conversely, animals that show little response to disturbance may simply be habituated to it.

Whales have been shown to alter their behavior around various vessels, including whale-watching and fishing boats (Williams et al., 2002a). For example, in the presence of whale-watching and fishing boats in Johnstone Strait, British Columbia, killer whales increased their travel budgets by 12.5% and reduced the time they spent feeding. These lost feeding opportunities could have resulted in a substantial (18%) estimated decrease in energy intake (Williams, Lusseau, and Hammond, 2006). These observations suggest that, in order to lessen the potential impacts of human activities, avoiding impacts to important feeding areas would provide considerable benefits to cetaceans and other marine mammals that are sensitive to human disturbance.

Marine mammals may temporarily move away from areas of heavy vessel activity but re-inhabit the same area when traffic is reduced (Allen and Read, 2000; Lusseau, 2004), or they may abandon a once-preferred region for as long as disturbance persists (Gerrodette & Gilmartin, 1990). For example, evidence exists that indicates that killer whales evade potentially harmful noise on annual and regional spatial scales (Morton and Symonds, 2002). When animals switch from short-term evasive tactics to long-term site avoidance in response to increasing disturbance, the costs of tolerance have likely exceeded the benefits of remaining in previously preferred habitat. For example, in a long-term study in Shark Bay Western Australia, cumulative vessel activity was shown to result in a decline in abundance of bottlenose dolphins over a relatively short time (Bejder et al., 2006). The authors attributed this to the long-term displacement of dolphins away from the area of disturbance. For animals such as cetaceans that exhibit enduring, individually specific social relationships, disruption of social bonds through displacement of sensitive individuals may have far-reaching repercussions (Bejder et al., 2006). Given the scarcity of long-term studies to fully evaluate the potential impacts of human activities, a cumulative impact, like those detected in Shark Bay and Johnstone Strait, could go unnoticed for decades. Thus, management deliberations must draw strong inferences from well-documented sites, where long-term information can be taken into account (Bejder et al., 2006).

Noise, rather than the simple presence of boats, seems the likeliest mechanism for boats to alter whale behavior. It is perhaps unsurprising that cetaceans have been shown to shorten their feeding bouts and initiate fewer of them in the presence of ships and boats (Williams, Lusseau, and Hammond, 2006). Such behavior has been shown throughout the animal kingdom in response to human disturbance. For example, many bird species have been observed to shorten their feeding bouts in response to human presence (Burger, et al., 1997; Galicia and Baldassarre, 1997; Ronconi and St. Clair, 2002). Terrestrial animals have also been shown to reduce food intake as a consequence of human disturbance. For example, grizzly bears (*Ursus arctos*) in Glacier National Park spent 53% less time feeding when disturbed by climbers (White et al., 1999). Similarly, Amur tigers (*Panthera tigris altaica*) in Russia showed strong vulnerability to human disturbance along road corridors (Kerley et al., 2002). Tigers at undisturbed sites spent more time at kills and consumed more of their kills than tigers in areas disturbed by humans. For tigers that occupied roaded areas, human disturbance was also linked to lower reproductive success and higher adult mortality (Kerley et al., 2002). For marine mammals, it is reasonable to assume that larger and noisier vessels, such as seismic and ice-breaking ships, would have greater and more dramatic impacts upon behavior than would smaller vessels.

The real issue may not be the increased expenditure of energy by cetaceans to avoid ships, but rather the potential for ships and seismic vessels to cause a reduction in their overall energy acquisition, via the masking effects of noise, interruption of feeding activities, or replacement of feeding activity with ship-avoidance activities (Williams, Lusseau, and Hammond, 2006). Disruption of feeding activity could lead to a substantial decrease in energy intake for animals exposed to ship disturbance. In fact, the energetic consequences of reduced energy acquisition have the potential to be at least four to six times as great as the cost of avoidance behavior (Williams, Lusseau, and Hammond, 2006). In food-limited populations, this is one mechanism that could link short-term consequences of vessel traffic to long-term, population-level consequences (Williams, Lusseau, and Hammond, 2006). For example, increasing whales' energetic costs or reducing their ability to acquire prey, if the effect is sufficiently strong, can change the demographic parameters that influence effective population size (Anthony and Blumstein, 2000). Therefore, marine "protected areas" could play a role in reducing the "take" of cetaceans, as long as these areas are located where whales concentrate their feeding activities. Such areas would greatly help to mitigate potential impacts to cetaceans from human activities.

At present, there is little direct evidence for biologically significant effects of seismic surveys on marine mammals; however, none of the research projects conducted to date have been scientifically capable of adequately testing for effects at this level (Gordon et al., 2004). Plausible cases can be made, however, that observed or potential responses could result in biologically significant effects if appropriate mitigation cannot be implemented to lessen the potential for these effects. Therefore, Section IV provides a list of mitigation and monitoring measures for seismic survey activity considered under this PEIS meant to avoid the potential for Level A Harassment (injury) and limit the potential for Level B Harassment (disturbance).

Based on the variability of factors influencing potential impacts on marine mammals from seismic survey activity, the impact analysis to follow on nonendangered and nonthreatened marine mammals takes a protective approach and bases conclusions on potential effects on the most sensitive members of the population. The conclusions then consider these potential impacts and mitigation measures outlined in Section IV to determine the level of potential impact from the Proposed Action and Alternatives 3 through 8. Additional reviews on the potential impacts of seismic surveys on marine mammals can be found in Richardson et al. (1995a), Gordon et al. (1998), Davis et al. (1998), and USDOI, MMS (2004).

III.F.4.d(1) Pinnipeds

Phocids (Ringed, Spotted, Ribbon, and Bearded Seals). Pinnipeds use the acoustic properties of sea water to aid in navigation, social communication, and possibly predator avoidance. Most phocid seals spend >80% of their time submerged in the water (Gordon et al., 2004); consequently they will be exposed to sounds from the proposed seismic surveys. Few studies of the reactions of pinnipeds to noise from open-water exploration have been published. Temporary threshold shift (TTS) values for pinnipeds exposed to brief pulses (either single or multiple) of underwater sound have not been measured.

Phocids have good low frequency hearing; thus it is expected that they will be more susceptible to masking of biologically significant signals by low frequency sounds, such as from seismic surveys (Gordon et al., 2004). Masking of biologically significant sounds by anthropogenic noise is equivalent to a temporary loss of hearing acuity. Brief, small-scale masking episodes, might, in themselves, have few long-term consequences for individuals or populations of marine mammals. However, the consequences might be more serious in areas where many surveys are occurring simultaneously. Underwater audiograms for phocids suggest that they have very little hearing sensitivity below 1 kHz; they can hear underwater sounds at frequencies up to 60 kHz; and make calls between 90 Hz and 16 kHz (Richardson et al. 1995a). While seismic surveys can contain energy up to 1 kHz, most of the emitted energy is less than 200 Hz. There is considerable variability in the vocalizations of seals, and many of the arctic species vocalize underwater in association with territorial and mating behaviors. Seismic surveys are unlikely to have significant impacts (e.g., masking) on vocalizations associated with breeding activity due to the time of year (i.e., the survey will occur after the breeding season).

Reported seal responses to seismic surveys have been variable and often contradictory, though some do suggest that pinnipeds frequently do not avoid the area within a few hundred meters of operating airgun arrays. However, Brueggeman et al. (1991) reported that 96% of the seals they encountered during seismic operations in the Beaufort Sea were encountered during non-data acquisition activities, suggesting avoidance of active data acquisition operations. Miller et al. (2002) reported that, on average, seals sighted during active seismic periods in the Beaufort Sea were significantly farther from the vessel (210 m) than those sighted during periods without airgun operations (150 m). At the 210-m distance, seals would have been exposed to sound levels of about 190 dB re 1 µPa (rms). Sighting rates of ringed seals from another seismic vessel in the Beaufort Sea showed no difference between periods with the full array, partial array, or no guns firing (Harris, Miller, and Richardson, 2001). Mean distances to seals sighted did increase during full array operations, however, suggesting some local avoidance at levels between 190-200 dB rms. By contrast, telemetry work by Thompson et al. (1998) (as cited in Gordon et al., 2004) suggests that avoidance and behavioral reactions to small airgun sources may be more dramatic than ship-based visual observations indicate. Instrumented gray (*Halichoreus grypus*) and harbor seals exhibited strong avoidance behavior of small air guns, swimming rapidly away from the seismic source. Many ceased feeding, and some hauled out, possibly to avoid the noise. The behavior of most of the seals seemed to return to normal within two hours of the seismic array falling silent. The authors suggest that responses to more powerful commercial arrays might be expected to be more dramatic, and occur at greater ranges.

Seals may be disturbed by vessel traffic and aircraft associated with the seismic surveys. Disturbance may cause seals to leave haulout locations and enter the water. However, there are few published studies addressing pinniped responses to vessels and aircraft (Richardson et al., 1995a). Jansen et al. (2006) reported that harbor seals approached by ships at 100 m were 25 times more likely to enter the water than were seals approached at 500 m. However, they also reported that seal abundance in Disenchantment Bay, Alaska steadily increased during the summer in concert with increasing ship traffic (i.e., no short-term avoidance of areas used by ships), suggesting that changes in overall abundance were influenced by other factors. Harbor seals in their study area did aggregate more closely with increasing ship presence, similar to studies of other marine mammals that show denser aggregations during periods of disturbance. Born et al. (1999) reported that the probability of hauled out ringed seals responding to aircraft overflights with escape responses was greatest at lateral distances of <200 m and overhead distances <150 m. Such responses are likely relatively minor and brief in nature.

It is uncertain how seismic surveys potentially might impact seal-food resources in the immediate vicinity of the survey. As previously discussed in Section III.F.1 (Fish, Fishery Resources, and Essential Fish Habitat) direct and adverse impacts affecting some prey species (i.e., some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years). If seismic surveys cause pinnipeds' prey to become less accessible, either because they move out of an area or become more difficult to catch, than pinniped distributions and feeding rates are likely to be affected. Newly weaned phocid pups may be particularly vulnerable to reduced feeding rates (Gordon et al., 2004), and thus may be disproportionately affected by seismic surveys. This is particularly pertinent considering that most phocid pups are weaned in June, just prior to the start of the proposed seismic surveys. Conversely, damaged or disoriented prey could attract pinnipeds to seismic survey areas, providing short-term feeding opportunities but increased levels of exposure Gordon et al., 2004).

Pacific Walrus. Pacific walruses will be present in the Chukchi Sea action area during seismic-survey activity. Walruses do not typically frequent water depths >200 m, which may exclude them from some survey areas.

Walruses produce a variety of sounds (grunts, rasps, clicks), which range in frequency from 0.1 Hz-10 Hz (Richardson et al., 1995a). Because vocalizations associated with breeding behavior occur during the winter mating season, summertime seismic-survey activities are not expected to affect their breeding behavior. However, walruses might be impacted by vessel and aircraft traffic associated with seismic surveys. Walruses will flee haulout locations in response to disturbance from aircraft and ship traffic, though the reaction is highly variable (Richardson et al., 1995a). Females with dependent young are considered the least tolerant of disturbances. Helicopters are more likely to elicit responses than fixed-wing aircraft, and walrus are particularly sensitive to changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Researchers conducting aerial surveys for walrus in sea ice habitats have reported little reaction to aircraft above 1,000 feet (305 m). Brueggeman et al. (1991) reported that 81% of walruses encountered by vessels in the Chukchi Sea exhibited no reaction to ship activities within less than a kilometer, which suggests that walruses may be tolerant of levels of ship activities and movements. Ice management operations are expected to have the greatest potential for disturbances to walrus. For example, Brueggeman et al. (1991) reported that walrus moved 20-25 km from active icebreaking operations, where noise levels were near ambient. Conversely, researchers on board an icebreaker during ice management operations observed little or no reaction of hauled out walrus groups beyond 0.5 mile (805 m) of the vessel (Garlich-Miller, 2006, pers. commun.). Potential effects of prolonged or repeated disturbance include displacement from preferred feeding areas, increased stress levels, increased energy expenditure, masking of communication, and the impairment of thermoregulation of neonates that are forced to spend too much time in the water (Garlich-Miller, 2006, pers. commun.).

Seismic surveys should have no impacts on the availability of walrus prey due to the sedentary nature of their prey source (primarily bivalves).

The potential for direct impacts causing injury (Level A) from seismic surveys would be most likely if individuals entered the 190-dB zone immediately surrounding the sound source. With appropriate mitigations (e.g., marine mammal observers and shutdown procedures), it is unlikely that walruses would be exposed to sounds that could cause injury. Direct impacts potentially causing injury (Level A) from the seismic surveys also could occur if walrus hauled out on ice floes stampede into the water due to the approach of seismic vessels or aircraft. Calves and young animals at the perimeter of these haulouts are particularly vulnerable to trampling injuries and to being separated from their mothers, which could prove fatal.

Most of the proposed activities will occur in areas of open water where walrus densities are expected to be relatively low, and monitoring requirements and mitigation measures are expected to minimize interactions with large aggregations of walruses. Because the proposed seismic operations will not be concentrated in any one area for extended periods, any impacts to walrus should be relatively short in duration, and should have a negligible overall impact on the Pacific walrus population.

III.F.4.d(2) Cetaceans. During 2D/3D seismic surveys, cetaceans could be adversely affected by noise and disturbance both from the seismic sound sources, the seismic vessel, and from related support ships, boats, icebreakers, and aircraft. In addition, animals could be injured by very close proximity to air gun discharges, seismic ships or boats, aircraft and small fuel spills. From a behavioral perspective, increased anthropogenic noise as what would result from the Proposed Action, could interfere with communication among cetaceans, mask important natural and conspecific sounds, or alter natural behaviors (i.e., displacement from migration routes or feeding areas, disruption of feeding or nursing). Behavioral impacts appear to be affected by the animal's sex and reproductive status, age, accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether the animal has heard the sound previously (e.g., Olesiuk et al., 1995; Richardson et al., 1995a: Kraus et al., 1997; NRC, 2003, 2005). For example, cetacean females with calves show a heightened behavioral response to seismic noise (Henley and Ryback, 1995 and McCauley et al., 2000). In other studies, animal reactions have been mixed during studies on the effects of seismic activity on feeding bowhead whales with some animals ceasing feeding and others continuing feeding (Fraker, Richardson, and Wursig, 1995; Richardson, Wells, and Wursig, 1985).

Section III.F.3 of this PEIS outlines the potential effects of noise and disturbance from the Proposed Action on threatened and endangered marine mammals, with a particular focus on cetaceans. This information is incorporated by reference here as it directly applies to the discussion to follow on general impacts of seismic surveys on nonthreatened and nonendangered cetaceans. Particularly useful subsections within Section III.F.3 include: (1) Potential Effects of Noise and Disturbance from Proposed Seismic Surveys; (2) Potential Exposure of Threatened and Endangered Marine Mammals to Seismic Survey Activities in the Chukchi and Beaufort Sea Program Areas (which is also relevant to nonthreatened and nonendangered cetaceans in these same areas); (3) Potential Effects from and Types of Seismic Surveys; and (4) Effects from Other Vessel Traffic Associated with Seismic Surveys. In addition, MMS (2004) contains information on potential seismic-survey impacts to marine mammals in the Gulf of Mexico and is considered in the following analysis. The following information therefore builds upon the information contained within Section III.F.3 and MMS (2004) and provides a summary of potential impacts from seismic surveys on non-threatened and non-endangered marine mammals found in the Proposed Action area. Conclusions are then drawn based on this impact assessment and the potential for mitigation measures outlined in Section IV to lessen potential impacts to determine the overall level of anticipated impact from the Proposed Action.

***Odontocetes or Toothed Whales (Beluga Whale, Killer Whale, and Harbor Porpoise*).** Among the odontocetes, hearing thresholds are highly species-specific. The high range of hearing sensitivity falls within 80-150 kHz (Richardson et al., 1995a) with the greatest sensitivity to sounds above 10 kHz (USDOI, MMS, 2004). Killer whales are most sensitive at 20 kHz (Szymanski et al., 1999) with an upper frequency limit near 120 kHz (Bain, Kriete, and Dahlheim, 1993; Bain and Dahlheim in Au, 1993:33). Harbor porpoise hearing ranges from 1 kHz to over 100 kHz (Richardson et al., 1995a). Beluga whales appear to hear sounds from as low as 40-75 Hz, although their sensitivity at these low frequencies is considered poor, to over 100 kHz (Richardson et al., 1995a). The sensitivity of toothed whales to high-frequency sounds is attributed to their use of high-frequency sound pulses in echolocation and moderately high-frequency calls for communication.

Below the 10 kHz level hearing ability deteriorates for toothed whales as frequency decreases, with the exception of the sperm whale (Carder and Ridgway, 1990). Below 1 kHz, hearing sensitivity of odontocetes in considered poor although some species may be able to detect sound frequencies as low as 60-105 Hz (USDOI, MMS, 2004) and, in the case of beluga whales, as low as 40-75 Hz (Richardson et al., 1995a). Although most seismic survey noise is concentrated below the 1 kHz level, more recent measurements of airguns at sea have shown that there is some level of significant seismic energy even within the higher frequency levels (Goold and Fish, 1998; Sodal, 1999). So, although toothed whales, such as the beluga whale, killer whale and harbor porpoise, specialize in hearing ranges generally outside of the majority of seismic survey impulse sounds, there is still the potential for sounds from these surveys to fall within the acoustic sensitivity of toothed whales.

There have been no documented instances of deaths, physical injuries, or auditory (i.e., temporary or permanent threshold shifts or other physiological) effects on toothed whales, or any marine mammal, from seismic survey activity. Despite this, NMFS and MMS recognize that it may be difficult to document injury or harm, and that the potential for injury may still exist, particularly if individuals entered the 180-dB zone immediately surrounding the acoustic source or were struck by seismic vessels or support ships (USDOI, MMS, 2004). However, with appropriate protective measures in place as discussed in Section IV (e.g., marine mammal observers and shutdown procedures), individuals are not likely to be exposed to sound levels that could cause injury and visual observance of the zone surrounding vessels would limit the potential for vessel strikes to occur.

Overall, little research has been done to study the effects of seismic activity, and related vessel and air traffic, on the behavior of toothed whales other than the sperm whale. However, a number of studies are useful in drawing conclusions on potential impacts. For example, Van Parijs and Corkeron (2001) found that vessel presence can affect the acoustic behavior of dolphins, particularly mother/calf pairs, by increasing the rate of vocalization (perhaps in an attempt to maintain group cohesion) as vessels passed through the area. Other studies have shown that seismic survey pulses change the vocal behavior of common dolphins in the open sea (Wakefield, 2001) and that certain dolphin species are sighted less often in the vicinity of surveys when the guns were firing than when the guns were silent (Stone, 1996, 1997, 1998). Morton and Symonds (2002) found in a 15-year study of killer whales in Johnstone Strait and Broughton Archipelago that killer whale presence was significantly lower during a seven year period when acoustic harassment devices (10 kHz devices with source levels of 194 dB re: 1 µPa at 1 m) were installed in the area and the number of whales returned to baseline estimates when the sound source was removed. The control population killer whales included in this study did not experience changes in individuals present over that same time period. Kraus et al., (1997) found acoustic alarms operating at 10 kHz with a source level of 132 dB re: 1 µPa at 1 m were an effective deterrent for harbor porpoises and harbor seals. Finally, Bejder et al. (2006) found declines in abundance of bottlenose dolphins in certain areas of Shark Bay, Australia resulting from long-term disturbance primarily from dolphin watching vessels. This study is one of the first for cetaceans to document changes in abundance due to long-term behavioral disturbance. These findings are particularly important for assessing long-term disturbance to closed, small or endangered populations. Again, the protective measures in place as discussed in Section IV would seek to limit any potential effects to Level B Harassment (disturbance) and even minimize the degree of Level B Harassment that might occur.

Beluga whales in Arctic Alaska consistently congregate in shallow coastal or estuarine waters during at least a portion of the summer. In the Eastern Chukchi, these areas of concentration are known to occur in Kotzebue Sound and Kasegaluk Lagoon. Research suggests these areas are likely used for molting and some of the largest gravel beds occur there. Beluga whales can also be found in large aggregations during the remainder of the summer when they are located further offshore and associated with deeper slope water. Additional analysis must then be considered on how seismic activity considered under this PEIS may affect these concentrations of whales, especially when they are engaged in important biological behaviors such as feeding or molting.

In reviewing these life history patterns of beluga whales and assessing the potential for disturbance from seismic activity, the potential exists, without appropriate mitigation, for seismic activities to displace whales from these areas. However, given the mitigation measures in Section IV (and any imposed under the MMPA authorization process) are designed to lessen potential impacts, seismic activity at these areas potentially would result in an adverse but not significant impacts to beluga whales.

It is uncertain about how seismic surveys might impact odontocete food resources (e.g., a variety of fish, squid, other marine mammals, and shellfish) in the immediate vicinity of the survey. As previously discussed in Section III.F.1 (Fish, Fishery Resources, and Essential Fish Habitat) direct and adverse impacts affecting some prey species (i.e. some teleost fishes) may last for days to weeks (e.g., displacement from foraging, staging, or spawning habitat areas) or longer (i.e., auditory and/or vestibular harm that lasts months or even years).

Mysticetes or Baleen Whales (Minke and Gray Whales). Mysticetes, with their larger body and ear size and basilar membrane thickness-to-width ration, are low frequency hearing specialists with an auditory range starting at 10 Hz and possibly moving as high as 30 kHz (Ketten, 1998). The most sensitive range appears to occur below 1 KHz. Given that seismic surveys produce sounds in the frequency range used by baleen whales, including minke and gray whales, potential impacts to these species are considered greater than would occur with toothed whales.

Given the greater potential for anthropogenic noise impacts on baleen whales, more research has been done to focus on potential effects than with toothed whales (although data is still considered limited). As with toothed whales, there have been no documented instances of deaths, physical injuries, or auditory effects (temporary or permanent threshold shifts or other physiological) from seismic surveys (USDOI, MMS, 2004) although NMFS and MMS recognize again that these effects are difficult to study and document. In 2004, the IWC's Scientific Committee's Standing Working Group on Environmental Concerns reviewed information related to whale strandings and determined that there is compelling evidence that increasing sound levels having the potential to impact whales. Although no documented injuries have occurred, NMFS and MMS consider there to still be a potential for injury to marine mammals from seismic activities. However, the mitigation measures outlined in Section IV are designed to avoid Level A Harassment (potential to injure) and maintain any takes of marine mammals at or below Level B Harassment (potential to disturb).

Baleen whales are also subject to behavioral disturbance from the presence of anthropogenic noise. Overall, studies of gray, bowhead and humpback whales have shown that received levels of impulses in the 160-170 dB re: 1 μPa rms range appear to cause avoidance behavior in a significant portion of the animals exposed. Dahlheim (1987) reported that in noisy environments, gray whales increase the timing and level of their vocalizations and use more frequency-modulated signals. Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100-in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Malme at al. (1986) estimated that an average pressure level of 173 dB occurred at a range of 2.6-2.8 km (1.4-1.5 nmi) from an airgun array with a source level of 250 dB (0-pk) in the northern Bering Sea. These findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast. Malme and Miles (1985) concluded that, during migration, changes in swimming pattern occurred for received levels of about 160 dB re 1 μPa and higher, on an approximate rms basis. The 50% probability of avoidance was estimated to occur at a CPA distance of 2.5 km (1.3 nmi) from a 4,000-in^3 array operating off central California (CPA = closest point of approach). This would occur at an average received sound level of about 170 dB (rms). Some slight behavioral changes were noted at received sound levels of 140 to 160 dB (rms). However, these slight behavioral changes at levels below 160 dB may have been more relevant to the location of the sound source as the seismic array was placed in the middle of the gray whale migratory pathway. In Würsig et al. (1999), observations of gray whales near Sakhalin Island found no indication that western gray whales exposed to seismic noise were displaced from these feeding grounds in 1999 and 2001. However, there were indications of subtle behavioral effects and (in 2001) localized avoidance by some individuals (Johnson 2002; Weller et al. 2002).

Currently, gray whales are believed to congregate along offshore shoals in the northern Bering and Chukchi seas for feeding during the summer months. Larger aggregations of feeding whales have been reported at these shoals. As this may indicate that these are important feeding areas for the expanding gray whale population and gray whales typically have shown documented disturbance reactions at levels at or above 160 dB, the effects of seismic surveys at these feeding sites must also be considered. The potential exists, without appropriate mitigation, for seismic activities to displace whales from these areas. However, given the mitigation measures in Section IV (and any imposed under the MMPA authorization process) which are designed to lessen potential impacts, seismic activity at these feeding areas potentially would result in adverse but not significant impacts to gray whales.

No studies are available specific to the effects of seismic survey noise on minke whales but the potential for impacts would be considered within the range of other baleen whales. Also, no known long-term impacts have been documented on gray and minke whale behavior as a result of seismic activity. However, mitigation and monitoring measures outlined in Section IV are considered to: (1) prevent Level A Harassment (injury); (2) lessen the potential for takes by Level B Harassment (disturbance); and (3) by limiting the potential for short-term harassment, ultimately avoid the potential for long-term, population level effects.

III.F.4.d(3) Marine Fissipeds (Polar Bear). Impacts to polar bears from marine open-water seismic activity have not been studied, but would likely be minimal. When swimming, polar bears normally keep their heads above or at the water's surface, where underwater noise is weak or undetectable (Richardson et al., 1995a). Direct impacts potentially causing injury (Level A) from the seismic surveys are possible if animals entered the 190-dB zone immediately surrounding the sound source. However, with appropriate measures in place (e.g., marine mammal observers and shutdown procedures), any potential seismic-survey-generated injuries could be mitigated. There is also the possibility that bears could be struck by seismic vessels or exposed to small scale fuel spills, though these risks are considered slight.

For most of the year, polar bears are not very sensitive to noise or other human disturbances (Amstrup, 1993). However, pregnant females and those with newborn cubs in maternity dens are sensitive to noise and vehicular traffic (Amstrup and Garner, 1994). Vessel traffic associated with seismic-survey activity is not expected to cause impacts to polar bears, because they show little reaction to vessels and generally do not linger in open water. Brueggeman et al. (1991) observed polar bears in the Chukchi Sea during oil and gas activities and recorded their response to an icebreaker. While bears did respond (walking toward, stopping and watching, walking/swimming away) to the vessel, their responses were brief. Seismic surveys have the potential to disturb polar bears that are swimming between icefloes or between the pack ice and shore. Swimming can be energetically expensive for polar bears, particularly for bears that engage in long-distance travel between the leading ice edge and land. Bears that encounter seismic operations may be temporarily deflected from their chosen path, and some may choose to return to where they came from. However, bears swimming to shore are most likely heading for reliable food sources (i.e., Native-harvested marine mammal carcasses on shore), for which they have a strong incentive to continue their chosen course. Therefore, although some bears may be temporarily deflected and or inhibited from continuing toward land due to seismic operations, this interruption likely would be brief in duration. For bears that are already severely energetically stressed, however, this could prove fatal. Due to the vast area that seismic surveys will be conducted over, and the fact that seismic operations will be curtailed during the bowhead migration (due to aggregations of migrating whales), which coincides with the time that large numbers of bears swim for land, the number of bears affected in this manner likely would be very small. Plans of Cooperation are being negotiated between permit applicants and the AEWC to mitigate the possible effects of seismic survey operations during bowhead whale-subsistence hunts. Because the whale hunts coincide with the time that many bears come ashore, particularly in the Kaktovik area, the impact to swimming polar bears would be mitigated to some extent. Ultimately, few bears are likely to be substantially affected by seismic operations during the open-water period.

Polar bears are closely tied to the presence of the sea-ice platform for the majority of their life functions, including hunting (Amstrup, 2003). Because effective seismic surveys are relegated to operating in an ice-free environment, it is unlikely that the proposed activities will impact the abundance and availability of ringed and bearded seals, which are the primary prey of polar bears.

Because the proposed seismic operations will not be concentrated in any one area for extended periods, any impacts to polar bears should be relatively short in duration, and should have a negligible impact on polar bear populations.

III.F.4.d(4) Conclusions. Potential effects from seismic survey activities on non-threatened and non-endangered marine mammals include tolerance (that is the capacity of the individuals to endure or become less responsive to the repeated exposure), masking of natural sounds, behavioral disturbance, auditory impacts (e.g., temporary and permanent threshold shifts), and other physiological effects (Richardson et al., 1995a). Seismic surveys, either alone or in combination with other factors, could also have subtle, chronic effects such as: excluding marine mammals from important habitats (e.g., feeding, resting or molting areas) at significant times, interfering with their migrations and movements, contributing to habitat degradation, disrupting biologically significant behaviors, and increasing levels of stress (Gordon et al., 2004). No documented instances of deaths, physical injuries, or auditory (temporary or permanent threshold shifts or other physiological) effects on marine mammals from seismic surveys have been reported although again these may be difficult to document (USDOI, MMS, 2004).

Overall, the potential for seismic survey activities to harass and injure non-threatened and non-endangered marine mammals is lessened through the implementation of appropriate protective measures as outlined in Section IV as well any imposed during the MMPA authorization process. These protective measures are designed to avoid Level A Harassment (potential to injure). Additional mitigation measures outlined in Section IV are designed to reduce uncertainty and further reduce the potential for harassment to occur at or below Level B Harassment (disturbance). In addition, these measures are meant to even further limit the potential for short-term harassment of marine mammals and thus avoiding the potential for long-term, population level effects.

III.F.4.e. Impact Assessment of Alternatives. The most likely effects on marine mammals from seismic activity and the proposed alternatives include disturbance reactions to seismic vessels and associated aircraft traffic, and altered prey availability. Responses, such as fright, avoidance, and changes in behavior and vocalization patterns have been observed in marine mammals at ranges of tens to hundreds of kilometers from a sound source. Sound could also affect marine mammals indirectly by changing the accessibility of their prey species. Populations could be adversely affected if feeding, orientation, hazard avoidance, migration, or social behaviors are altered. Serious long-term consequences could also result from chronic exposure. Baleen whales (bowhead, fin, humpback, gray, and minke whales) are the most sensitive marine mammal species to anthropogenic noise in the action area.

The potential for seismic survey activities to significantly harass and injure non-threatened and non-endangered marine mammals is lessened through the implementation of appropriate protective measures as outlined in Section IV. These mitigation measures are designed to avoid Level A Harassment (potential to injure) or limit the potential for harassment to occur at or below Level B Harassment (disturbance). Many of the measures were developed to lessen impacts to baleen whales, the most sensitive marine mammals to anthropogenic noise; thus these measures will also considerably decrease potential impacts to other non-threatened and non-endangered marine mammals. In addition, by further limiting the potential for short-term harassment of marine mammals, the potential for long-term, population level effects are avoided.

One potential mitigation measure which was considered but not adopted was for active acoustic monitoring. Active acoustic monitoring utilizes sound (e.g., sonar) to detect, locate and track marine mammals within a certain distance of the sound source which includes and can extend beyond the determined exclusion zone. Generally, this involves a short sound pulse (energy) from a high power source (transducer) that travels through the water, reflects off an object, and travels back to the hydrophone receiver. Appendix E, pages 29-32 of MMS (2004) provides additional detail on active acoustic monitoring systems known to date and their use for monitoring exclusion zones. Essentially, MMS (2004) concludes that active acoustic monitoring, although holding potential for use in monitoring exclusions zones during seismic work, is not yet well-used in this regard, its effects are not well-documented, and systems are not yet readily available. In addition, the sound source used may or may not be more disturbing to cetaceans than the sound source being mitigated against. Behavioral impacts may be acceptable if the active acoustic monitoring sound source is ultimately less disturbing than the seismic sound source. However, information to make this determination is not readily available at this time. Therefore, the use of active acoustics as a marine mammal monitoring technique is not feasible and is not considered further here.

The following analysis provides a comparison of the relative levels of protection to non-threatened and non-endangered marine mammals found in the Proposed Action area under the various alternatives, using the significance criteria defined in Section III.D and the mitigation measures that apply as outlined in Section IV.

III.F.4.e(1) Alternative 1. The No Action alternative (No seismic survey permits issued for geophysical exploration activities) would not expose marine mammals in the project area to noise associated with seismic surveys and their associated support vessels (air and sea). Other methods to collect geophysical and geological data (as yet undetermined) may disturb animals in the project area in unknown, but possibly similar ways.

III.F.4.e(2) Alternatives 3 through 8. Alternatives 3 through 8 are essentially the same with varying levels of protection for marine mammals depending on the size of the safety or exclusion zone (Alternative 3, 120 dB safety zone; Alternative 4, 160 dB safety zone; Alternative 5, 120/160 dB safety zones; Alternative 6, 180/190 dB exclusion zone; Alternative 7, 120/160 dB safety zones and 180/190 dB exclusion zone; Alternative 8, 160 dB safety zone, 180/190 dB exclusion zone, and temporal/spatial/operational restrictions) and related monitoring. They would all require that MMPA authorizations be approved before the start of seismic survey activity. Given that Alternatives 3 though 8 all require an MMPA authorization (and subsistence determination), then the alternatives are all similar in regards to avoiding unmitigable adverse impacts on subsistence. The difference then is in the degree of protection of marine mammals provided within each alternative with the more protective alternatives (i.e., those with large safety zones or implementation of spatial/temporal/operational restrictions) further reducing any potential for negative effects to subsistence harvest activities and marine mammal populations. They all are environmentally sound, as they all contain protective measures to mitigate possible impacts on marine mammals, and through the NEPA and MMPA process, contain measures to further protect other fish, wildlife, and subsistence-harvest resources from being adversely impacted. Theoretically, alternatives with larger safety zones (e.g. Alternative 3 at 120-dB) and imposed temporal/spatial/operational restrictions (e.g. Alternative 8) would provide greater levels of protection for marine mammals from potential harm and harassment than those alternatives having a higher dB isopleth exclusion zone (e.g. Alternative 6 at 180/190-dB). In addition, Alternatives 3 through 8 would prohibit seismic surveys around bowheads in the spring lead system (i.e., no MMPA authorizations issued until July 1), thereby reducing potential impacts to other marine mammal species present in this system as well.

Although the radii of the safety and exclusion zones are meant to cover the area required to prevent Level A Harassment and limit the potential for Level B Harassment, disturbance to marine mammals from the projected seismic activity could extend beyond the zone if animals are exposed to moderately strong-pulsed sounds generated by the airguns. Variability in the size and configuration of the airgun arrays, water depth, and bottom properties necessitate that empirical data be collected to verify the actual exclusion zone. For example, based on 3-D seismic with 8-16 airguns totaling 560-1,500 in^3, these exclusion zones may be as large as 30 km for the 120 dB zones and as small as 100 m for the 190 dB zones, depending on the seismic array and environmental conditions. Field verification of the zone(s) would be required under these alternatives, and the appropriate size of the zone(s) would be based on these results. It is likely that the exclusion zone for these bigger arrays would be larger than what has been previously used, and this may result in an increased area where marine mammals may be harassed. In addition, as the safety zone increases in size (from 190/180-dB to 120 dB; Alternatives 3 through 8), the ability of vessel-based visual observers to effectively monitor the exclusion zone decreases. Therefore, additional monitoring techniques (i.e., aerial surveys and passive acoustic monitoring) or mitigation measures would be required for the alternatives with larger exclusion zones.

III.F.4.e(2)(a) Pinnipeds (Ringed, Spotted, Ribbon, and Bearded Seal and Pacific Walrus). The NMFS' current Level A harassment threshold for pinnipeds (excluding the pacific walrus) is 190 dB. Pacific walrus are managed by the FWS, and they recently implemented a 180-dB exclusion zone for walrus (USDOI, FWS, 2005).

Alternatives 3 through 8 all provide exclusion zones capable of providing protection for pinnipeds in the project area. The exclusion zone would be the smallest for Alternative 6 (180/190 dB) and could be monitored visually by vessel-based observers. Conversely, Alternative 3 would provide the largest safety zone (120 dB). Increased disturbance from vessel and aircraft activity could consequently cause pinnipeds to leave haul-out locations and enter the water, though the response is highly variable. This could have a greater impact if flushing of haul out sites occurs when pups are present, as they can be more easily injured and separated from their mothers. Use of the 160 dB safety zone in Alternative 4 and in Alternative 5 would provide an intermediate-sized safety zone. Alternatives 3-5, when properly monitored, would provide exclusion zones which are sufficient for pinnipeds.

The mitigation measures outlined in Section IV, and that apply to Alternatives 3 through 8, are set to avoid any takes of marine mammals by Level A Harassment. Based on the above, the fact that no injuries to marine mammals have been documented from seismic survey activities, and that protective measures outlined in Section IV are in place, MMS believes the potential for any injuries to pinnipeds from the proposed activity and Alternatives 3 through 8 is very limited, with Alternative 6 providing a slightly greater potential for Level A Harassment as its specified exclusion zone of 190 dB most closely approaches the lower limits of levels set by NMFS for Level A Harassment.

Alternatives 3 through 8 require trained observers to visually monitor the safety and exclusion zones, regardless of its size, and to be able to call for a shut-down if marine mammals enter the zone. The ability of observers to effectively monitor the zone, and be able to call for a shut-down if marine mammals enter the zone is critical to the success of the protective measures described in Alternatives 3 through 8, though it is often difficult to observe all marine mammals, especially pinnipeds, within the zone (Gordon et al., 2004).

The above assessment of the degree of impacts of Alternatives 3 through 8 is based solely on the protection afforded by the various safety and exclusion zones and assumes effective monitoring of those zones will occur. This evaluation must therefore also consider any differences in the ability of Alternatives 3 through 8 to monitor their zones. From this standpoint, the larger zones to monitor would be Alternative 3, 5, and 7, respectively, with the smaller zones being Alternatives 4, 6, and 8, respectively. Larger zones would require implementation of additional monitoring techniques beyond vessel-based visual monitoring, such as aerial surveys and passive acoustic monitoring, where the smaller zones would rely mainly on vessel-based visual monitoring. If these methods of additional monitoring are not effective, then additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis). Conversely, Alternative 8 includes required spatial/temporal/operational restrictions that may be equal to or exceed the protection provided by the 120-dB safety zone.

Because most phocid seals spend >80% of their time submerged and are particularly difficult to observe at sea (Gordon et al., 2004), even within 250 m of a seismic vessel (Brueggeman et al., 1991; Richardson, 2000; Harris, Miller, and Richardson, 2001), it is possible some may be exposed to significant levels of received sound from the seismic array. However, pinnipeds are not likely to be exposed to sound levels which could cause injury, as they would have to swim within extremely close proximity to the seismic array in order to be vulnerable, and there is no specific evidence that exposure to pulses of airgun sound can cause direct injury to pinnipeds. The most likely potential impacts to pinnipeds from seismic surveys and associated activities would be disturbance and possible impacts to food resources. See Section III.F.4.b for a more detailed discussion of these impacts.

With the mitigation included in Section IV and the MMPA authorization required for Alternatives 3 through 8, all aircraft overflights would be required to fly at or above 1,000 ft in order to minimize the potential for behavioral impacts to marine mammals and adversely affect subsistence hunting. Therefore, the use of aerial surveys is not expected to significantly increase the potential for harassment of pinnipeds under Alternatives 3, 5, and 7. Therefore, the varying degrees of impact between the alternatives, as discussed in the paragraphs above, remains the same with the greatest to least level of protection from behavioral disturbance and injury being Alternatives 3, 5, 4, 7, 8, and 6 respectively. However, depending on the temporal/spatial/operational restrictions imposed, Alternative 8 might exceed the level of protection afforded in Alternatives 3-7.

III.F.4.e(2)(b) Cetaceans (Beluga Whale, Killer Whale, Harbor Porpoise, Minke Whale, and Gray Whale). NMFS' current threshold for Level A Harassment (potential to injure) of cetaceans is 180 dB. The mitigation measures outlined in Section IV, and which apply to Alternatives 3 through 8, are set to avoid any takes of marine mammals by Level A Harassment. In addition, the MMPA authorization required under Alternatives 3 through 8 would not authorize any Level A takes of marine mammals. Based on the above, the fact that no injuries to marine mammals have been documented from seismic survey activities (although again difficult to document), and that protective measures outlined in Section IV are in place, NMFS and MMS believes the potential for any injuries to cetaceans from the proposed activity and

Alternatives 3 through 8 is very limited, with Alternative 6 providing a slightly greater potential for Level A Harassment as its specified exclusion zone of 180 dB most closely approaches the lower limits of levels set by NMFS for Level A Harassment.

The NMFS' current threshold for Level B Harassment (potential to disturb) for cetaceans is 160 dB. No studies have shown that toothed whales in the Proposed Action area have reacted behaviorally to seismic sound below the 160 dB received sound level. Studies on most baleen whales, except for the bowhead and gray whale, have also not demonstrated behavioral reaction at a received sound level of less than 160 dB. However, data exists showing that gray and bowhead whales may react behaviorally at received sound levels lower than 160 dB. For example, Malme and Miles (1985) found some slight behavioral changes in gray whales from seismic surveys at received sound levels of 140 to 160 dB (rms). However, reactions from gray whales at levels below 160 dB may be more relevant to the location of the sound source during this study as it was placed directly in the migratory path of the whales. Richardson (1999) reported that monitoring studies of 3-D seismic work (8-16 airguns totaling 560-1,500 in^3) in the nearshore Beaufort Sea during 1996-1998 have shown that nearly all bowhead whales will avoid an active seismic source at 20 km distance, while deflection may begin at distances up to 35 km. The received sound level at 20 km ranged from 117-135 dB re 1µPa rms and at 30 km was 107-126 re 1 µPa rms. Based on the results stated in Richardson (1999), this programmatic environmental analysis has provided three alternatives (3, 5, and 7) that set safety zones completely or partially at 120 dB.

In comparing Alternatives 3 through 8, looking purely at the size of the safety or exclusion zone and assuming the monitoring requirements will be effective, there are differences in the level of potential behavioral impact across these alternatives. The most protective (i.e., resulting in the least potential for takes by Level B Harassment and avoidance of Level A Harassment) would be Alternative 3 as this provides the largest exclusion zone (120 dB). Given the bowhead whale is the only cetacean in the Proposed Action area to show avoidance near the 120 dB received sound levels from impulse sounds and all other cetaceans in the Proposed Action area have generally demonstrated avoidance at higher received sound levels (i.e., 160 to 180 dB), Alternative 3 would result in the least impact to cetaceans and other marine mammals in the Proposed Action area.

After Alternative 3, Alternative 5 would provide the next most protective level for cetaceans. In this alternative, the safety zone would be set at 160 dB unless a certain number of bowhead whales (individuals, reproductive-age females, calves) were present, as determined by MMS and NMFS, where the zone would be changed to 120 dB. The combination of the two zones under this alternative would provide all cetaceans with additional protective measures but still would provide a zone at 160 dB (the level set by NMFS beyond which Level B Harassment is more likely to occur) at all remaining times. Therefore, Alternative 5 provides the next most protective alternative for marine mammals.

Alternative 4 follows Alternatives 3 and 5, respectively, in the degree of potential impacts to cetaceans. This alternative sets the safety zone at 160 dB the level set by NMFS beyond which Level B Harassment is more likely to occur. Therefore, the greatest potential for Level B Harassment exists for Alternative 6 where the zone for cetaceans is set at 180 dB, which exceeds NMFS' 160 dB determination for Level B Harassment (disturbance) and most closely approaches the NMFS determination for Level A Harassment (injury).

Depending on the temporal/spatial/operational restrictions imposed, Alternative 8 might exceed the level of protection afforded in Alternatives 3-7. For example, closure on an operational area to surveys during bowhead whale migration would also protect other marine mammals found within this area. Also, avoiding impacts to important feeding areas would provide considerable benefits to cetaceans that are sensitive to human disturbance. However, a closure may result in greater impacts to non-listed marine mammal if the closure area pushes seismic survey activity into an area of higher non-ESA marine mammal concentration, especially if this area is important for feeding, resting, caring for young or migrating.

The above assessment of the degree of impacts of Alternatives 3 through 8 is based solely on the protection afforded by the various safety and exclusion zones and restrictions and assumes effective monitoring of those zones will occur. This evaluation must therefore also consider any differences in the ability of

Alternatives 3 through 8 to monitor their zones. From this standpoint, the larger zones to monitor would be Alternative 3, 5, and 7, respectively, with the smaller zones being Alternatives 4, 6, and 8, respectively. Larger zones would require implementation of additional monitoring techniques beyond boat-based visual monitoring, such as aerial surveys and passive acoustic monitoring, where the smaller zones would rely mainly on boat-based visual monitoring. If these methods of additional monitoring are not effective, then additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis).

While the additional techniques required for Alternatives 3, 5, and 7 would be costly and a larger zone in theory would provide a much larger, and possibly more difficult, area to monitor, this does not necessarily mean these larger zones are less effective in limiting impacts to cetaceans for the following reasons: (1) each zone in Alternatives 3 through 8 would require boat-based visual monitoring (i.e., all observers are scanning areas from the vessel as far as visually possible with appropriate equipment); (2) larger zones in Alternatives 3, 5, and 7 would by definition require further distance of operating seismic vessels from cetaceans than Alternatives 4, 6, and 8 with smaller zones; (3) the aerial survey and passive acoustic monitoring required in Alternatives 3, 5, and 7 (and not in Alternatives 4, 6, and 8) would provide additional coverage further away from the seismic source; and (4) additional mitigation measures would be set in place (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis) should monitoring measures prove ineffective.

These alternatives that include a 120-dB safety zone would also incorporate the use of aerial surveys and/or acoustic monitoring (i.e., passively listening for the presence of marine mammal sounds) in addition to boat-based visual monitoring. This analysis must then determine if any additional disturbance caused by aircraft overflights or acoustic monitoring could impact some cetaceans and whether this would ultimately change the degree of impact of alternatives including a 120-dB safety zone.

Richardson et al. (1995a) suggest that airborne sounds (and visual stimuli) from aircraft may be less relevant to toothed whales than baleen whales but reactions are variable. For example, beluga responses in offshore waters near Alaska ranged from no overt response to abrupt diving and avoidance, and generally increased with decreasing flight altitude. Reactions to aircraft include diving, tail slaps, or swimming away from the aircraft track. Gray whale mother-calf pairs seem to be sensitive while migrating gray whale responses are not as detectable. In other cases, both baleen and toothed whales showed no reaction to aircraft overflights. In summary, responsiveness depends on variables, such as the animal’s activity at the time of the overflight or altitude level of aircraft, and most animals quickly resume normal activities after the aircraft has left the area. Richardson et al. (1995a) state that there is no indication that single or occasional overflights can cause long-term displacement of cetaceans.

With the mitigation measures outlined in Section IV and those required under the MMPA authorization process, all aircraft overflights would be required to fly at or above 1,000 ft in order to minimize the potential for behavioral impacts to marine mammals and adversely affect subsistence hunting. Therefore, the use of aerial surveys is not expected to significantly increase the potential for harassment of cetaceans under alternatives imposing a 120-dB safety zone.

Passive acoustic monitoring involves simply listening for cetacean sounds and occurs from a vessel-based system and/or hydrophone or sonobuoy placed o the seafloor. Systems are available in the commercial sector. They leave no acoustic footprints that could affect cetaceans and would therefore not result in any level of additional disturbance to cetaceans. The main drawback is that these systems can only detect vocalizing animals.

The passive acoustic monitoring requirement would also not increase the impact level anticipated for alternatives imposing a 120-dB. Additional mitigation measures would be set in place for the largest 120 dB safety zone (i.e., adaptive management schemes where specific areas of higher marine mammal concentrations are avoided on a temporal or spatial basis) should monitoring measures prove ineffective.

The difference then within Alternatives 3 through 8 remains with the amount of protection afforded to marine mammals through the mitigation included within each alternative. Again, alternatives with larger safety zones (i.e., Alternatives 3, 4, 5 and 7) would provide a greater level of protection than the 180/190-dB exclusion zone specified in Alternative 6. In addition, Alternative 8 includes a larger safety zone of 160-dB and also adds temporal/spatial/operational restrictions that would close areas or reduce activity in areas of higher bowhead whale presence and subsequently provide additional protection to other marine mammals in these areas.

III.F.4.e(2)(c). Marine Fissipeds (Polar Bear). Polar bears are managed by the FWS, and they recently implemented a safety radius for polar bears of 190 dB (USDOI, FWS, 2005). Because any polar bears encountered will most likely be on the ice, air gun effects on them are expected to be minor. If polar bears are encountered in the water, received sound levels would be substantially reduced due to the pressure release effects near the water surface (Richardson et al. 1995a). The most likely impacts to polar bears from seismic surveys and associated activities would be disturbance and possible impacts to bears' food resources. Any impacts of seismic activity to polar bear food resources will probably be minor, local and brief in nature. Bearded and ringed seals are the primary prey of polar bears in the action area, and abundance and availability of these seals are not expected to be significantly altered by the proposed seismic surveys and associated activities. See Section III.F.4.b(3) for a more detailed discussion of these impacts.

Alternative 6 provides the smallest exclusion zone (180/190 dB) and could be visually monitored by vessel-based observers. As the zones grow in size, it becomes less likely that the zone can be effectively monitored by vessel-based observers and aircraft-based observers will need to be added (i.e., when 120-dB level is used in Alternatives 3 and 5). Vessel activity should cause only a brief disturbance, with bears resuming normal activities after the vessel passes. Aircraft activity may be more problematic as polar bears often run away from aircraft passing at low altitude (e.g., altitude < 200 m and lateral distance < 400 m) (Richardson et al. 1995a). The inclusion of aircraft-based observers has the potential to disturb more polar bears than vessel-based observers alone if the aerial observations are flown at a sufficiently low altitude. However, protective measures as outlined in Section IV should limit this impact. Use of the 160-dB exclusion zone in Alternative 4 and in Alternative 5 will provide an intermediate-sized safety zone. The ability of observers to effectively monitor the exclusion zone, and be able to call for a shut-down if polar bears enter the safety zone is critical to the success of the protective measures described in Alternatives 3 through 8.

The difference then within Alternatives 3 through 8 remains with the amount of protection afforded to marine mammals through the mitigation included within each alternative. Again, alternatives with larger safety zones (i.e., Alternatives 3, 4, 5 and 7) would provide a greater level of protection than the 180/190-dB exclusion zone specified in Alternative 6. In addition, Alternative 8 includes a larger safety zone of 160-dB and also adds temporal/spatial/operational restrictions that would close areas or reduce activity in areas of higher bowhead whale presence and subsequently provide additional protection to other marine mammals in these areas.

III.G. Community Setting.

III.G.1. Economy.

III.G.1.a. Affected Environment. The economy of the North Slope Borough (NSB) and the major Inupiat communities it supports (Point Hope, Noatak, Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik) rely heavily on oil- and gas-generated revenues generated from property taxes. The NSB received no OCS revenues for the period 1995-2000 (USDOI, MMS, 2003a). However, in 2001, the NSB did receive a share of OCS revenues through the Coastal Impact Assistance (CIA) program administered by the National Oceanic and Atmospheric Administration. The Energy Act of 2005 will start a new CIA program through 2010, and will be administered by the Minerals Management Service (MMS). Approximately 70% of the oil and gas workers on the North Slope commute to permanent residences in Alaska but outside the NSB, primarily in Southcentral Alaska and Fairbanks, and the remaining 30% reside outside Alaska (USDOI, MMS, 2003a). Education and other government services provide the majority of full-time employment in the NSB, and the NSB government employs many people directly and finances construction projects under its Capital Improvement Program (CIP)

The predominately Inupiat residents of the NSB traditionally have relied on subsistence activities. Although not fully part of the cash economy, subsistence hunting is important to the NSB's whole economy and even more important to the culture. Households do need to expend cash to purchase equipment used in the subsistence harvest such as boats, rifles, all-terrain vehicles, snowmachines, etc.

Most full-time positions in Point Hope (which is on the Chukchi Sea coast) are with the city and borough governments. Residents manufacture whalebone masks, baleen baskets, ivory carvings, and Eskimo clothing. Some residents hold commercial-fishing permits. Most year-round employment opportunities in Point Lay are with the NSB government. Subsistence activities provide food sources. Seals, walrus, beluga whale, caribou, and fish are staples of the diet.

Noatak is on the Chukchi Sea coast and its economy is based principally on subsistence, although the available employment is diverse. The school district, city, and retail stores are the primary employers. Several residents hold commercial-fishing permits. During the summer, many families travel to seasonal fish camps at Sheshalik, and others find seasonal work in Kotzebue or work as firefighters.

Economic opportunities in Wainwright (which is on the Chukchi Sea coast) are influenced by its proximity to Barrow and the fact that it is one of the older, more established villages. Most of the year-round positions are in NSB services. Sale of local Eskimo arts and crafts supplements income.

Barrow is on the Beaufort Sea coast and is the economic center of the NSB and the city's primary employer. Numerous businesses provide support services to oil-field operations. State and Federal agencies also provide employment. Tourism and sale of arts and crafts provide some cash income. Several residents hold commercial-fishing permits. Many residents rely on subsistence-food sources; whale, seal, polar bear, walrus, duck, caribou, and grayling and whitefish are harvested from the coast or nearby rivers and lakes.

Unemployment is high in Nuiqsut (which is located inland of the Beaufort Sea coast). The Kuukpik Native Corporation, school, NSB services, and the local store provide most of the year-round employment in the village. Trapping and craft making provide some income. Caribou, bowhead and beluga whale, seal, moose, and fish are staples of the diet. Polar bears also are hunted.

Economic opportunities in Kaktovik, on the Beaufort Sea coast, are limited due to the community's isolation, and unemployment is high. Most employment is in education, the NSB, or in providing city services. Part-time seasonal jobs, such as construction projects, also provide income.

For further details on the economy of the NSB, see the final EIS for Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a:Section.C.1).

III.G.1.b. Impact Assessment. Marine seismic-exploration activities themselves will not generate revenues for the NSB or local Alaskan Native communities, because all activities will occur in Federal waters of the OCS, far from shore. However, if the information collected during these seismic surveys leads to leasing of tracts in the Proposed Action area, NSB employment and personal income could be generated if further exploration, development, and production activities occur. In general, employment and associated personal income would be at a relatively low level in exploration, peaking during development, and dropping to a plateau in production.

The MMS concludes that the economic effect of the Proposed Action and associated alternatives are not greater than that analyzed in the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), specifically that the Proposed Actions would not exceed the threshold for economics. The threshold for the economy is defined as "economic effects that would cause important and sweeping changes in the economic well-being of the residents of the area or region. Local employment is increased by 20% or more for at least 5 years." The term "local employment" here means workers who are permanent residents of the NSB, both Inupiat and non-Inupiat, and does not include North Slope oil-industry workers who commute to residences within or outside of Alaska.

III.G. 2. Subsistence Environment.

The term "subsistence" has been defined differently by many (Caulfield and Brelsford, 1991; Bryner, 1995; Naiman, 1996; State of Alaska, DNR, 1997; Loescher, 1999), but generally, subsistence is considered hunting, fishing, and gathering for the primary purpose of acquiring traditional food.

The North Slope Borough Municipal Code (NSBMC) defines subsistence as: "an activity performed in support of the basic beliefs and nutritional needs of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities" (NSBMC 19.20.020 (67)). Harvest and consumption are merely the most visible aspects of such a system, and the most logical entry point for examining a social system with a subsistence ideology. The fundamental values of such societies are expressed in the *idiom* of subsistence, so that kinship, sharing, and subsistence-resource-use behaviors (i.e., preparation, harvest, processing, consumption, and celebration) become inseparable (Langdon and Worl, 1981; Elanna and Sherrod, 1984).

The Alaska National Interest Lands Conservation Act (ANILCA) provides the operational basis for defining the term subsistence in this analysis (even though it has been ruled to apply only to onshore Federal lands and waters in Alaska, and not to offshore waters) (USDOI, FWS, 1992; Hulen, 1996a,b). The ANILCA defines subsistence as the customary and traditional uses by rural Alaskan residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of nonedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter or sharing for personal or family consumption; and for customary trade (16 U.S.C. § 3113).

In addition to ANILCA, other legislative acts and regulatory actions relevant to the understanding of subsistence management of Federal lands include the Federal Subsistence Management Regulations (36 CFR 242 or 50 CFR 100; as summarized and available in USDOI, FWS [1992]), the Federal Advisory Committee Act, and the Federal Advisory Committee Management Regulations (41 CFR 101-6). The Marine Mammal Protection Act and Endangered Species Act also are pertinent, addressing the harvest of marine mammals, which currently is restricted to subsistence use by coastal Alaskan Natives.

Examples of subsistence resources potentially affected by OCS activities, including geophysical exploration using seismic surveys, are marine mammals (e.g., bowhead and beluga whales, seals, and walruses); fishes; caribou; and waterfowl.

III.G.2.a. Cultural Importance. "Subsistence" as a label incorporates a complex set of behaviors and values that extends far beyond the harvesting and consumption of wild resources, even though it is formally defined primarily in those terms. Worl (1979) and Nelson (1979) describe subsistence as a central focus of

North Slope personal and group cultural identity in addition to its primary economic role. Hopson (1976, 1978) establishes the political and ideological power of subsistence as an organizing concept for the NSB.

Subsistence activities are assigned the highest cultural values by the Inupiat and provide a sense of identity, in addition to being an important economic pursuit. Many species are important for the role they play in the annual cycle of subsistence-resource harvests, yet effects on subsistence can be serious, even if the net quantity of available food does not decline. Subsistence resources provide more than dietary benefits. They also provide materials for personal and family, use and the sharing of resources helps maintain traditional Inupiat family organization. The sharing, trading, and bartering of subsistence foods structures relationships among communities, while at the same time the giving of these foods helps maintain ties with family members elsewhere in Alaska. Subsistence resources also provide special foods for religious and social occasions; the most important ceremony, *Nalukataq*, celebrates the bowhead whale harvest.

Communities express their unique identities based on their enduring connections between current residents, those who used the areas in the past, and the wild resources of the land. Elders' conferences, spirit camps, and other information exchange and gathering events serve to solidify these cultural connections between generations, and between the people and the land and its resources.

III.G.2.b. Socioeconomic Importance. Many studies have examined the relationship between subsistence and wage economies and how both subsistence and wage activities are integrated into rural Alaskan socioeconomic systems. Although not always explicit, it is recognized that all rural communities and rural socioeconomic systems are not the same. One salient variable is the ethnic composition of the community, while another is the diversification of the local economy and the availability of wage employment. An extensive study series was conducted across a wide range of Alaskan communities during the 1980's that focused on local patterns of wild resource use as a component of the overall economy (Galginaitis et al., 1984; Reed, 1985; Sobelman, 1985; Impact Assessment, Inc., 1989; Stratton, 1989, 1990, 1992). Additional community-specific studies are cited in Fall and Utermohle (1999). Some of these communities are predominantly Alaskan Native, others are predominantly non-Alaskan Native, while others are more ethnically "mixed." Some have developed wage (or self-employment) economies; others have few such opportunities.

Within the NSB, both subsistence activities and wage economic opportunities are highly developed and highly dependent on each other (Kruse, Kleinfeld, and Travis., 1981; Kruse, 1982, 1991; Harcharek, 1995; Shepro and Maas, 1999). Those communities most active in subsistence activities tend to be those who also are very involved in the wage economy. That is, monetary resources are needed to effectively assist in the harvest of subsistence resources, both as they affect individual harvesters (e.g., to purchase a boat, snow machine, four-wheeler or all-terrain vehicle, fuel, and guns and ammunition) or as they affect the head of a collective crew (e.g., for whaling). However, full-time employment also limits the time a subsistence hunter can spend hunting to after-work hours. During midwinter, this window of time is further limited by waning daylight. In summer, extensive hunting and fishing can be pursued after work and without any limitations. As one North Slope hunter observed: "The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together." (ACI, Courtnage, and Braund, 1984).

III.G.2.c. Community Harvest Patterns and Traditions. Rural Alaskans Statewide harvest more than 40 million pounds (lb) of wild foodstuffs every year (Wolfe, 1996). They generally are rich in nutrients and contain more heart-healthy fats than many non-Native foods (Nobmann, 1997). According to 1990 estimates (Wolfe, 1996), the annual wild food harvest in rural Alaska was 375 lb per person, compared to 22 lb per person in urban Alaska. Assuming that, on average, 0.2 lb of wild food contains 44 grams of protein, and 2.94 lb of wild foods contains 2,400 kilocalories, the amount of wild food harvested in 1990 represented 243% of the rural population's protein requirements and 35% of the population's calorie requirement. In contrast, the food reportedly harvested by urban residents represented 15% of their protein requirements and 2% of their calorie requirements. Clearly, wild foods represent a major source of healthy foodstuff in rural Alaska.

Two major subsistence-resource categories occur on the North Slope: the coastal/marine and the terrestrial/aquatic. In the coastal/marine group, the food resources traditionally harvested are whales, seals, walruses, waterfowl, and fish. In the terrestrial/aquatic group, the resources sought are caribou, freshwater fishes, moose, Dall sheep, edible roots and berries, and furbearing animals. Generally, communities harvest resources most available to them. Harvests tend to be concentrated near communities, along rivers and coastlines, and at particularly productive sites. The distribution, migration, time of the year, and cyclical variation of animal populations make decisions on what, where, and when to harvest a subsistence resource very complex. Many areas might be used infrequently, but they can be quite important harvest areas when they are used (USDOI, BLM, 1978). For these reasons, harvest activities might occur anywhere in the Arctic PEA project area.

How a village uses any particular species can vary greatly over time, and data from short-term harvest surveys often can lead to a misinterpretation of use/harvest trends. For example, if a particular village did not harvest any bowhead whales in one year, whale use would go down; consequently, consumption and use of caribou and other species likely would go up. If caribou were not available one winter, other terrestrial species could be hunted with greater intensity. The overall harvest of animal resources, such as marine and terrestrial mammals and fish, is heavily emphasized in the NSB; but when compared to other more southern areas used for subsistence by other non-NSB communities, the total spectrum of available resources in the NSB-region is limited.

While subsistence-resource harvests may differ from community to community, the resource combination of caribou, bowhead whales, and fish is the primary grouping of resources harvested in the NSB. Caribou is the most important overall subsistence resource in terms of hunting effort, quantity of meat harvested, and quantity of meat consumed. The bowhead whale is the preferred meat and the subsistence resource of primary importance, because it provides a unique and powerful cultural basis for sharing and community cooperation (Stoker, 1984, as cited by ACI, Courtnage, and Braund, 1984). In fact, the bowhead could be said to be the foundation of the sociocultural system in the NSB. Depending on the community, fish is the second or third most important resource after caribou and bowhead whales. Bearded seals and various types of birds also are considered primary subsistence species. Waterfowl are particularly important during the spring, when they provide variety to the subsistence diet. In the late 1970's when bowhead whale quotas were low and the Western Arctic herd of caribou crashed (and the Alaska Board of Game placed bag limits on them), hunters turned to bearded seals (*ugruk*), ducks, geese, and fish to supplement the subsistence diet (Atqasuk could only turn to the last three resources) (Schneider, Pedersen, and Libbey, 1980). Seal oil from hair seals and bearded seals is an important staple and a necessary complement to other subsistence foods.

The subsistence pursuit of bowhead whales has major importance to the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope (some Point Lay men whale with crews from Wainwright, and some Atqasuk men whale with Barrow crews). The sharing of whale *muktuk*, or fat, and whale meat is important to the inland community of Atqasuk and continues to be the most valued activity in the subsistence economy of these communities. This is true, even in light of harvest constraints imposed by quotas from the International Whaling Commission (IWC); relatively plentiful supplies of other resources such as caribou, fish, other subsistence foods; and the availability of retail grocery foods. There are regional exceptions to the bowhead whale-harvest tradition. In Point Lay, the beluga whale harvest is the mainstay of the community, and most Chukchi Sea communities rely more heavily on the harvest of walrus and seals than do Beaufort subsistence communities.

Whaling traditions include kinship-based crews, use of skin boats (only in Barrow and Point Hope—aluminum boats have almost entirely replaced skin boats for Wainwright's spring hunt) for their spring whale-hunting season, distribution of the meat, and total community participation and sharing. In spite of the rising cash income, these traditions remain as central values and activities for all Inupiat on the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Inupiat heritage, culture, and way of life. Thus, whale-hunting activities provide strength, purpose, and unity in the face of rapid change. In terms of the whale harvest, Barrow is the only community within the planning area that harvests whales in the spring and fall. Wainwright and Point Hope whale only during the spring season and the communities of Kaktovik and Nuiqsut whale only during the fall season, although some

Nuiqsut hunters travel to Barrow to join Barrow whaling crews during the spring whaling season (North Slope Borough, 1998; Alaska Consultants Inc. and S.R. Braund and Assocs., 1984).

An important shift in community-harvest patterns occurred in the late 1960's, when the substitution of snowmachines for dogsleds decreased the importance of ringed seals and walruses as key sources of dog food and increased the relative importance of waterfowl. This shift illustrates how technological or social change can lead to the modification of subsistence practices. Because of technological and harvest-pattern changes, the dietary importance of waterfowl also may continue to increase. However, these changes would not affect the central and specialized dietary roles that bowhead whales, caribou, and fish—the three most important subsistence-food resources to North Slope communities—play in the subsistence harvests of Alaska's Inupiat, and for which there are no practical substitutes. The subsistence resources used by and harvest patterns of the NSB communities is described in Appendix C. The harvested resources used by NSB communities are identified by common species name, Inupiaq name, and scientific name in the Northwest National Petroleum Reserve-Alaska final EIS (USDOI-BLM and MMS, 2003:Table III.G.1).

III.G.2.d. Concerns about Climate Change. In the NSB, a factor of increasing concern is the potential for adverse effects on subsistence-harvest patterns and subsistence resources from habitat and resource alterations due to the effects of global climate change. The Council on Environmental Quality considers that there is adequate scientific evidence indicating that climate change is a "reasonably foreseeable" impact of greenhouse gas emissions (Council on Environmental Quality, 1997; IPCC, 2001a,b). The Alaskan Native communities have settled in particular geographic locations because of their proximity to important subsistence food resources and dependable sources of water, shelter, and fuel. These communities and their subsistence practices will be stressed to the extent that these following observed changes continue:

- settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise;
- traditional hunting locations are altered;
- subsistence travel and access difficulties increase; and
- game patterns shift, and their seasonal availability changes.

Large changes or displacements of resources would require subsistence communities to adapt quickly or move (Langdon, 1995; Callaway, 1995; *New Scientist*.com, 2002; Parson et al., 2001; AMAP, 1997; *Anchorage Daily News*, 1997; Weller, Anderson, and Nelson, 1998; IPCC, 2001a). Great decreases or increases in precipitation could affect local village water supplies, shift the migration patterns of land mammals, alter bird breeding and molting areas, affect the distribution and abundance of anadromous and freshwater fish, and limit or alter subsistence access routes (particularly in spring and fall) (AMAP, 1997). Changes in sea ice could have dramatic effects on sea mammal-migration routes and this, in turn, would impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al., 1999; Bielawski, 1997). Between 1980 and 2000, three sudden ice events caused Barrow whalers to abandon their spring whaling camps on the ice lead (George et al., 2003; National Assessment Synthesis Team, 2000; Groat, 2001).

III.G.2.e. Impact Assessment Overview. The coastal environment of the Beaufort and Chukchi seas contains important populations of whales, pinnipeds, fishes, and birds valued by subsistence hunters in the region. In the Beaufort Sea, river deltas, especially the Colville and McKenzie deltas, are important subsistence-resource areas, as is the barrier island environment. In the Chukchi Sea, pivotal habitats include the Chukchi polynya open-water lead system (important to migrating whales, other sea mammals, and birds); the shores and offshore waters of Capes Lisburne, Lewis, and Thompson (for seabirds); Ledyard Bay (for seabirds); Skull Cliff Kelp Beds (important marine habitat); Kasegaluk Lagoon (for nonsalmonid anadromous fish; birds, beluga whales, and spotted seals); Peard Bay (for birds, anadromous fish, spotted seals, and belugas); Kuk River Inlet (for anadromous fish); Pitmega River and Thetis Creek deltas (for birds); and Point Hope Spit (for migrating birds). Cape Lisburne is an important walrus haulout site—the only major haulout site on the eastern Chukchi coast (Braund and Burnham, 1984).

All of the aforementioned biological resources could, to varying degrees, be impacted by geophysical seismic-exploration activities. As discussed in earlier sections (III.F.1-4, Biological Resources) of this

PEA, vessel movements and traffic (seismic vessel, support vessels, ice-management vessel, etc.) and high-energy sound sources generated by the seismic-airgun arrays could adversely affect the biological resources of the Chukchi and Beaufort seas, including those depended on by Alaskan Natives for subsistence, if protective mitigation measures are not incorporated in to seismic operation plans.

Potential effects from seismic noise and associated vessel movements could affect whaling, sealing, bird hunting, and fishing in the spring and open-water season. Access to subsistence resources, subsistence hunting, and the use of subsistence resources also could be affected by reductions in subsistence resources and changes in subsistence-resource-distribution patterns (USDOI, MMS, 1987:2001).

III.G.2.e(1) Subsistence-Harvest Patterns. To understand effects on subsistence-harvest patterns, it is important to recognize three major conditions for regional communities: (1) they rely heavily on sea mammals, particularly bowhead and beluga whales, walruses, bearded seals, and fishes in the annual average harvest; (2) community subsistence-hunting ranges overlap for many species harvested; and (3) subsistence hunting and fishing are central cultural values in the Inupiat way of life.

Subsistence land use and harvest patterns often are different among villages because of differences in access to game and fish, village size, and traditional patterns of use. For example, bowhead whales generally are accessible to hunters only at Point Hope, Wainwright, and Barrow; cliff-nesting seabirds and eggs are available only near Point Hope. Barrow, situated where the Chukchi and Beaufort seas meet, has access to resource bases from each environment (Becker, 1987).

Because primary subsistence resources are migratory, the extent of potential impacts from oil exploration on subsistence hunting largely depends on the time of year that specific activity occurs and the location. Subsistence activities are concentrated in time and space. Should exploration activities be coincident in time and space such that subsistence animals are frightened away or hunter access to the animals is hindered, the subsistence-hunting effort may not provide the expected returns (Becker, 1987). For example, seismic-survey activities that coincide in time and space with the use of the lead system by these animals and subsistence hunters could have potential detrimental effects (Braund and Burnham, 1984). The spring lead system in the Chukchi Sea is the only dependable open water available in spring; it is vital to subsistence hunters who hunt bowhead and beluga whales in the leads and seals, walruses, and other marine mammals that inhabit the retreating ice.

For more than 30 years, representatives of the NSB, the Alaska Eskimo Whaling Commission (AEWC), the Northwest Arctic Borough, local tribal and city governments, and individual subsistence hunters have made their concerns clear about the potential impact of OCS exploration and development activity in the form of a list of community-specific issues: bowhead whales (problems related primarily to noise); interference with the spring hunt; seaward displacement of the fall migration route. Hunters believe this displacement has happened before and can happen again and that noise—especially that associated with seismic exploration—can push whales seaward by the time they get to Barrow (Becker, 1987; USDOI, MMS, 1987d, 1990b, 1997, 2003a, 2004).

III.G.2.e(2) Subsistence Resources. The animals commonly hunted by Natives in Chukchi and Beaufort sea coastal communities are bowhead and beluga whales; walruses; bearded, ringed, and spotted seals; polar bears; anadromous and marine fishes; waterfowl; and seabirds. The species hunted by each village depend mainly on proximity of harvestable populations to each village and secondarily on harvest tradition (Becker, 1987; USDOI, MMS, 1987d, 1990b, 1995a, 2003a, 2005).

III.G.2.e(2)(a) Bowhead Whales. Bowhead whales can respond to noise and disturbance in a manner that would adversely affect the hunting of this species. Seismic surveys and associated vessels and helicopter traffic to and from the vessels have the potential to disturb these animals and displace them from normal migration patterns; such disturbance could disrupt the subsistence harvest. Generally, spring-lead whaling is done very quietly in man-powered skin boats. Gaining access to leads suitable for bowhead hunting dictates the success of North Slope whale hunters, and this access can be hindered by double leads, young ice, changing weather conditions, and fairly recent changes in ice thickness and extent brought on by changing climatic conditions in the Arctic (Braund and Burnham, 1984; USDOI, MMS, 1987d).

If a seismic survey or support vessel were in the path of a whale chase, it could cause that particular harvest to be unsuccessful. Animals tend to avoid areas of high noise and disturbance and, thus, could become unavailable to a particular community or become more difficult to harvest. Short-term effects, such as flight behavior or increased wariness, also may make animals difficult to harvest. Noise and traffic disturbance from seismic survey vessels and non-seismic survey-related icebreakers in or near the bowhead whaling area could cause bowhead whales to move into the broken-ice zone and offshore leads inaccessible to the Inupiat hunters or under the pack ice and become unavailable to hunters. This displacement could have a major impact on local access and harvest success of bowhead whales. In plentiful ice years, the length of the whaling season still might allow a successful hunt; in a year when poor weather and ice conditions shortened the whaling season, such an occurrence could cause the harvest to be reduced. Because seismic survey activity is not planned until after July 1 and conflict avoidance measures are expected to be in place, such conflicts during the spring whaling season are not expected (Braund and Burnham, 1984; USDOI, MMS, 1987d, 1990b, 1995a, 2003a, 2005).

Recent acoustic studies indicate that bowheads showed behavioral changes from recorded drilling and icebreaker noise at levels 20 dB or more above ambient levels. Whales could react to nonseismic-survey-related icebreaking noise at distances ranging from 2-25 km (USDOI, MMS, 2006).

III.G.2.e(2)(b) Beluga Whales. Beluga whales are sensitive to noise and may be displaced from traditional harvest areas by heavy boat traffic or seismic survey noise. This disturbance response, even if brief might temporarily interrupt the movements of belugas or temporarily displace some animals when the vessels pass through an area. Such events could especially interfere with beluga movements to and from the lagoon areas, particularly Kasegaluk Lagoon where Point Lay hunts belugas; this harvest is concentrated during a few weeks in early July. Reducing or delaying the use of these habitats by belugas could affect their availability to subsistence hunters. Additionally, there is evidence that belugas will accommodate or acclimate to a particular pattern of noise after extensive exposure, and such acclimation also could affect Inupiat hunter access. For example, Point Lay residents rely on the harvest of belugas more than any other Chukchi Sea village and, at the present time, they are very successful at herding these animals by boat into Kasegaluk Lagoon where they are then hunted. If noise from boat traffic and seismic survey activity increased and the belugas acclimated to the noise, there is the possibility that this herding technique would be less successful and the hunt reduced (Braund and Burnham, 1984; USDOI, MMS, 1987d, 1995a, 1998).

In other coastal communities, belugas are harvested in the pack-ice leads in the early summer. Because the beluga-hunting season for Kaktovik, Barrow, Wainwright, and Point Hope takes place under two different conditions (in ice leads and in open water) and hunting is possible at different times over a 6-month period (late March-September), noise and traffic disturbance would be expected to have lesser effects; still, repeated vessel passes close (within 1-4 km) to both hunters and cetaceans could disturb the whale hunt. At present, the beluga is not intensively hunted by Barrow, Nuiqsut, or Kaktovik (USDOI, MMS, 1987d, 1990b, 1998, 2003a).

III.G.2.e(2)(c) Seals. Effects of noise and disturbance on seals are likely to have less important subsistence use effects than is the case with whales. Icebreakers could briefly disrupt some seal concentrations for up to a few days within a lead system, temporarily interrupt their movements, or temporarily displace some animals when the vessels pass through the area. However, there is no evidence to indicate that vessel traffic would block or significantly delay their migrations. Such traffic is not likely to have more than short-term effects on migrations or distributions; but the displacement of pinnipeds, polar bears, and beluga whales could affect the availability of these animals to subsistence hunters for that season. These short-term, localized effects on seals could negatively affect localized subsistence hunting areas but probably not affect overall annual harvest levels, and seals would not become unavailable during the year. Generally, the seal-harvest period is longer than for whales and allows residents to harvest seals during more times during the year (USDOI, MMS, 1987d, 1990b, 1995a, 1998, 2003a).

III.G.2.e(2)(d) Walrus. Impacts to walrus subsistence-harvest activities are most likely to occur during summer when the animals migrate from the Bering Sea into the Chukchi Sea. Walrus hunting is concentrated in each community’s subsistence-resource area during the open-water months, primarily from late May and early June through the end of August. Peard Bay is preferred by Barrow and Wainwright residents to harvest walruses. Helicopter traffic and seismic survey noise at this time could disturb walruses resting on ice pans, although it is not expected to affect walrus migration or distribution patterns. The common method Eskimos use to hunt walruses is to approach the herds as they rest on ice pans in the broken-ice margin of the pack ice. If increased seismic survey noise caused the dispersal of these herds, hunting success of local residents could be detrimentally affected. Noise and disturbance from aircraft could have localized, short-term effects that would cause some disruption to the harvest but would not cause walruses to become unavailable to subsistence hunters. Noise and disturbance from seismic survey boats and other vessels could be a problem, if boat traffic moved near marine mammal-haulout areas. Because seismic survey activities would are not planned until after July 1 and would avoid areas of high ice concentration, conflicts with the subsistence walrus hunt are not expected. The walrus hunt is much more important in Chukchi Sea subsistence communities; it should be noted that the subsistence walrus hunt in Nuiqsut and Kaktovik in recent years has not been intensive (USDOI, MMS 1987d, 1990a, 1995a, 1998, 2003a).

III.G.2.e(2)(e) Waterfowl. The impacts of noise and disturbance in offshore areas on waterfowl could disturb waterfowl-feeding and nesting activities, but these low-level biological effects are expected to be periodic and short term and not have significant effects on bird harvesting by coastal subsistence communities. Kaktovik resident Mike Edwards stated in public testimony that he thought noise would adversely affect the waterfowl--an important springtime source of food (Edwards, 1979, as cited in USDOI, BLM, 1979a; Braund and Burnham, 1984; USDOI, MMS, 1987d, 1990b, 1995a, 1998).

III.G.2.e(2)(f) Fish Resources. The impacts of noise and disturbance in offshore areas on fish harvests likely would be minimal, although the increased noise potential of six concurrent seismic surveys (especially ocean-bottom-cable surveys in shallower waters nearshore) could displace and disturb fish migrations and distributions and potentially “herd” them away from traditional subsistence fishing areas (Braund and Burnham, 1984; USDOI, MMS, 1987d, 1990b, 1995a).

III.G.2.e(2)(g) Polar Bear. Active seismic survey activities are likely to result in startle responses by polar bears near the sound source. As with other vessel traffic, this disturbance response is likely to be brief, and affected animals are likely to return to normal behavior patterns within a short period of time after seismic vessels have left the area. Polar bears could experience short-term, localized aircraft-noise disturbance-effects that would cause some disruption in their harvest, but this is not expected to affect annual harvest levels. Icebreaker noise would result only in short-term, local displacement on polar bear migrations and distributions, but such displacement could affect the availability of polar bears to subsistence hunters for that season. Because seismic-survey activities would are not planned until after July 1 and would avoid areas of high ice concentration, conflicts with the subsistence polar bear hunt are not expected. (USDOI, MMS 1987d, 1998, 2003a).

III.G.2.e(3) Traditional Knowledge. Inupiat concern over seismic-survey disturbance is well documented. Don Long from Barrow stated: “Any disruption, whether it be oil spill or noise, would only disturb the normal migration [of bowhead whales], and a frightened or a tense whale is next to impossible to hunt” (Long, 1990, as cited in USDOI, MMS, 1990c). Barrow resident Eugene Brower had similar fears about seismic-survey disturbance, believing that noise associated with drilling, seismic survey, and other exploration activities will disturb the migration of the bowhead whales (Brower, 1995, as cited in USDOI, MMS, 1995a). The late Burton Rexford, then Chairman of the AEWC, described seismic-survey effects on whales in a 1993 symposium on Native whaling this way:

> …I had the…experience in Barrow in 1979, 1980, and 1981 of geophysical seismic work in the ocean, and it’s a ‘no-no’ to a hunter during the whaling migration. I know from experience. There were three of us captains that went out whaling in the fall. In those three years, we didn't see one bowhead whale, and we saw no gray whales, no beluga, and no bearded seal. We traveled as far as 75 miles away from our home on the ocean waters in those three years (McCartney, 1995; USDOI, MMS, 1998).

Nuiqsut whaling captain, Frank Long, Jr., stated that oil-industry activity offshore has affected not only whales but also seals and birds (Long, as cited in NMFS, 1993). Expressing concern about aircraft disturbance, a Nuiqsut resident and whaling captain said in recent testimony for an offshore lease sale that seismic traffic and helicopter overflights "were the cause of whales migrating farther north out to the ocean, 20 miles farther north than their usual migration route" (USDOI, MMS, 1995b). Earlier, Patsy Tukle from Nuiqsut had expressed this same sentiment. He explained that ships and helicopters are interfering with whale hunting, even though they are not supposed to. He affirmed the need to enforce controls so whaling may go on unimpeded (Tukle, 1986, as cited in USDOI, MMS, 1986a; USDOI, MMS, 2003a).

The late Thomas Napageak, former whaling captain, President of the Native Village of Nuiqsut, and AEWC Chairman, related in 1979 that he had not seen one whale while going to Cross Island every year and believes it is the result of seismic activity in the area (Napageak, 1979, as cited in USDOI, BLM, 1979b). Maggie Kovalsky from Nuiqsut, testifying in 1984 on Endicott development, explained that with all the noise and activities, bowhead whales that migrate not far from that area all the way to Canada probably will be hurt (Kovalsky, 1984). In a Statewide survey by the Alaska Department of Fish and Game, Division of Subsistence from 1992-1994, 86.7% of the respondents in Nuiqsut believed that there were fewer marine mammals as a result of exploration activities on the outer continental shelf (State of Alaska, Dept. of Fish and Game, 1995). At a village meeting for the Northstar Project in 1996, Nuiqsut residents said they feared effects from the project, because it was in the migratory path of the bowhead whales. They made it clear that seismic surveying and transportation noise are of primary concern to Beaufort Sea residents because of their impacts on bowhead whales (Dames and Moore, 1996; USDOI, MMS, 2003a).

The MMS is conducting long-term environmental monitoring in the region and, as part of this effort, has conducted a multiyear collaborative project with Nuiqsut whalers that describe present-day subsistence whaling practices at Cross Island to empirically verify any changes to whaling due to weather, ice conditions, and oil and gas activities. After the first field season of monitoring in 2001, Nuiqsut whalers reported the following changes in whale behavior and whaling practices: fewer whales in smaller groups were seen; the need to travel farther from Cross Island to find whales; whales observed were more skittish than in previous years and stayed more in the ice than in open water, spent more time on the surface, and followed more unpredictable paths underwater; whales were more difficult to spot because blows were not as observable as in past years; and whales appeared to be skinnier (**Note**: there was no OCS seismic activity that year). Possible causes suggested by the whalers for these behavioral changes were: offshore seismic survey work for the natural gas-pipeline route; barge supply traffic to Kaktovik for a water- and sewer-construction project; the presence of killer whales offshore and to the east of Cross Island; ice conditions in Canadian waters; air and water traffic to the east of Cross Island; and general poor weather (Galginaitis, 2004, 2005; USDOI, MMS, 2003a).

Herman Rexford from Kaktovik recounts that oil ships affect the migration of the whales. He would like to see no ships or exploration off of Kaktovik during the fall whaling time. He knows that the ships are noisy and can affect whaling routes (Rexford, 1986, as cited in USDOI, MMS, 1986b). Herman Aishanna, former Kaktovik vice-mayor, recounted that "tugs make a lot of noise in the summertime" (Aishanna, 1996, as cited in Dames and Moore, 1996). The late Barrow elder, Thomas P. Brower, Sr., began whaling in 1917 as a boy. He stated in a 1978 interview that:

> The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In the fall, we have to go as much as 65 miles out to sea to look for whales. I have adapted my boat's motor to have the absolute minimum amount of noise, but I still observe that whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration, the bowheads travel in pods of 60 to 120 whales. When they hear the sound of the motor, the whales scatter in groups of 8 to 10, and they scatter in every direction (NSB, Commission on History and Culture, 1980; USDOI, MMS, 2003a).

The Bowhead Whale Feeding in the Eastern Beaufort Sea Study: Update of Scientific and Traditional Information, contracted by MMS, recorded a great deal of traditional knowledge of the local Kaktovikmiut (Kaktovik) whalers. Whaling knowledge pointed out the following: The historic core whaling area extends from the Hulahula River in the west to Tapkaurak Point in the east and offshore as far as 20 mi; most whales are taken within 18-19 mi of the village; the mean distance of harvest locations from Kaktovik has not changed from the 1970's to the present; whaling captains select small whales over large whales; whalers have noted a significant decrease in the average size of whales harvested from the 1970's to the present; two whale-feeding areas are traditionally recognized, one to the east in the Demarcation Point/Icy Reef area and the other near Arey Island west of Kaktovik; whales can occur near Kaktovik in July and August, although they are more common in Canadian waters at this time; and Kaktovik's main hunting period for bowheads is in September, but whales can remain near Kaktovik as late as mid-October (Richardson and Thomson, 2002; USDOI, MMS, 2003a).

According to the late Burton Rexford, former chairman of the AEWC: "Loud noises drive the animals away.... We know where whales can be found; when the oil industry comes into the area, the whales aren't there. It is *not* the ice; it is the noise" (NMFS, 1993; USDOI, MMS, 1998).

In a March 1997 workshop on seismic survey effects conducted by MMS in Barrow, Alaska, with subsistence whalers from the communities of Barrow, Nuiqsut, and Kaktovik, whalers agreed on the following statement concerning the "zone of influence" from seismic survey noise: "Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles" (USDOI, MMS, 1998).

III.G.2.e(4) Conclusions. Noise and disturbance impacts would be associated with the seismic surveys that are described in the scenario, with up to six permits issued in each of the Chukchi and Beaufort Sea action areas. Up to six concurrent 2D/3D seismic surveys could operate in each action area. Surveys would not be allowed in the Chukchi Sea until July 1, unless authorized by NMFS, and could continue until conditions make it impossible to conduct surveys; the Beaufort Sea season would begin in July and, depending on ice conditions, extend into late October. Ocean-bottom-cable surveys could occur in the shallower State of Alaska waters of the Beaufort Sea. Six additional vessels (one of which could be used for ice management in emergency situations), would serve as support vessels for the six seismic-survey vessels. Helicopters also would be used for vessel support and crew changes. No estimates have been developed for the expected number of line miles of seismic survey to be done or the number of helicopter support flights that might be needed.

Because the spring subsistence-whale hunt in the communities of Point Hope, Wainwright, and Barrow would be concluding by the time seismic activities begin in the Chukchi Sea region, adverse noise effects on the spring whale harvest are not anticipated.

The greatest potential disruption of the subsistence whale hunt would be expected in the traditional bowhead whale-hunting areas for Kaktovik, Nuiqsut, and Barrow, where multiple seismic-survey operations could deflect whales away from traditional hunting areas. Conflict avoidance agreements between the AEWC and oil operators conducting one or perhaps two seismic-survey operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities, but the magnitude of six concurrent seismic surveys would test the ability of survey operators and whalers to coordinate their efforts to prevent disruptions to the hunt.

Barrow's fall bowhead whale hunt could be particularly vulnerable. Noise effects from multiple seismic surveys to the west in the Chukchi Sea and to the east in the Beaufort Sea potentially could cause migrating whales to deflect farther out to sea, forcing whalers to travel farther—increasing the effort and danger of the hunt—and increasing the likelihood of whale-meat spoilage, as the whales would have be towed from greater distances. Barrow's fall hunt is particularly important, as it is the time when the Barrow whaling effort can "make up" for any whales not taken by other Chukchi Sea and Beaufort Sea whaling communities. These communities give their remaining whale strikes to Barrow, hoping that Barrow whaling crews will successfully harvest a whale and then share the meat back with the donating community. This practice puts a greater emphasis on the Barrow fall hunt. Additionally, a changing spring-lead condition—ice becoming thinner in recent years due to arctic warming—have made the spring hunt more problematic and makes the fall hunt even more pivotal in the annual whale harvest for all communities in the region. Thus, any disruption of the Barrow bowhead whale harvest could have significant effects on regional subsistence resources and harvest practices (USDOI, MMS 1987d; Brower, 2005).

Beluga whales, when in confined areas such as spring leads or lagoons, are potentially sensitive to noise; however, when not restricted they appear not to be particularly sensitive. If boat traffic moved north and south along the coast very near Kasegaluk Lagoon and interfered with beluga whale or spotted seals movements to and from the lagoon, such disturbance could compromise the Point Lay subsistence effort. Icebreaking activities (which would only occur if a seismic-survey vessel working the Beaufort Sea became stuck in the ice in the fall) has been demonstrated to disturb beluga whales at much greater distances than bowhead whales. In summer, if vital lagoons and bays used by beluga whales and spotted seals, and a walrus haulout site near Cape Lisburne are not avoided by seismic-survey vessels, local harvests could be compromised. Any displacement of the local movements of whales, seals, and walruses by seismic survey noise could disturb the subsistence-harvest of a particular species. If multiple surveys were done in close proximity to each other, seismic survey noise could displace fish species, making them more difficult to harvest.

Barrow whaler Gordon Brower, stated in his comments on MMS' 2007-2012 Proposed 5-Year Leasing Program:

> Barrow whalers and Nuiqsut whalers have encountered 'unacceptable levels' of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Inupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Inupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season's events. Our culture is surrounded by the whale (Brower, 2005).

Even though the potential of up to six concurrent surveys being conducted in the 2007 open-water season in the Chukchi and the Beaufort seas is low, the additive and synergistic noise impacts produced by more than a single seismic survey would indicate an acoustic environment where clearly much more than a single sound event and a "low level" of activity is occurring; thus the approach of considering seismic-survey noise as a short-term and local disturbance phenomenon to these species could be considered too simplistic.

Given the level of potential seismic-survey activity described in the scenario—six concurrent seismic surveys in both the Chukchi and Beaufort seas—and past assessments of species and resource effects discussed above, whales, pinnipeds, and polar bears might be displaced and their availability affected for an entire harvest season, potentially causing significant impacts. Protective mitigation measures incorporated into the proposed alternatives and seismic-survey permits and plans of cooperation (e.g. Conflict Avoidance Agreements) measures are expected to ensure that no unmitigable adverse effects to subsistence resources and harvest practices would occur.

III.G.2.f. Impacts of Alternatives on Subsistence-Harvest Patterns.

III.G.2.f(1) Alternative 1 (No Action). The MMS would not approve seismic-survey-permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic-survey methodologies. Because no seismic activity would occur, no impacts to subsistence resources and practices would be expected.

III.G.2.f(2) Alternatives 3, 4, 5, 6, 7, and 8. Alternatives 3, 4, 5, and 6 all would have similar impacts on subsistence harvests. The following discussion pertains to all these alternatives unless otherwise indicated. Seismic surveys for prelease geophysical exploration activities would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures for marine mammals, including an isopleth-specified exclusion zone. These alternatives would permit seismic surveys in the Beaufort and Chukchi seas and incorporate standard G&G-permit stipulations and additional protective measures to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. An inability to effectively perform mitigation measures would result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated. Theoretically, the larger the safety/exclusion zone, coupled with shut-down procedures, the greater protection is afforded marine mammals from potential harassment and injury. Therefore, the 120-dB isopleth-zone would afford more protection from harassment and injury for marine mammals than the 180/190-dB isopleth-zone alone. The more marine mammals are protected, the more subsistence-harvest activities are protected.

Alternative 3 with its 120-dB safety zone would provide the greatest protection for all species of whales, bowhead cow/calf pairs, and other marine mammals and would be the preferred alternative for maximum protection of biological resources.

Alternative 8 with its 180/190-dB exclusion zone for marine mammals, its 160-dB monitored safety zone for feeding whales and the implementation of specific temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (e.g. Conflict Avoidance Agreement) negotiation process and mitigate the stress on the AEWC and Whaling Captains' Associations who are generally forced to advocate for such provisions very late in the permitting process.

The following section discusses mechanisms for protecting subsistence-harvest activities from the possible impacts associated with the Proposed Action's alternatives. An operator could propose to conduct seismic-survey activity in an area critical to whaling during the whaling season; however, if this condition did occur, potential conflict could be mitigated by the cessation of activities during the whale migration. Because fall ice conditions are not predictable events, user conflicts between vessels and whalers due to bad ice conditions might be more difficult to mitigate. This problem has been reported once for the Alaskan Arctic. In fall 1985, extreme ice conditions curtailed the length of Kaktovik's whaling season and, at the same time, caused vessels traveling to their overwintering sites to operate near whaling locations (Smythe, 1987**,** pers. commun., as cited in USDOI, MMS, 1990a). As a result of this conflict, a cooperative program was formed in 1986 between the NSB, the AEWC, the Nuiqsut and Kaktovik whaling captains, and those petroleum companies interested in conducting geophysical studies and activities in the Beaufort Sea. This program was approved through a Memorandum of Understanding between NOAA and the AEWC pursuant to the 1983 Cooperative Agreement, as amended. The 1986 Oil/Whalers Working Group established a communication system and guidelines to assure that industry vessels avoided interfering with or restricting the bowhead whale hunt and to establish criteria whereby the oil industry would provide certain kinds of assistance to the whalers. The program was successful for 2 years; however, it has been discontinued due to some difficulties with the communication systems and equipment. The Oil/Whalers Working Group cooperative program was a good example of how interference with a subsistence harvest can be effectively mitigated. In the absence of such mitigation, such a curtailment of the whale-harvest season due to noise could cause bowhead whales to become locally unavailable for the harvests in Kaktovik, Nuiqsut, Barrow, Wainwright, and Point Hope (USDOI, MMS, 1990b).

Presently, individual companies coordinate with the whalers through the auspices of the AEWC. Such coordination was a requirement under MMS leases for Beaufort and Chukchi Sea Sales 97,109, 144, 170, 186, and 195. The working protocol is for the company to submit a plan of cooperation as a part of their exploration plan. Seismic surveying requires submission of a letter stating that cooperation will occur.

The MMS, along with industry, their contractors, scientists, the NSB Mayor's Office, the NSB Wildlife Management Department, and the AEWC, participate in the NMFS annual Peer Review Workshop to address monitoring issues as they relate to the NMFS administration of its responsibilities for ESA and Incidental Harassment Authorization (IHA) processes under the Marine Mammal Protection Act. Workshop participants review the results of monitoring efforts to determine the impacts of industry activities on marine mammals in the Beaufort Sea and review monitoring plans for the upcoming field season. Required mitigation similar to the lease-specific Stipulations No. 4 - Industry Site-Specific Bowhead Whale-Monitoring Program and Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities and conflict avoidance measures defined in an IHA would specify any noise-monitoring program for marine mammals required for ongoing seismic operations in the Chukchi Sea and would be considered through the Peer Review Workshop meetings. Any potential monitoring program would be designed to: (1) assess when bowhead and beluga whales, walrus, and bearded seals are present in the vicinity of potential operations and the extent of behavioral effects on these species due to operations; (2) consider the potential scope and extent of impacts that the particular type of operation could have on these species; and (3) address local subsistence hunters' concerns and integrate Inupiat traditional knowledge (USDOI, MMS, 2003a).

Other coordination meetings concerning noise impacts included the Arctic Seismic Synthesis Workshop in Barrow in 1997, hosted by MMS that brought together Native whalers, the oil industry, and acoustic scientists to discuss the issue of the distance at which bowheads are deflected from their normal migration path by seismic noise. Whaling captains collectively presented information on distances at which bowhead whales reacted to seismic vessels. Other concerns raised by local subsistence hunters that pertain to potential seismic-noise impacts include: (1) developing a plan for minimizing the number of sealifts and making sure they are completed before the fall subsistence whaling season begins; and (2) developing a plan that ensures that local/Native observers are present during seismic activity to monitor for potential noise disturbance to marine mammals (USDOI, MMS, 2003a). Because the permittee is seeking a Letter of Authorization (LOA) or IHA for incidental take from the NMFS, the monitoring program and review process required under the LOA or IHA generally will satisfy the requirements of Stipulations 4 and 5.

Mitigation similar to the lease-specific Stipulation No. 5 - Conflict Avoidance Mechanisms to Protect Subsistence Whaling and Other Subsistence Activities is proposed, where seismic survey operations will be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).

Mitigation would include submitting a plan to the MMS for activities proposed during the bowhead whale-migration period and consulting with the directly affected subsistence communities, Kaktovik, Nuiqsut, Barrow, Wainwright, Point Hope, Kivalina, the NSB, and the AEWC to discuss potential conflicts with the timing and methods of proposed operations and the safeguards or other measures that would be implemented by the operator to prevent unreasonable conflicts.

Through this consultation, the seismic-survey operator would make every reasonable effort, including such mechanisms as drafting a conflict avoidance agreement, to ensure that exploration activities are compatible with whaling and other subsistence-hunting activities and will not result in unreasonable interference with subsistence harvests. A discussion of resolutions reached during this consultation process and plans for continued consultation will be included in the exploration plan or permit. In particular, the permittee will show in the plan how its activities, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities.

The seismic-survey operator also would include a discussion of multiple or simultaneous operations, such as seismic activities, that can be expected to occur during operations to more accurately assess the potential for any cumulative effects. Communities, individuals, and other entities who were involved in the consultation will be identified in the plan. The Regional Supervisor (RS) shall send a copy of the plan to the directly affected communities and the AEWC at the time they are submitted to the MMS to allow concurrent review and comment as part of the plan approval process. In the event no agreement is reached between the parties, the permittee, the AEWC, the NSB, the NMFS, or any of the subsistence communities that could be affected directly by the proposed activity may request that the RS assemble a group consisting of representatives from the subsistence communities, AEWC, NSB, NMFS, and the permittee(s) to specifically address the conflict and attempt to resolve the issues before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests.

On request, the RS will assemble this group if the RS determines such a meeting is warranted and relevant before making a final determination on the adequacy of the measures taken to prevent unreasonable conflicts with subsistence harvests. The permittee shall notify the RS of all concerns expressed by subsistence hunters and of steps taken to address such concerns. Permittee-related use will be restricted when the RS determines it is necessary to prevent unreasonable conflicts with local subsistence-hunting activities. In enforcing this stipulation, the RS will work with other agencies and the public to ensure that potential conflicts are identified and efforts are taken to avoid these conflicts.

This stipulation, which has evolved from the Oil/Whaler Cooperative Program required in Sale 97, has been adopted in all Beaufort Sea sales since Sale 124, although the wording and requirements of the stipulation have changed over time. This stipulation helps reduce potential conflicts between subsistence hunters and whalers and potential oil and gas activities. This stipulation helps to reduce noise and disturbance conflicts from exploration operations during specific periods, such as the annual spring and fall whale hunts. It requires that the lessees meet with local communities and subsistence groups to resolve potential conflicts. This stipulation reduces the potential of adverse effects to subsistence-harvest patterns, sociocultural systems, and environmental justice. The above mitigation measures incorporate traditional knowledge and the cooperative efforts between the MMS, the State, the people of the North Slope, and tribal and local governments.

This stipulation has been requested during scoping by the NSB and the AEWC. The consultations required by this stipulation ensure that Permittees, including contractors, consult and coordinate both the timing of events with subsistence activities. This stipulation has proven to be effective in mitigating prelease—primarily seismic activities—activities through the development of the annual oil/whaler agreement between the AEWC and oil companies (USDOI, MMS, 2003a).

Stipulations and required mitigation and conflict avoidance measures under MMP authorization as defined by NMFS and FWS will be followed in locations where the subsistence hunt is affected. The MMPA authorization obligates operators to demonstrate no unmitigable adverse impacts on subsistence practices. Conflict avoidance agreements between Permittees and the AEWC facilitate avoiding unreasonable conflicts and disturbances to hunters and bowhead whales. Similar avoidance measures could be required for the subsistence beluga whale hunt by the Alaska Beluga Whale Committee (ABWC), for the subsistence walrus hunt by the Alaska Eskimo Walrus Commission (EWC), and for the subsistence polar bear harvest by the Nanuk Commission (NC). Such conflict avoidance agreements likely would follow protocols similar to those reached annually between Permittees and the AEWC for the subsistence bowhead hunt and address industry seismic-vessel activities under provisions of the MMPA. The AEWC prefers to negotiate a conflict avoidance agreement with industry on an annual basis using a regional rather than a project-specific approach, so as to address potential impacts from all ongoing projects. With the use of the conflict avoidance agreement methodology, Native subsistence-whale hunters have generally been successful in reaching their annual whale "take" quotas.

In cases where the seismic survey operator has applied for an Incidental Take Authorization (ITA) - which could be in the form of an IHA or LOA - from the NMFS and/or FWS, MMS-permitted seismic-survey activities shall not commence until such time that the ITA has been secured. This will ensure compliance with the MMPA, that impacts to marine mammals will be negligible, and that there will be no unmitigable adverse impact on subsistence uses of marine mammals.

To achieve this standard, seismic operators negotiate a plan of cooperation (which could be in the form of a CAA) with the AEWC and the affected villages' Whaling Captains Association. The plan of cooperation could include a prohibition on conducting seismic surveys during the bowhead whale-hunting season in the Beaufort Sea, describe a dispute-resolution process, and provide emergency assistance to whalers at sea. Implementation of the plan of cooperation further ensures that there will not be significant social or economic impacts on the coastal inhabitants of the Beaufort and Chukchi seas by avoiding an adverse impact on subsistence marine mammal-harvest activities. In the past, CAAs between the AEWC, local whaling captains' associations and oil operators conducting one or perhaps two seismic-survey operations per open-water season have tended to mitigate disruptions to the fall hunt in these communities, but the magnitude of six concurrent seismic surveys would test the ability of survey operators and whalers to coordinate their efforts to prevent disruptions to the hunt.

For MMS-permitted seismic surveys, NMFS- and FWS-sanctioned observers, usually local Alaskan Natives and biologists employed by the monitoring contractor, are onboard survey vessels. These observers stop seismic operations when they observe marine mammals within the safety radius designated by the NMFS. Shut down of the airguns occurs if marine mammals are within this radius because of concern about possible effects on marine mammal hearing sensitivity (USDOI, MMS, 2003a).

III.G.3. Sociocultural Environment. A sociocultural system encompasses the social organization, behavior, and cultural values of the society. This section provides a profile of the sociocultural environment that characterizes the communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope and, whose ethnic, sociocultural, and socioeconomic makeup primarily is Inupiaq.

III.G.3.a. Background. The sociocultural systems described in this document are regional and community systems that: (1) heavily rely on traditional Inupiat values, which include a close relationship with natural resources, specifically game animals; (2) are tied to supernatural beliefs; and (3) emphasize community, its needs, and its support of others. Although there have been substantial social, economic, and technological changes in Inupiat lifestyle, subsistence continues to be the central organizing values of Inupiat sociocultural systems. The Inupiat remain socially, economically, and ideologically loyal to their subsistence heritage. The hunt, the sharing of the products of the hunt, and the beliefs surrounding the hunt tie families and communities together, connect people to their social and ecological surroundings, link them to their past, and provide meaning for the present. Bowhead whale hunting remains at the center of Inupiat spiritual and emotional life; it embodies the values of sharing, association, leadership, kinship, arctic survival, and hunting prowess.

For most Alaskan Natives, if not all, subsistence (and the relationship between people, land, water, and its resources) is the idiom of cultural identity. The cultural identity of Alaskan Native people also can be explained in terms of the sociological concept of "place." This concept is comprised of three components that are key elements in understanding sociocultural systems. First, "place" is essential and spiritual. That is, it has a fixed and true meaning based on social facts and is an engulfing ideology. Second, it is socially constructed. It is negotiated, dynamic, and contested over time. This takes into account what the "place" was like in the past, what it has become, and how it has changed. Finally, "place" is based on geography. It has boundaries, and residents are connected to it as a geographic location where daily "social action" occurs. Much of this "social action" is in the form of subsistence. Section III.G.2 (Subsistence Environment) describes in detail the important roles of subsistence in various NSB communities.

Sociocultural systems in the NSB are dynamic and influenced by many interacting causes and effects. Oil and gas development is only one element inducing and influencing sociocultural change in Alaska. The history of Native and Euro-American contact, the attainment of Statehood, and many other factors have combined to shape recent sociocultural change. The Federal legislative conjunction of these processes, as well as the passage of the ANCSA and ANILCA, also have contributed to major changes in social organization and cultural value systems (Chance, 1966, 1990; Arnold, 1978; Schneider, Pedersen, and Libby, 1980; Klausner and Foulks, 1982; Berger, 1985; Downs, 1985; Hoffman, Libbey, and Spearman, 1988; S.R. Braund and Assocs. and UAA, ISER, 1993a,b; Alaska Natives Commission, 1994; Human Relations Area Files, Inc., 1994; Fall and Utermohle, 1995; State of Alaska, Dept. of Fish and Game, 1996, 2002; Fuller and George, 1997).

Aboriginal North Slope social organization is not well known in terms of local detail (Oswalt, 1967; Damas, 1984; Impact Assessment, Inc., 1989, 1990a,b; Ray, 1885; Murdoch, 1892; Nelson, 1899). The broad model of precontact North Slope social organization based on this evidence consists of a dynamic system composed of small kinship-based territorially defined “nations” of subsistence hunters (Chance, 1966; Burch, 1970, 1975a, 1998; Damas, 1984).

Although Euro-American contact greatly influenced Inupiat social organization, the fundamental organizational feature is that of kin-related groups engaged in subsistence activities—particularly the marine subsistence hunt of the bowhead whale. Euro-American contact introduced new resources (such as food items and technology) that enhanced subsistence hunting and wage-earning opportunities, as well as many other agents of change (Salisbury, 1992). Development of the oil industry on the North Slope transformed the economic basis on which the North Slope region as a whole operated, but not the importance of kinship-based social organization.

Historically, perhaps the most significant social changes include the Inupiat adoption of Euro-American technology and the shift in Inupiat settlement patterns from a system of many small, territorially confined, local groups to that of a more limited number of large, permanent, communities located within a shared regional territory. The formation and actions of the NSB and its constituent communities are the most concrete expressions of these cultural continuities—a successful result of the adoption, integration, and manipulation of “modern” resources within an Inupiat sociocultural system (Burch 1975a,b; Hopson, 1976, 1978; Morehouse and Leask, 1978; Worl, 1978; North Slope Borough Contract Staff, 1979; McBeath, 1981; Kruse, 1982; Kruse et al., 1983; Morehouse et al., 1984; Harcharek, 1995; Shepro and Maas, 1999).

Prior to the discovery and development of oil and gas on the North Slope, and the formation of the NSB in 1972, the population of the five then-existing villages (i.e., Barrow, Kaktovik, Anaktuvuk Pass, Point Hope, and Wainwright) totaled about 2,500 people. Each village had limited political power, social services, and infrastructure. Per capita and household incomes were low; both in absolute and relative terms, and North Slope residents relied heavily on local subsistence resources for food, clothing, and heat (Van Valin, 1945; Ingstad, 1954; Sonnenfeld, 1956; Foote, 1959, 1960a,b, 1961; Spencer, 1959; Vanstone, 1962; Gubser, 1965; Nelson, 1969; Brosted, 1975).

Considerable information exists in the literature on the history and current dynamics of the NSB socioeconomics, including the resettlement of three communities since 1970 (Nuiqsut, Point Lay, and Atqasuk). A regional overview and a discussion of each community are provided in Impact Assessment, Inc. (1990), as well as within previously cited MMS documents. Both the State and the North Slope communities have grown significantly since 1939. The State grew at a rate that was approximately 1.5 times that of the North Slope communities between 1939 and 1970. After 1970, as North Slope oil was developed, the reverse was true. The majority of NSB growth since 1970 has been in the three communities established after the incorporation of the NSB; however, large investments have been made in the infrastructures of all NSB communities (Lowenstein, 1981). Despite modernization, Inupiat society maintains its subsistence-based culture, with the bowhead whale hunt as an integral element.

There have been more than 20 years of public hearings and meetings on State and Federal oil leasing, exploration, and development on the North Slope and in Northwest Alaska. Residents of the North Slope and in Chukchi Sea coastal communities have been remarkably consistent in their primary concerns during that time (USDOI, MMS, 1996a, 1998; U.S. Army Corps of Engineers, 1999, incorporated by reference). The main categories of their concern are:

- Marine mammals, especially whales, are sensitive to noise. Hunters avoid making any sort of extraneous noise, and the loud and relatively constant noises associated with seismic testing, drilling, and boat and air transport will cause whales (and other marine mammals) to avoid areas where such noise is audible to them. The range of whale sensitivity to noise is quite large, and noise effects on bowhead whales may be the biggest concern of NSB residents.
- Any given oil spill may be a relatively low-probability event, but over the long run the probability of at least one such spill occurring is quite high. Oil spills are likely to have long lasting effects upon the Inupiat people, primarily in terms of subsistence activities.
- Many NSB residents believe that the technology to clean up oil spills in arctic waters, and especially in broken ice conditions, is poorly developed and has not been adequately demonstrated to be effective.

- Many NSB residents believe that public comments at public hearings and other public forums may be noted, but have little or no effect on project decisions or the overall direction and philosophy of the leasing program.
- There is a general fear of cultural change, especially in terms of the loss of a subsistence lifestyle, which may lead to social disruptions or social problems in local communities (including youth becoming less interested in traditional ways).
- Oil development will result in an influx of population and other influences, which will disrupt and degrade Inupiat community life. In addition, oil development and its effects will impose additional demands upon Inupiat communities and individuals (and appearances at numerous hearings and the review of numerous documents are only the most visible of such demands).

Many of the stated concerns are interrelated and based on traditional knowledge. The isolated “examples” with each bullet are only examples but provide at least a minimal guide for the reader in understanding the context from which the generalized concern was formed. This context, as it relates to noise impacts, will be developed further in the analysis of potential effects.

III.G.3.b. Sociocultural Community Profiles. The following describes the Alaskan North Slope and Chukchi Sea communities that might be affected by geophysical exploration seismic surveys. Descriptions include factors relevant to the sociocultural analysis of each community in relation to industrial activities, population, and current socioeconomic conditions. The primary sociocultural variables—population, social organization, cultural values, and institutional organization—have not altered since MMS’ Beaufort Sea Multiple-sale final EIS appeared in 2003 and the Beaufort Sea Sale 195 EA was published in 2004.

III.G.3.b(1) Kaktovik. Incorporated in 1971, Kaktovik is the easternmost village in the NSB. Its population 2004 population of 284 was 84.0% Inupiat (State of Alaska, Dept. of Community and Economic Development [DCED], 2005). The village is on the north shore of Barter Island situated between the Okpilak and Jago rivers on the Beaufort Sea coast, and is located 300 mi east of Barrow. Kaktovik abuts the Arctic National Wildlife Refuge; its coastal and marine subsistence-harvest areas are in and adjacent to areas potentially affected by seismic surveys. However, subsistence is highly dependent on caribou. Until the late 19^{th} Century, the island was a major trade center for the Inupiat and was especially important as a bartering place for Inupiat from Alaska and Inuit from Canada. Possession of alcohol is banned in the community.

III.G.3.b(2) Nuiqsut. Nuiqsut sits on the west bank of the Nechelik Channel of the Colville River Delta, about 25 mi inland from the Arctic Ocean and approximately 150 mi southeast of Barrow. Its 2000 population of 433 was 89.1% Inupiat Eskimo (State of Alaska, DCED, 2005). Nuiqsut, one of three abandoned Inupiat villages in the North Slope region identified in ANCSA, was resettled in 1973 by 27 families from Barrow. Today, Nuiqsut is experiencing rapid social and economic change due to the development of new local infrastructure, including natural gas hookups soon to come to all community households, the development of the Alpine facility and potential Alpine Satellite development, and potential oil development in the National Petroleum Reserve in Alaska (NPR-A). Most of Nuiqsut’s marine subsistence-harvest area lies adjacent to areas in the Beaufort Sea potentially to be seismic surveyed in 2006. Nuiqsut’s important bowhead whale-hunting area is at Cross Island.

Local testimony at a 2003 public hearing for the Alpine Satellite Development Plan (USDOI, BLM, 2004) provides some insight at to the community’s values and concerns. Rosemary Ahtuangaruak, Mayor of Nuiqsut, observed that although the village ethnic makeup had not changed, oil-development infrastructure was creeping closer to the community and bringing with it new health issues, including an increasing number of asthma cases. Testifying at the same meeting, Bernice Kaigelak commented that the qualifications for Natives to get local oil-industry jobs had gotten more prohibitive. Testing used to be restricted to passing a urinary analysis but recently had been extended to other licensing requirements, many of which were hard to get certification for in a small community like Nuiqsut.

III.G.3.b(3) Barrow. Barrow is the largest community on the North Slope and is its regional center. In 1970, the Inupiat population of Barrow represented 91% of the total population (USDOC, Bureau of the Census, 1971), but by 1990, Inupiat representation had dropped to 63% and remains approximately there today. Between 1980 and 1985, Barrow's population grew by 35% (Kevin Waring Assocs., 1989). Barrow's population stood at 4,351 in 2004 (State of Alaska, DCED, 2005). The dramatic change in population and demographics is due primarily to the impacts of oil and gas development. Increased revenues from onshore oil development and production at Prudhoe Bay and in other smaller oil fields have fueled the change. These revenues stimulated NSB Capital Improvements Projects (CIP's) which, in turn, stimulated a boom in Barrow's economy and an influx of non-Alaskan Natives to the community. The social organization of the Barrow community has become diversified with the proliferation of formal institutions and the large increase in the number of different ethic groups. Traditional marine mammal hunts and other subsistence practices are still an active part of the culture. The sale of alcohol is banned in the community, although importation or possession is allowed.

III.G.3.b(4) Atqasuk. Atqasuk is a small, predominantly Inupiat community on the Meade River, about 60 mi south of Barrow. In 2000, there were 228 residents, 94.3% of whom were Inupiat; in 2004, there were 247 community residents (State of Alaska, DCED, 2005). The area has traditionally been hunted and fished by Inupiat Eskimos. The name means "the place to dig the rock that burns." During World War II, bituminous coal was mined in Atqasuk and freighted to Barrow for use by government and private facilities. The community was established in mid-1970 under ANCSA by Barrow residents who had traditional ties to the area. People lived in tents until NSB-sponsored housing arrived in 1977. The 1980 Census tallied 107 residents; 2 years later, a Borough census recorded 210 residents. By July 1983, the population had risen to 231, a 166% increase since the first census in 1980.

Atqasuk is an inland village, and its subsistence preferences are caribou and fish. Grayling, whitefish, caribou, geese, ptarmigan, polar bear, seal, walrus, and whale are harvested and traded. Residents trap and sell furs to supplement cash income. Social ties between Barrow and Atqasuk remain strong, and men from Atqasuk go to Barrow to join bowhead-whaling crews. To a large degree, Atqasuk has avoided the rapid social and economic changes experienced by Barrow and Nuiqsut brought on by oil-development activities, but future change could accelerate as a result of oil exploration and development in the Northwest NPR-A Planning Area. Possible new pipeline routes could cross Atqasuk's terrestrial subsistence-harvest areas, as most of its traditional subsistence-use area is within the NPR-A (USDOI, BLM and MMS, 2003).

III.G.3.b(5) Wainwright. Wainwright is located on the Chukchi Sea 100 mi southwest of Barrow on the western boundary of the NPR-A. In 2004, Wainwright's population was 531(State of Alaska, DCED, 2005). As in other North Slope communities, the changes in Wainwright from 1975-1985, stimulated by the NSB CIP boom, are not as dramatic as the changes in Barrow. Nonetheless, the CIP led to retention of the population and the creation of new jobs, housing, and infrastructure. Although there has been an influx of non-Natives into Wainwright, most are transient workers and cannot be considered permanently settled or even long-term residents. In 1989, approximately 8.7% of all Wainwright residents were non-Native (NSB, Dept. of Planning and Community Services, 1989). This was a decrease from 30% non-Alaska Native in 1983 (Luton, 1985) and is most likely a direct result of the end of the NSB CIP boom. Of these approximately 43 residents, only a few remained in Wainwright 6 months to a year later. The Caucasians in Wainwright tend to be nonpermanent, mobile residents who have relatively little interaction with the Native population (Luton, 1985).

The Wainwright CIP has not only been central to the local economy, but it also has changed the face of the community and affected the quality of life. Residents now live in modern, centrally heated homes with running water, showers, and electricity. New buildings dominate the town and upgraded roads have encouraged more people to own vehicles. Between July 1982 and October 1983, the number of pickup trucks and automobiles in Wainwright more than tripled (Luton, 1985). All of Wainwright's subsistence marine resources are harvested in offshore in the Chukchi Sea, and all of the community's terrestrial subsistence use areas are within NPR-A (USDOI, BLM and MMS, 2003). Bowhead and beluga whales, seals, walruses, caribou, polar bears, birds, and fishes are harvested. Sale of local Eskimo arts and crafts supplements income.

III.G.3.b(6) Point Lay. Point Lay is one of the more recently established Inupiaq villages on the Arctic coast, and has historically been occupied year-round by a small group of one or two families. The community has the smallest population of any community in the NSB, with a population of 251 in 2004, and is the only unincorporated community in the NSB (State of Alaska, DCED, 2005). About 90 mi southwest of Wainwright, the community sits on the Chukchi Sea coast at the edge of Kasegaluk Lagoon near the confluence of the Kokolik River and Kasegaluk Lagoon.

The community was established in the 1920's and its number of residents increased until the 1930's, when its population began a slow decline, largely because of the decline in reindeer herding. By 1960, it was not included in the national census. The village was reestablished on a barrier island spit opposite the Kokolik River in the 1970's (motivated by the terms of ANCSA). Residents of Barrow, Wainwright, Point Hope, Kotzebue, and other Inupiat with traditional ties to the area resettled here. The town then moved to its present mainland site south of the Kokolik Delta in 1981. In 1983, a NSB census recorded 126 residents in the community. Local employment during this period revolved around DEW Line and Borough CIP projects. Smaller Borough-, village corporation-, and State-funded construction projects continue to employ local workers on a temporary basis, and the NSB government remains the largest local full-time employer (USDOI, BLM and MMS, 2003).

Limited oil-exploration activity has occurred near Point Lay, with a well drilled 25 mi northeast of the community in 1981 on Arctic Slope Regional Corporation lands, the Tunalik #1 test well drilled within NPR-A inland and southeast of Icy Cape in 1978 and 1979. Both wells were plugged and abandoned. Point Lay is similar to Atqasuk in avoiding the rapid social and economic changes experienced by Barrow and Nuiqsut from past oil development activities.

Point Lay residents enjoy a diverse resource base including marine and terrestrial animals. The community is unique because its wild food dependence is relatively balanced between marine and terrestrial resources; and unlike the other communities discussed, local hunters do not pursue the bowhead whale because the deeply indented shoreline has prevented effective bowhead whaling. However, the village participates in beluga whaling.

III.G.3.b(7) Point Hope. Point Hope residents, with a population of 726 in 2004 (State of Alaska, DCED, 2005) enjoy a diverse resource base that includes both terrestrial and marine animals. Bowhead and beluga whales, seals, caribou, polar bears, birds, fishes, and berries are important subsistence resources. The community, 330 mi southwest of Barrow and is located on a large gravel spit that forms the westernmost extension of the northwest Alaska coast. Once called Tigaraq, the peninsula has been occupied for at least 2,000 years and is one of the longest continuously occupied areas in Alaska. This likely is due to its proximity to marine mammal-migration corridors and favorable ice conditions that allow hunting in open leads early in the spring-whaling season. Local government is the main employer of Point Hope residents. Additionally, the local manufacture of Alaskan Native crafts also contributes to the community economy (U.S. Army Corps of Engineers, 2005).

The city government was incorporated in 1966 and, in the early 1970's, the community moved, because of erosion and periodic storm-surge flooding, to its present location just east of the old settlement. The Native Village of Point Hope is a federally recognized tribe and is active in community government and in providing services. The NSB provides all utilities to Point Hope and subsidizes fuel costs. No roads connect Point Hope with other communities. Point Hope has better facilities than many other communities of the region, but problems remain concerning high fuel costs, uncertain transportation, erosion, storm-surge flooding, unemployment, and the need for better utilities (Fuller and George, 1997; U.S. Corps of Engineers, 2005). The sale, importation, or possession of alcohol is banned in the village.

III.G.3.c. Impact Assessment Overview. The primary aspects of the sociocultural systems covered in this analysis are: (1) social organization; (2) cultural values; and (3) subsistence and social health. For purposes of analysis, it is assumed that effects on social organization and cultural values could be brought about at the community level by increased effects on subsistence-harvest patterns that could be associated with seismic-survey activity. Potential effects are evaluated relative to the tendency of introduced social forces to support or disrupt existing systems of organization, relative to how rapidly they occur and their duration (Langdon, 1996; USDOI, MMS, 2003a).

III.G.3.c(1) Social Organization. An analysis of the effects on sociocultural systems must first look at the social organization of a society that involves examining how people are divided into social groups and networks. Social groups generally are based on kinship and marriage systems and on nonbiological alliance groups formed by such characteristics as age, sex, ethnicity, community, and trade. Kinship relations and nonbiological alliances serve to extend and ensure cooperation within the society.

Disruption of the subsistence cycle could change the way social groups are organized. The sharing of subsistence foods is profoundly important to the maintenance of family ties, kinship networks, and a sense of community well-being. In rural Alaskan Native communities, task groups associated with subsistence harvests are important in defining social roles and kinship relations: the individuals one cooperates with help define kin ties, and the distribution of specific tasks reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others. Disruption of these task groups can damage social bonds that hold a community together. Any serious disruption of sharing networks can appear as a threat to the established way of life in a community and can trigger an array of negative emotions—fear, anger, and frustration—in addition to a sense of loss and helplessness. Because of the psychological importance of subsistence in these sharing networks, perceived threats to subsistence activities from oil exploration activities are a major cause for anxiety.

An Alaska Department of Fish and Game social-effects survey administered by the Division of Subsistence Management in 1994 in Nuiqsut included questions on effects from OCS development. One question asked was: "How do you think the offshore development of oil and gas in this area would affect the following resources available for harvest; would the resource decrease, not change, or increase?" Eighty-percent of Nuiqsut respondents answered that fish resources would decrease, 87% said marine mammals would decrease, 43% said land mammals would decrease, and 55% said that birds would decrease; 67% were not in favor of the search for oil, and 42% believed the search for oil would have an adverse impact on subsistence; 68% were not in favor of the development and production of oil, and 52% believed that oil development and production would have an adverse impact on subsistence (Fall and Utermohle, 1995).

III.G.3.c(2) Cultural Values. An analysis of a social group's cultural values is desirable and represents what is accepted, explicitly or implicitly, by its members. Forces powerful enough to change the basic values of an entire society would include a seriously disturbing change in the physical conditions of life—a fundamental cultural change imposed or induced by external forces. One example would be an incoming group that demands that residents accept their intrusive culture's values. Another would be a basic series of technological inventions that change physical and social conditions. Such changes in cultural values can occur slowly and imperceptibly or suddenly and dramatically (Lantis, 1959). Disturbances to subsistence-harvest patterns from seismic surveys might induce such a change, i.e., changes to cultural values on the North Slope, including strong ties to Native foods, to the land and its wildlife, to the family, to the virtues of sharing the proceeds of the hunt, and to independence from institutional and political forces outside the North Slope.

For the system of sharing to operate properly, some households must be able to produce, rather consistently, a surplus of subsistence goods; it is obviously more difficult for a household to produce a surplus than to simply satisfy its own needs. For this reason, sharing—and the supply of subsistence foods in the sharing network—often is more sensitive to harvest disruptions than the actual harvest and consumption of these foods by active producers. Thus, when disturbance occurs from oil exploration and development, it may disrupt a community's culture, even though it does not cause "biologically significant" harm to a subsistence species' overall population.

III.G.3.c(3) Subsistence and Social Health. Stress would occur if a village were not successful in the bowhead whale harvest, with potential disruption of sharing networks and task groups. This stress could disrupt the community's social organization but likely would not displace the long-term social processes of whaling and sharing, if it did not occur often. Other more successful villages would share with a village having an unsuccessful whaling season. There have been no unsuccessful whaling seasons for Nuiqsut since 1994 and Kaktovik since 1991 (Braund, Marquette, and Bockstoce, 1988; Alaska Eskimo Whaling Commission, 1987-1995), and negotiated conflict resolution agreements between the AEWC, subsistence-whaling communities, and the oil industry have successfully served as a means to coordinate whaling activities and potential disturbance to whaling from industry activities.

Any effects on social health would have ramifications on social organization. On the other hand, NSB Native communities have, in fact, proven quite resilient to such effects with the Borough's continued support of Inupiat cultural values and its strong commitment to health, social service, and other assistance programs. Health and social-service programs have attempted to meet the needs of alcohol- and drug-related problems by providing treatment programs and shelters for wives and families of abusive spouses and by placing greater emphasis on recreational programs and services. However, in comments before the Department of the Interior's OCS Policy Committee's May 2000 meeting, NSB Mayor George Ahmaogak stated that Borough residents are extremely concerned that a lack of adequate financing for local NSB city governments has hampered the development of these programs, and declining revenues from the State of Alaska have seriously impaired the overall function of these city governments. Partnering together, Tribal governments, city governments, and the NSB government have been able to provide some programs, services, and benefits to local residents. For several years, all communities in the Borough have banned the sale of alcohol, although alcohol possession is not banned in Barrow, and many communities are continually under pressure to bring the issue up in local referendums (North Slope Borough, 1998). Effects on social health in Nuiqsut would have direct consequences on sociocultural systems but would not tend toward the displacement of existing systems above the displacement that has already occurred with the current level of development.

Stress created by the fear that oil exploration, development, and production (and anticipated oil spills) will soon follow the seismic surveys is a distinct predevelopment impact-producing agent. Stress from this general fear can be broken down into the particular fears of:

- being inundated during cleanup with outsiders who could disrupt local cultural continuity;
- the damage that spills would do to the present and future natural environment;
- drawn out oil-spill litigation;
- contamination of subsistence foods;
- lack of local resources to mobilize for advocacy and activism with regional, State, and Federal agencies;
- lack of personal and professional time to interact with regional, State, and Federal agencies;
- retracing the steps (and the frustrations involved) taken to oppose offshore development;
- responding repeatedly to questions and information requests posed by researchers and regional, State, and Federal outreach staff; and
- having to employ and work with lawyers to draft litigation in attempts to stop proposed development.

III.G.3.c(4) Alaska Native Views. North Slope Inupiat continue to express concern about the differences in how they and the dominant culture relate to the land and waters. Rex Okakok from Barrow expressed the problem when he said, "Our land and sea are still considered and thought by outsiders to be the source of wealth, a military arena, a scientific laboratory, or a source of wilderness to be preserved, rather than as a homeland of our Inupiat" (USDOI, MMS, 1987b). Considering such use of Inupiat territory, Robert Edwardson from Barrow said that he would like to see revenues paid to the Inupiat for mineral rights (USDOI, MMS, 1995a; USDOI, MMS, 2003a).

At hearings in 1982, Mark Ahmakak from Nuiqsut stated that there should be economic benefits to Nuiqsut, such as cheaper diesel, from any oil and gas development activities in the Beaufort and Chukchi seas (Ahmakak, 1982, as cited in USDOI, MMS, 1982). The consensus is that some benefit should come to the community from nearby oil activities. Nuiqsut resident Joseph Ericklook expressed the community's wish to see employment opportunities for local people result from development (Ericklook, 1990, as cited in USDOI, MMS, 1990d). In a 1996 public meeting for the Northstar Project, a Nuiqsut elder stated that she wanted potential human-health issues that could result from the project looked into beforehand. These issues could be found in information from other projects. She specifically expressed concern about cancers, health problems related to air pollution, and shortened lifespans (Dames and Moore, 1996).

As early as 1983, Nuiqsut residents asked to be part of industry activities in the region. Mark Ahmakak stated: "I think that if you are going to go ahead with this sale that you should utilize Natives in the areas affected by this lease sale; then utilize some of these Natives as monitors on some of your projects" (Ahmakak, 1983, as cited in USDOI, MMS, 1983). Mayor Lon Sonsalla of Kaktovik believes that to keep up with development activities, the village needs an impact office there to review EIS documents and monitor offshore activities (Sonsalla, 1996, as cited in USDOI, MMS, 1996a).

III.G.3.c(5) Conclusions. Effects on the sociocultural systems of the communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope might result from seismic-exploration activities. Because the seismic-survey activities are vessel based, stresses to local village infrastructure, health care, and emergency response systems are expected to be minimal; therefore, social systems in these communities would experience little direct disturbance from the staging of people and equipment for seismic exploration. However, the possible long-term deflection of whale migratory routes or increased skittishness of whales due to seismic-survey activities in the Beaufort and Chukchi seas might make subsistence harvests more difficult, dangerous, and expensive. To date, no long-term deflections of bowheads have been demonstrated; however, seismic activity of the magnitude discussed in the scenario for this draft PEIS has not been approached since the 1980's.

The more predominant issue associated with potential impacts on sociocultural systems is the potential disruption of seismic survey noise on subsistence-harvest patterns particularly on the bowhead whale, which is a pivotal species to the Inupiat culture. Such disruptions could impact sharing networks, subsistence task groups, and crew structures as well as cause disruptions of the central Inupiat cultural value: subsistence as a way of life. These disruptions also could cause a breakdown in family ties, the community's sense of well-being, and could damage sharing linkages with other communities. Displacement of ongoing sociocultural systems by seriously curtailing community activities and traditional practices for harvesting, sharing, and processing subsistence resources might occur.

III.G.3.d. Impacts of Alternatives on Socioculture.

III.G.3.d(1) Alternative 1 (No Action). The MMS would not approve seismic-survey permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data-processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic. Because no seismic-survey activity would occur, no impacts to subsistence resources and practices and consequent impacts on sociocultural systems would be expected. However, if other nonseismic field techniques are proposed to be used, they would require additional environmental analysis.

III.G.3.d(2) Alternatives 3, 4, 5, 6, 7, and 8. Seismic surveys for geophysical exploration activities in each alternative would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures, including specified isopleth-safety/exclusion zones ranging from a 120 dB safety zone to a 180/190 dB exclusion zone. Safety zones imply monitoring within the specified zone and exclusion zones imply a shutdown of seismic activity within the specified zones. Additional protective measures (beyond the existing Alaska OCS exploration stipulations and guidelines) have been identified and incorporated into these alternatives to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. An inability to effectively perform mitigation measures will result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated.

Alternative 8 with its temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (which could be in the form of a CAA) negotiation process and reduce stress on local community organizations that normally negotiate such agreements. The more marine mammals are protected, the more subsistence-harvest activities are protected. If impacts on subsistence resources are mitigated, than consequent sociocultural impacts would be reduced.

Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under MMPA authorization are defined by NMFS and FWS (identified in the subsistence discussion for Alternative 3) and made a part of each alternative would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices and would likely mitigate any consequent impacts on sociocultural systems.

In cases where the seismic survey operator has applied for an Incidental Take Authorization (ITA) - which could be in the form of an IHA or LOA - from the NMFS and/or FWS, MMS-permitted seismic-survey activities shall not commence until such time that the ITA has been secured. This will ensure compliance with the MMPA, that impacts to marine mammals will be negligible, and that there will be no unmitigable adverse impact on subsistence uses of marine mammals.

To achieve this standard, the seismic operators negotiate a plan of cooperation (which could be in the form of a CAA) with the AEWC and the affected villages' Whaling Captains Associations. The plan of cooperation could include a prohibition on conducting seismic surveys during the bowhead whale-hunting season in the Beaufort Sea, describe a dispute-resolution process, and provide emergency assistance to whalers at sea. Implementation of the plan of cooperation further ensures that there will not be significant social or economic impacts on the coastal inhabitants of the Beaufort and Chukchi seas by avoiding an adverse impact on subsistence marine mammal-harvest activities.

III.G.4. Archaeological Resources.

III.G.4.a. Overview. "Archaeological Resources" can be defined as "any prehistoric or historic district, site, building, structure, or object [including shipwrecks]...including artifacts, records, and remains which are related to such a district, site, building, structure, or object" (National Historic Preservation Act, Sec. 301 as amended, 16 U.S.C. 470). Significant archaeological resources are either historic or prehistoric and generally include properties of >50 years that: (1) are associated with events that have made a significant contribution to the broad patterns of our history; (2) are associated with the lives of persons significant in the past; (3) embody the distinctive characteristics of a type, period, or method of construction; (4) represent the work of a master; (5) possess high artistic values; (6) present a significant and distinguishable entity whose components may lack individual distinction; or (7) have yielded, or may be likely to yield, information important in history. These resources also represent the remains of the material culture of past generations of the region's prehistoric and historic inhabitants. They are basic to our understanding of the knowledge, beliefs, art, customs, property systems, and other aspects of the nonmaterial culture.

The two locational categories and the two time sequences of archaeological resources applicable to the proposed seismic survey action are respectively, offshore/onshore and prehistoric/historic.

III.G.4.b. Offshore Prehistoric Resources. At the height of the late Wisconsinan glacial advance (approximately 19,000 years ago), global (eustatic) sea level was approximately 120 m lower than present. During this time, large expanses of what is now the OCS were exposed as dry land. The exact elevation of past sea levels in relation to present sea level varies geographically, depending primarily on the location of the area in relation to the major late-Wisconsinan ice masses. This is referred to as relative sea level. There are no good relative sea-level data for the major portion of the Alaska OCS; however, relict fluvial channels and shoreline features evident at the seafloor suggest that sea level was probably between 50 and 60 m lower than present at 12,000 B.P. (Before Present) (Dixon, Sharma, and Stoker, 1986). Therefore, a conservative estimate of 60 m below present is used for relative sea level at 12,000 B.P., the date at which prehistoric human populations could have been present in the area. The location of the 12,000-B.P. shoreline is roughly approximated by the 60-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to about 12,000 B.P.

Seismic-survey and borehole data that have been collected in the Beaufort and Chukchi seas indicate areas of well-preserved Holocene sedimentary sequences and landforms that have potential for containing prehistoric archaeological deposits. In the Beaufort Sea, remote-sensing data from the Liberty, Warthog, and McCovey prospects, landward of the barrier islands, indicate little evidence of ice gouging at the seafloor and areas of well-preserved landforms, such as river channels with levees and terraces just below the seafloor. Although these features have not been directly dated, their stratigraphic position indicates that they are most likely Holocene in age. The presence of these preserved landforms just beneath the seafloor indicates that there also is potential for preservation of prehistoric archaeological sites that may occur in association with the landforms. However, the potential for the occurrence of archaeological resources in the Beaufort Sea seaward of the barrier islands probably is much lower than for those areas landward of the barrier islands and in areas protected by floating, landfast ice during the winter.

Analyses of shallow geologic cores obtained by the U.S. Geological Survey in the northeastern Chukchi Sea indicate the presence of well-preserved coastal plain sedimentary sequences of Holocene age just beneath the seafloor (R.L. Phillips, written commun., USGS, Menlo Park, California, April 18, 1991). Radiocarbon dates on in situ freshwater peat contained within these deposits indicate that relative sea level in the Chukchi Sea area would have been approximately 50 m below present at 11,300 B.P., the approximate date of the earliest known prehistoric human populations in the area. The location of the 11,300-B.P. shoreline is roughly approximated by the 50-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to approximately 11,300 B.P. The presence of preserved nonmarine Holocene sedimentary sequences in the Chukchi Sea indicates that there also is potential for preservation of prehistoric archaeological sites. Even in some areas of intense ice gouging, such as off Icy Cape, the Holocene sediments are thick enough that any archaeological sites that occurred in the underlying Late Pleistocene deposits would be below the depth affected by ice gouging (USDOI, MMS, 1990c).

III.G.4.c. Offshore Historic Resources. Between 1851 and 1934, 34 shipwrecks occurred within a few miles of Barrow; another 13 wrecks occurred to the west and east of Barrow in the waters of the Chukchi and Beaufort seas. No surveys of these shipwrecks have been made; therefore, no exact locations are known. These wrecks would be valuable finds, providing us with information on past cultural norms and practices, particularly with regard to the whaling industry (Tornfelt and Burwell, 1992).

At Point Belcher near Wainwright, 30 ships were frozen in the ice in September 1871; 13 others were lost in other incidents off Icy Cape and Point Franklin. Another 7 wrecks occurred off Cape Lisburne and Point Hope. From 1865-1876, 76 whaling vessels—an average of more than 6 per year—were lost because of ice and also because of raids by the *Shenandoah*, which burned 21 whaling ships near the Bering Strait during the Civil War (Bockstoce, 1977). The possibility exists that some of these shipwrecks have not been completely destroyed by ice and storms. The probabilities for preservation are particularly high around Point Franklin, Point Belcher, and Point Hope (Tornfelt and Burwell, 1992).

A recent remote-sensing survey in the Beaufort Sea recorded a large side-scan sonar target. The size and shape of this object and historical accounts suggest that it may be the crash site of the *Sigismund Levanevsky*, a Russian airplane that was lost during a transpolar flight in 1939 (Rozell, 2000). Subsequent attempts at ground-truthing this object has been unsuccessful in relocating the object and confirming its identity.

III.G.4.d. Onshore Prehistoric and Historic Resources. Onshore archaeological resources near the Chukchi Sea coast receive less damage from the eroding shoreline than those on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost (Lewbel, 1984). Therefore, known onshore archaeological resources exist in greater numbers in the Chukchi Sea area; also, unknown resources are more likely to exist. There are 200-300 known archaeological sites in the Hope Basin area, and the area around Point Hope is especially rich in archaeological resources. Many of the known sites are of Kukmiut and Inupiat tradition and include villages, graves, whaling camps, and fishing/hunting camps.

The Alaska Heritage Resources Survey (AHRS) keeps a database of all known archaeological sites, including those on the National Historic Register. A review of the AHRS site files indicates that 18 sites with prehistoric components have been recorded in areas adjacent to the Beaufort Sea. They are comprised of habitation sites, lithic scatters, and isolated finds.

III.G.4.e. Impact Assessment. Alternatives 3 through 8 includes potential use of OBC surveys to gather seismic data. The OBC surveys could be used in the Beaufort Sea Planning Area to acquire seismic-survey data in water that is too shallow (14 m or shallower) for the data to be acquired using marine streamers and too deep to have bottomfast ice in the winter, which would allow over-ice winter operations. It is possible that cables would be laid in water deeper than 14 m, if the deeper water data was part of a larger acquisition program that went from shallow to deeper water. The OBC surveys require the use of multiple ships (usually two ships for cable layout/pickup, one for recording, one for shooting, and two smaller utility boats). These vessels are generally smaller than those used in streamer operations, and the utility boats are quite small.

Operations begin by dropping cables off the back of the layout boat. Cable length is typically 4,200 m but can be up to 12 km. Groups of seismic detectors (usually hydrophones and vertical motion geophones) are attached to the cable in intervals of 25-50 m. Multiple cables are laid on the seafloor parallel to each other using this layout method, with a 50- to 100-m interval between cables. When the cable is in place, a ship towing a dual airgun array passes between the cables, firing every 25 m. Sometimes a faster source ship speed of 6 kn instead of the normal 4.5-kn speed is used, with an increase in time between airgun firings.

After a source line is shot, the source ship takes about 10-15 minutes to turn around and pass down between the next two cables. When a cable is no longer needed to record seismic data, it is retrieved by the cable-pickup ship and moved to the next recording position. A particular cable can lay on the bottom anywhere from 2 hours to several days, depending on operation conditions. Normally, a cable is left in place about 24 hours; however, cables left on the bottom during storms sometimes can work into the substrate before they can be recovered. The OBC surveys might occur in the Beaufort Sea but are not anticipated to occur in the Chukchi OCS because of its great water depths and the greater efficiency of streamer operations in deep water.

The OBC seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water as part of one program. Activities associated with such offshore seismic-exploration activities projected for the 2006 open-water season could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' G&G Permit Stipulation 6 (regarding the discovery of archaeological resources) and CFR 251.6 (a)(5) regarding G&G Explorations of the Outer Continental Shelf to not "disturb archaeological resources," most impacts to archaeological resources in shallow offshore waters of the Beaufort Sea Planning Area would be avoided. Therefore, no impacts or only minor impacts to archaeological resources are anticipated.

III.G.5. Land Use Plans and Coastal Zone Management.

III.G.5.a. Land Status and Use. The Federal Government is the sole owner of the Chukchi and Beaufort Sea OCS, but the adjacent nearshore and onshore areas is a mix of landholders. With the exception of the tidelands offshore of the Arctic National Wildlife Refuge (ANWR), the State of Alaska owns all submerged lands along the coast out to 3 nmi. The adjacent onshore area is within the NSB, and most land within the NSB is held by a few major landowners. The predominant landowner within the NSB is the Federal Government, which owns the NPR-A ANWR. Other major landholders include the State of Alaska, eight Native village corporations, and the Arctic Slope Regional Corporation.

Documents addressing land use in the NSB include the NSB Comprehensive Plan and Land Management Regulations (NSBCP&LMR), and the NSB Coastal Management Program (NSBCMP). Major land uses and offshore areas on the North Slope are divided between traditional subsistence uses of the land, community development, and hydrocarbon-development operations. Along the Chukchi Sea coast, traditional settlement patterns and subsistence uses of land prevail.

The NSBCP&LMR is intended to guide decisions affecting land use, transportation, fire protection, public facilities, and the economy. The major goal is to support development of the villages and natural resources in a way that preserves the Inupiat way of life. Offshore policies are specifically limited to development and uses in the portion of the Beaufort and Chukchi seas that are within the boundary of the NSB. Activities on the OCS would not be subject to the NSBCP&LMR.

III.G.5.b. Coastal Zone Management. Through the Federal Coastal Zone Management Act and the Alaska Coastal Management Act (ACMA), development and land use in coastal areas are managed to provide a balance between the use of coastal areas and the protection of valuable coastal resources. Alaska recently amended its coastal management program (ACMP) and adopted new standards under 11 AAC 110, 112, and 114. The National Oceanic and Atmospheric Administration (NOAA), Office of Ocean and Coastal Resource Management (OCRM), reviewed the amended the ACMP, completed a full NEPA analysis, and approved Alaska's revised program on December 29, 2005.

The process for determining consistency for activities requiring a Federal permit is governed by 15 CFR 930, Subpart D. Under the subpart, a State is directed to develop a list of specific Federal licenses or permit activities that it wishes to review for consistency with its management program (15 CFR 930.53). Alaska's list of Federal licenses and permits that are subject to consistency review is found in 11 AAC 110.400. Geophysical exploration permits issued by MMS are not included on the list. Consequently, a consistency review under ACMP is not required for these permits. Should the State of Alaska desire to review permits issued by MMS for geophysical exploration in the Chukchi and Beaufort seas, it would need to obtain approval to review the unlisted activity from OCRM.

III.G.6 Environmental Justice

III.G.6.a. Overview. Environmental Justice is an initiative that culminated with President Clinton's February 11, 1994, Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," and an accompanying Presidential memorandum. The Executive Order requires each Federal Agency to make the consideration of Environmental Justice part of its mission. Its intent is to promote fair treatment of people of all races, so no person or group of people shoulders a disproportionate share of the negative environmental effects from this country's domestic and foreign programs. It focuses on minority and low-income people, but the Environmental Protection Agency (USEPA) defines environmental justice as the "equal treatment of all individuals, groups or communities regardless of race, ethnicity, or economic status from environmental hazards" (U.S. Department of Energy, 1997; USEPA, 2006). Specifically, the Executive Order requires an evaluation as to whether the proposed project would have "disproportionately high adverse human health and environmental effects…on minority populations and low income populations." The Environmental Justice Executive Order also includes consideration of potential effects to Native subsistence activities and, to this end, MMS continues to maintain a dialogue on Environmental Justice with local communities in this region.

Since 1999, all MMS public meetings have been conducted under the auspices of Environmental Justice. Environmental Justice-related concerns are taken back to MMS management and incorporated into environmental study planning and design, environmental impact evaluation, and the development of mitigating measures.

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," requires Federal agencies to consult with tribal governments on Federal matters that significantly or uniquely affect their communities. In January 2001, a USDOI Alaska Regional Government-to-Government policy was signed by all the USDOI Alaska Regional Directors, including the MMS. In acknowledgement of the importance of consultation, the MMS invites tribal governments to participate in its environmental assessment processes.

The Inupiat People of the North Slope and the Northwest Arctic boroughs have made MMS aware of the potential burden of participating in too many planning and public meetings. Therefore, MMS has taken measures to more carefully plan the number and timing of meetings with regional tribal groups and local governments.

III.G.6.b. Demographics.

III.G.6.b(1) Race. Alaska Inupiat Natives, a recognized minority, are the predominant residents of the NSB and Northwest Arctic Borough, which make up the Alaska regional governments in the action area. The 2000 Census counted 7,385 persons resident in the North Slope Borough; 5,050 identified themselves as American Indian and Alaskan Native for a 68.38% indigenous population. In the Northwest Arctic Borough, the 2000 Census counted 7,288 persons, 5,944 identified themselves as American Indian and Alaskan Native for an 82.5% indigenous population (USDOC, Bureau of the Census, 2000).

Inupiat Natives are the only minority population allowed to conduct subsistence hunts for marine mammals in the region and, in potentially affected Inupiat communities, there are no significant numbers of "other minorities." Additionally, "other minorities" would not be allowed to participate in subsistence marine mammal hunts and, therefore, would not constitute a potentially affected minority population (North Slope Borough, 1999).

Because of the homogeneous Inupiat population of the NSB and Northwest Arctic Borough, it is not possible to identify a "reference" or "control" group within the potentially affected geographic area, for purposes of analytical comparison, to determine if the Inupiat are affected disproportionately. This is because a non-minority group does not exist in a geographically dispersed pattern along the potentially affected area of the North Slope and Northwest Arctic Boroughs. Population counts from the 2000 Census for Native subsistence-based communities in the region and their total American Indian and Alaskan Native population percentages can be seen in Table III.G.1.

III.G.6.b(2) Income. The U.S. average median household income in 2000 was $42,148, and the U.S. average per-capita income was $29,469. The Alaskan average median household income in 2000 was $50,746, and the Alaska average per-capita income was $29,642. The average NSB median household income ($63,173) was above State and national averages, but the average per-capita income ($20,540) was below the State and national averages. The median household incomes in all subsistence-based communities in the Borough were above State averages except Nuiqsut ($48,036), and all were above national averages. Per capita incomes in all these communities were below State and national averages. The average Northwest Arctic Borough median household income ($45,976) was below the State average but above the national average, but the average per-capita income ($15,286) was below State and national averages. The median household incomes of the subsistence-based communities of Kivalina ($30,833), Buckland ($38,333), and Deering ($33,333) were below State and national averages, and those for Kotzebue ($57,163) and Noorvik ($51,964) were above. Per capita incomes in all these communities were below State and national averages.

The thresholds for low income in the region were household incomes below $57,500 in the NSB and $54,550 in the Northwest Arctic Borough. Poverty-level thresholds were based on the U.S. Census Bureau, Census 2000 Survey; low income is defined by the U.S. Census Bureau as 125% of poverty level.

Subsistence-based communities in the region qualify for Environmental Justice analysis based on their racial/ethnic minority definitions alone. Nevertheless, the figures indicate that low income commonly also correlates with Native subsistence-based communities in the region (USDOC, Bureau of the Census, 2000, 2002). The 2000 Census "Tiger" files (files from the U.S. Census' Topologically Integrated Geographic Encoding and Referencing [TIGER] database) identify no nonsubsistence-based coastal communities in the North Slope and Northwest Arctic boroughs with median incomes that fall below the poverty threshold.

The median household, median family, and per capita incomes; the number of people in poverty and the percent of the total Borough or Native subsistence-based community population are shown in Table III.G.2.

III.G.6.b(3) Consumption of Fish and Game. As defined by the NSB Municipal Code, subsistence is "an activity performed in support of the basic beliefs and nutritional need of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities" (State of Alaska, DNR, 1997). This definition gives only a glimpse of the importance of the practice of the subsistence way of life in Inupiat culture, but it does underscore that it is a primary cultural and nutritional activity on which Native residents of the North Slope depend. For a more complete discussion of subsistence and its cultural and nutritional importance, see section III.G.2 (Subsistence Environment).

III.G. 6.c. Impact Assessment Overview. Seismic surveys, with very little anticipated onshore support activities, might affect coastal communities. Most Alaskan coastal communities are rural and predominantly Native (a defined ethnic minority), and many contain at least subpopulations with low incomes. Therefore, specific local minority (and possibly poor [low-income]) populations are present that could be potentially affected by the proposed seismic survey activities. For these reasons, the MMS socioeconomics studies agenda has emphasized the documentation of subsistence uses, and the potential impacts of OCS activities on such uses, along with the more general characterization of rural (Native and non-Native) social organization and the incorporation of local and traditional knowledge. The MMS-sponsored studies have focused most heavily on communities on the North Slope (the area of most onshore and offshore oil and gas activity) and MMS has funded projects to synthesize local and traditional knowledge. The MMS has recognized the extreme importance of whales and whaling to the North Slope communities, and has conducted a bowhead whale aerial survey annually since 1987. A newly-funded MMS study, "*Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting and Subsistence Activities in the Beaufort Sea*," is ongoing.

Perhaps more importantly, MMS has recognized the importance of local consultation, and the important role that the NSB and other local organizations and institutions can play in the development and evaluation of specific actions. Such a consultation process will also be a part of all actions addressed in this PEA. Although MMS has amassed an astounding body of public testimony—much of it from Alaskan Natives—as a result of the public hearing process, the agency's consultation process extends far beyond these formal hearings. The MMS now routinely includes Native representation on the Scientific Review Boards for its major projects, and tries to conduct at least occasional Information Transfer Meetings (discussing the findings of recently concluded and ongoing studies and proposed efforts) near those communities most likely to be affected. Major concerns expressed at public meetings included:

- Identifying and protecting important subsistence areas (all 6 communities)
- Restricting access to subsistence areas and resources (5 communities)
- Studying and maintaining the health of wildlife (3 communities)
- Providing natural gas to local communities (3 communities)
- Studying caribou and fish (3 communities)
- Mitigating seismic disturbance of caribou, fish, and whales (3 communities)
- Making better use of traditional knowledge (3 communities);
- Providing more local hire (3 communities)
- Updating outdated resource data (2 communities)
- Involving local people in scientific studies of resources (2 communities)
- Including local people in the planning process (2 communities)

Many of these issues are discussed in government-to-government consultation with tribes and the Inupiat Community of the Arctic Slope and in meetings with the NSB and the AEWC.

The MMS conducted seismic survey-related outreach meetings under the auspices of Environmental Justice from January through March 2006 with regional and local governments and tribes in Point Hope, Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik to consult on current stakeholder concerns and issues with regard to upcoming offshore exploration and leasing in the region, and specifically concerning seismic activities planned for the 2006 open-water season.

One overarching way MMS has tried to address Native concerns has been to include local Inupiat traditional knowledge in its environmental assessments and environmental impact statements.

In summary, Alaskan Inupiat Natives, a recognized minority, are the predominant residents of the communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, Point Hope, and Kivalina, the areas potentially most affected by activities assessed in this draft PEIS. Effects on Inupiat Natives might occur because of their reliance on subsistence foods, and noise from seismic survey activities may affect subsistence resources and harvest practices. "Significant" effects on environmental justice is defined as: disproportionately high adverse impacts to low-income and minority populations. Potential significant impacts to subsistence resources and harvests and consequent impacts to sociocultural systems could result in adverse environmental justice impacts. However, potential adverse affects are expected to be mitigated substantially, though not eliminated. Furthermore, potential long-term impacts on human health from contaminants in subsistence foods and climate change effects on subsistence resources and practices would be expected to exacerbate overall potential effects on low-income, minority populations.

III.G.6.d. Impacts of Alternatives.

III.G.6.d(1) Alternative 1. The MMS would not approve seismic survey permit applications for the purpose of obtaining geophysical information about the location, extent, and properties of hydrocarbon resources in the Chukchi and Beaufort seas. Industry would have to rely on other measures to obtain needed geophysical information, such as using new data processing technology to reanalyze existing geophysical exploration seismic data and/or using other survey techniques, other than seismic. Because no seismic survey activity would occur, no environmental justice impacts would be expected.

III.G.6.d(2) Alternatives 3, 4, 5, 6, 7, and 8. The following discussion pertains to all these alternatives unless otherwise indicated. Seismic surveys for prelease geophysical exploration activities would be permitted with existing Alaska OCS exploration stipulations and guidelines and additional specific protective measures for marine mammals, including an isopleth-specified exclusion zone. These alternatives would permit seismic surveys in the Beaufort and Chukchi seas and incorporate standard G&G-permit stipulations and additional protective measures to ensure that fish, wildlife, and subsistence-harvest resources and practices are not adversely impacted. An inability to effectively perform mitigation measures would result in the suspension of a G&G permit until such time that the protective measures can be successfully performed and demonstrated. Theoretically, the larger the safety/exclusion zone, coupled with shut-down procedures, the greater protection is afforded marine mammals from potential harassment and injury. Therefore, the 120-dB isopleth safety zone would afford more protection from harassment and injury for marine mammals than the 180/190-dB isopleth exclusion zone alone.

Alternative 8 with its temporal/spatial/and operation restrictions off Kaktovik, Nuiqsut, and Barrow during the fall migration would make this the preferred alternative for ensuring the least interference with subsistence whaling activities near these communities. By specifying restricted locations and time periods, this alternative would streamline the plan of cooperation (which could be in the form of a CAA) negotiation process and reduce stress on local community organizations that normally negotiate such agreements. The more marine mammals are protected, the more subsistence-harvest activities are protected. If impacts on subsistence resources are mitigated, than consequent sociocultural and environmental justice impacts would be reduced, as well.

Inupiat Natives could be disproportionately affected by any alternative that allows seismic because of their reliance on subsistence foods; and actions under these alternatives could affect subsistence resources and harvest practices. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under IHA requirements as defined by NMFS and FWS (identified in Section III.G.2, the Subsistence Environment discussion for Alternative 3) and made a part of each alternative would serve collectively to mitigate disturbance effects on environmental justice. Mitigating measures likely would incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and tribal and local governments. With required mitigation and conflict avoidance measures in place, significant impacts to subsistence resources and hunts would not be expected to occur as a result of this action, thereby avoiding significant impacts on sociocultural systems and disproportionately high adverse impacts on low income and minority populations in the region—significant environmental justice impacts.

III.G.6.d(3) Standard, Potential, and Ongoing Studies and Mitigation Initiatives. Avoidance planning, stipulations and required mitigation, and conflict avoidance measures under IHA requirements as defined by NMFS and FWS, the employment of Inupiat observers onboard seismic-survey vessels, and the additional noise and disturbance mitigation discussed in the subsistence-harvest discussion for Alternative 3 (Section III.G.2, Subsistence Environment) would serve collectively to mitigate disturbance effects on environmental justice.

The Alaska OCS Region promotes studies that directly address the standing issues and concerns of Native stakeholders. The MMS involves local and tribal governments in its studies planning process and has held meetings in all local communities to assist their involvement in this effort. The MMS' participation in the newly formed North Slope Science Initiative ensures MMS' continued involvement in slopewide scientific research formulation and coordination.

Particular studies that the MMS has funded to address sociocultural and environmental justice impacts include: the MMS' Bowhead Whale Feeding Study, conducted out of the village of Kaktovik, that includes local Inupiat in the study design, data gathering, and data analysis; the *Arctic Nearshore Impact Monitoring In Development Areas (ANIMIDA)* study (designed specifically to meet requests from the Inupiat community) and its followup study, *Continuation of Arctic Nearshore Impact Monitoring in Development (CANIMIDA)*; the *Quantitative Description of Potential Effects of OCS Activities on Bowhead Whale Hunting/Subsistence Activities in the Beaufort Sea* study; the *Alaska Marine Mammal Tissue Archival Project, the Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow: Past and Present Comparison* study; and the *North Slope Borough Economy, 1965 to Present* study.

One study that particularly tried to address seismic effects was the *GIS Geospatial Database of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea*, completed in 2002. This study was initiated to compile detailed information describing the locations, timing, and nature of oil and gas related and other human activities in the Alaskan Beaufort Sea. An important objective of the database was to assess concerns expressed by subsistence hunters and others living within the coastal villages of the Beaufort Sea about the possible effects that oil and gas activities (particularly seismic activity, drilling, and oil and gas support-vessel activities) had on the behavior of marine mammals, especially the bowhead whale. The Human Activities Database, however, is proprietary because it includes sensitive oil and gas industry data. With the exception of ice-management activity, the compiled information for the period 1990-1998 is relatively complete and considered adequate for the investigation of potential effects of disturbance on the fall bowhead whale migration. However, there are significant gaps in the data for the period 1979-1989. This initiative continues under the ongoing study *Analysis of Covariance of Human Activities and Sea ice in Relation to Fall Migrations of Bowhead Whales*.

Newly funded MMS studies that address sociocultural and environmental justice impacts include: (1) *Dynamics of Distribution and Consumption of Subsistence Resources in Coastal Alaska*; (2) *Researching Technical Dialogue with Alaskan Coastal Communities: Analysis of the Social, Cultural, Linguistic, and Institutional Parameters of Public/Agency Communication Patterns*; (3) *Analysis of Variation in Abundance of Arctic Cisco in the Colville River* (this study has a Traditional knowledge component); (4) *Monitoring the Distribution of Arctic Whales*; (5) *Bowhead Whale Feeding in the Central and Western Alaska Beaufort Sea*; (6) *Aerial Photography of Bowhead Whales to Estimate the Size of the Western Arctic Population*; (7) *Satellite Tracking of Eastern Chukchi Sea Beluga Whales in the Beaufort Sea and Arctic Ocean*; and (8) *Development of Remote Sensing Survey techniques for Arctic Marine Mammals: Pacific Walrus.*

Other initiatives include an MMS-sponsored Information Transfer Meeting (ITM) in Anchorage in January 1999 and the Beaufort Sea Information Update Meeting in Barrow in March 2000, which presented updates on research and studies being conducted in the Beaufort Sea. The March 1999 meeting included presentations by Barrow, Nuiqsut, and Kaktovik whaling captains. In early 2005, MMS held an ITM in Anchorage, a mini-ITM in Barrow. In October 2005, MMS held a Chukchi Sea Science Update Meeting in Anchorage to update its analysts on the current information base and conditions for oceanography and marine mammal, fish, bird, subsistence, and sociocultural resources. The meeting's other purpose was to develop a studies regime for these resources in the region.

The MMS Alaska OCS Region homepage also maintains an Alaska Native Links page that provides information on the MMS traditional knowledge-incorporation process, information on Barrow whaling, and MMS assistance with the bowhead whale census, in addition to links to Alaskan Native sites and U.S. Government Native-related sites. The MMS Alaska OCS Region's community liaison, Albert Barros, was instrumental in getting an Alaskawide Department of the Interior Memorandum of Understanding (MOU) with Alaskan tribes on government-to-government consultation signed by all the Alaska Department of the Interior Agency Regional Directors. The MMS signed an MOU with the community of Kaktovik in March 2005 that specifies consultation procedures with the community, and George Ahmaogak, former Mayor of the NSB, is a member of MMS' OCS Policy Committee.

Over the two decades of MMS involvement in the Arctic, local communities have been very vocal about finding a "compensation" source—impact assistance, revenue sharing, bonds, or mitigation payments—to address impacts from OCS activities. Without congressional authorization, the MMS cannot provide or require industry to provide such compensation. Federal Agencies cannot commit to impact assistance, because that is a role of Congress and not the Executive Branch. Only Congress can alter the OCS Lands Act to include provisions for local impact assistance from MMS revenues or provide the authorization for funding such revenues. Nevertheless, in response to this critical concern, Department of the Interior and MMS staff have drafted legislative language on this subject in response to Congressional requests. Furthermore, the MMS OCS Policy Committee has developed a white paper on impact assistance and revenue sharing options and has shared this paper and its findings with concerned policymakers.

In 2001, Congress appropriated impact-assistance funds for coastal states affected by OCS oil and gas production. Nationwide, Congress appropriated \$150 million to be allocated among eligible oil- and gas-producing states. Alaska received an appropriation of \$12.2 million, \$1,939,680 of which went to the NSB, and \$102,530 went to the Northwest Arctic Borough. The Coastal Impact Assistance Program (CIAP) was reauthorized by Congress under the Energy Act of 2005. Under the new CIAP, \$250 million for each of fiscal years 2007 through 2010 will be disbursed directly to eligible producing states and to qualifying counties, parishes and boroughs within those states. Under the new CIAP, states eligible to receive funding are Alabama, Alaska, California, Louisiana, Mississippi, and Texas. The CIAP funds will be allocated to these states based on the proportion of qualified OCS revenues offshore of the individual state to total qualified OCS revenues from all states. Because Alaska currently lacks significant OCS production, its contribution to total OCS revenues is much less than the other states. Accordingly, Alaska likely will receive the minimum allocation provided under the program, or \$2.5 million for each year. Thirty-five percent must go to local communities. This amount could rise in the future if Alaska's OCS revenues increase as a result of lease sales, lease rentals, and production.

Twenty-seven percent of all OCS leasing, rental, and royalty receipts, within the first 3 mi of the Alaska OCS, go to the State of Alaska. Also, subsistence-impact funds administered by the U.S. Coast Guard under the Oil Pollution Act of 1990 would be available, in the unlikely event of an oil spill, to provide for subsistence-food losses.

Since July 2003, MMS and the NSB have been in constant consultation and coordination on a number of issues that include conflict avoidance, oil-spill-risk analysis, peer review of scientific studies, disturbance effects on subsistence resources, cumulative effects recommendations of the 2003 NRC (2003) Report *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope,* bowhead whale feeding in the Beaufort Sea, deferral area boundaries, and ways to improve stakeholder communication. This ongoing dialogue may result in the development of new mitigation, scientific studies, and avenues of cooperation (USDOI, MMS, 2004).

III.H. Cumulative Impacts Analysis.

Cumulative impacts can result from individually minor but collectively significant actions taking place over time. Cumulative effects are the identifiable present effects of past actions to the extent that they are relevant and may have a continuing additive effect to the potential effects of the Proposed Action and its alternatives. Cumulative impacts describe the incremental impact from the Proposed Action when added to the aggregate effects of past actions together with other current and reasonably foreseeable future actions.

The Proposed Action is MMS-permitted seismic surveying and NMFS-issued ITAs in the Arctic OCS. Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, there is the potential that seismic surveys will continue in the Chukchi and Beaufort seas for the foreseeable future, and be dependent on: (1) the amount of seismic survey data that was collected in the past; (2) what the data indicate about the subsurface geology; and (3) the results of Beaufort Sea Sale 202 and Chukchi Sea Sale 193.

The cumulative analyses acknowledge continuing effects from past activities and potential future additive effects from the Proposed Actions, where appropriate. The main agents of the cumulative activity scenario are: (1) marine seismic surveys; (2) vessel traffic and movements; (3) aircraft traffic; (4) oil and gas exploration and development in Federal and State waters; and (5) miscellaneous activities and factors (see Section III.C.). Cumulative effects may arise from single or multiple actions and may result in additive or interactive effects. Interactive effects may be either countervailing—where the net adverse cumulative effect is less than the sum of the individual effects, or synergistic—where the net adverse cumulative effect is greater than the sum of the individual effects. 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.

III.H.1 Fish/Fishery Resources and Essential Fish Habitat

III.H.1.a. OCS Seismic-Survey Activities. Impacts to fish resources from past seismic-survey activity in the Chukchi and Beaufort seas (Figures III.C.1-3) were not monitored or studied. We cannot determine whether or to what extent past seismic surveys conducted in the Chukchi and Beaufort seas influenced results obtained in the fish surveys conducted in the past.

Impacts to fish, fishery resources, and essential fish habitat (EFH) from seismic surveys are outlined in Section III.F.1. Seismic surveys conducted on the OCS beyond 2006 would be anticipated to result in the same potential for impacts as outlined in Section III.F.1 and, if impacts were to occur from surveys in 2007-2010, they potentially would add an incremental degree of adverse but not significant impacts to fish resources and EFH. In comparison, over the last few decades the Gulf of Mexico has experienced a much higher level of seismic activity on an annual basis than what is projected over the next 4-5 years in the Alaskan Arctic. Despite this much higher level of activity in the Gulf of Mexico, no population-level or significant impacts to fish resources and EFH have been documented in that region from seismic surveys. Although there are different species and environmental conditions in the Alaskan Arctic than in the Gulf of Mexico, the types of impacts to fish resources and EFH would be expected to be similar, therefore, making a comparison between the two regions possible.

In the Beaufort Sea OCS, site-clearance surveys in 2006 are projected on up to three oil and gas prospects. Figure III.C-4 illustrates the existing locations of MMS OCS leases in the Beaufort Sea. Currently leased blocks occur approximately 5 km (3 mi) or more offshore of Dease Inlet and Smith Bay, the Colville River around to the Sagavanirktok River; the Canning River Delta; the Hulahula and Okpilak rivers; Kaktovik; and Aichilik River. Many of these areas, such as Dease Inlet, Smith Bay, and the Colville and Sagavanirktok rivers, are important nursery and critical summer feeding habitat to diadromous and marine fishes. Potential impacts from site-clearance surveys in these areas may include: displacement, behavioral disturbance and, in some specific cases, mortality, or physiological damage. These impacts could be short term or long term.

III.H.1.b. Seismic-Survey Activities in Alaska State Waters. No seismic surveys are forecast to occur in State waters in the Chukchi Sea. One seismic survey in State waters of the Beaufort Sea is forecasted to occur in each of the following years: 2006, 2008, and 2010. Effects from seismic surveys in Federal waters may be amplified if seismic surveys were to simultaneously occur in close proximity to those occurring in State waters. However, companies are expected to maintain the minimum required separation because, seismic sound sources operating in close proximity will affect data collection. In addition, three surveys in State waters over the next 4 years are projected; these would not be expected to add a significant level of activity in the Proposed Action area.

III.H.1.c. Other Seismic-Survey Activities. The University of Texas at Austin, Institute for Geophysics plans to conduct a seismic survey in the western Canada Basin, Chukchi Borderland, and Mendeleev Ridge, Arctic Ocean, during the period of approximately July 15 to August 25, 2006. The project will include collection of seismic reflection and refraction data as well as sediment coring. An assessment of the proposed survey concluded that any injurious effects on fish would be limited to very short distances; that adult fish near seismic operations are likely to avoid the sound source, thereby avoiding injury; and that the proposed seismic program, consisting of one seismic-survey vessel operating well out into the western Arctic Ocean, is predicted to have negligible to low adverse physical effects on the various life stages of fish and invertebrates encountered during its ~40 day duration and 3,625 km extent (LGL Alaska Research Assocs., Inc., 2006). GX Technology Corporation plans a 2D seismic survey in late summer and autumn this year in the Mackenzie Delta of the Canadian Beaufort Sea. Potential effects would be similar to those described in Section III.F.1.i.

III.H.1.d. Vessel Traffic and Movements. Vessel traffic introduces noise into the marine environment that may disturb fish behavior. Its impact upon fish/fishery resources and EFH may be adverse but is regarded as negligible. Vessels may anchor or place other equipment overboard into the sea or on the seafloor. Anchoring or overboard equipment may damage fragile biocenoses, such as the Boulder Patch or macroalgal beds (described in Section III.F.1.e(1)). The OCS seismic-survey vessel operators are to avoid such areas with their equipment and operations. Other vessel operators may or may not avoid the areas, although the Boulder Patch is well known and mapped.

III.H.1.e. Air Traffic. Air traffic is not anticipated to contribute additional impacts to fish/fishery resources and EFH.

III.H.1.f. Oil and Gas Exploration and Development Activities in Federal Waters. Section III.C.4.a briefly describes oil and gas development activity on the OCS in the Chukchi and Beaufort seas. Information describing the impacts realized by past and present exploration and development activities on the Alaskan Arctic OCS is limited for fish resources and EFH. Exploratory drilling typically involves introducing additional noise into the marine environment, temporarily increased localized turbidity, and the disturbance, fragmentation or destruction of habitats (including EFH) and fish/fishery resources. Drilling activity also may lead to direct and indirect mortality of fish resources. Fish/fishery populations readily may absorb such mortalities or habitat loss if the respective population is sufficiently abundant and widespread, or if the habitat loss is only a small fraction of the available habitat necessary to complete all phases of its life history. Exploration drilling also requires additional vessel and traffic. No exploration drilling is expected to occur during the period of the Proposed Action seismic surveys.

III.H.1.g. Oil and Gas Exploration and Development in State Waters. Section III.C.4.b. briefly describes oil and gas exploration and development activities in State of Alaska waters of the Chukchi and Beaufort seas. Information describing the impacts realized by past and present development activity in state waters is unknown for fish resources and EFH. Impacts are generally similar to those described above, except the fish assemblages affected by activities in state waters are generally different than those assemblages occurring in Federal waters. One important exception is that past developments in state waters have relied on the construction of causeways connecting the developments to the mainland. The impacts of such causeways are generally regarded as adverse to EFH and some fish/fishery resources, the magnitude of which is unknown.

III.H.1.h. Subsistence-Harvest Activities. Section III.G.2 describes subsistence activities on the North Slope. While subsistence-harvest resources may differ from community to community, fishes are among the primary resources harvested in the NSB. Moreover, fishes are the second or third most important resource after caribou and bowhead whales in some communities. Populations of North Slope villages are increasing by as much as 31-119% over the last 30 years (USDOI, BLM, 2005:Table 4-20). The Alaska Department of Fish and Game maintains a Subsistence Community Profile Database that shows subsistence harvest of fish resources also is increasing over time, indicating that population growth in villages leads to more subsistence harvest of fish resources.

Information is lacking regarding stock estimates of available fish resources used in subsistence harvests. Harvesting fish resources removes individuals from the population; hence, it has a negative effect to the resource. Many fish populations are capable of a sustainable harvest regime; however, some fish resources, such as many rare species, are unsuitable for even moderate-scale harvest practices.

Given that climate change is occurring in the region and that subarctic and boreal marine and coastal fish species, such as Pacific salmon, are expected to expand their distribution and abundance in the Chukchi (first) and Beaufort (subsequently) seas, the composition of fish resources harvested by North Slope villages is likely to change. With the warming climate and change in fish fauna, it is expected that the diversity and general biomass of fish resources will increase in the Chukchi and Beaufort seas. These more abundant resources may then supplement the trend of population growth in the villages. It is unknown whether the increase in fish diversity and biomass as a result of climate change in the region will be sufficiently synchronized with the burgeoning populations in the villages; population growth in the villages may outpace any increase in fish diversity and biomass in the region, and increased harvest of the resources may delay or countervail fish resource population expansions.

III.H.1.i. Military Activities. Upon occasion, military vessels may transit through the area; no military vessels or aircraft are home ported or stationed in the Beaufort and Chukchi seas. Military vessels may employ active or passive sonars and echo sounders in their operations that add adverse noise into the marine environment as introduced by other anthropogenic sources, such as offshore seismic surveys. Active sonar may kill, stun, or displace fish resources in proximity to the source. However, no military activities are expected in the Proposed Action area in the foreseeable future.

III.H.1.j. Industrial Development. Section III.C.5.c describes industrial development on the North Slope. Onshore industrial development may adversely affect anadromous streams in the region (i.e., EFH), and freshwater and diadromous fish populations. Adverse impacts may include mortality, sublethal harm, behavioral disturbances, and habitat fragmentation or loss. Impacts may or may not serve to decrease populations in the long term.

III.H.1.k. Community Development. Section III.C.5.d describes in general the North Slope communities, noting that most village populations are increasing. Communities are expected to require additional food resources to support burgeoning village populations, and impacts are described above relating to the subsistence harvest of fish/fishery resources. Community development projects may be beneficial and/or adverse to fish/fishery resources and EFH, depending on the scope of the projects.

Nearshore development activities in Barrow and Kaktovik include curtailing shoreline erosion. Such activities may adversely impact fish/fishery resources and EFH but may benefit fish/fishery resource populations in the long term.

III.H.1.l. Climate Change. The response of fish/fishery resources to past and present climate change in the Bering, Chukchi, and Beaufort seas large marine ecosystems (LME's) are described in detail in Sections III.F.1.d and III.F.1.h. The effects of arctic warming appear to already be influencing fish/fishery resource populations in the Chukchi and Beaufort seas.

Information from past surveys indicate some species (e.g., capelin, arctic cisco, arctic cod, arctic staghorn sculpin, Pacific sand lance, Bering flounder) exhibit considerable interannual variation in distribution and abundance, and that such variation is likely a product of dynamic meteorological and oceanographic conditions. We also know that climatic warming has been and continues to influence the Bering, Chukchi, and Beaufort seas LME's. We know that a major ecosystem shift occurred in the southeastern Bering Sea in the late 1970's; that the northern Bering Sea experienced a major ecosystem shift in the last decade or more. These major ecosystem shifts are coincident with changes to the distribution and abundance of fish resources; and are best explained by climatic warming in the arctic and subarctic regions. We have no reason to expect that the fish fauna of the Chukchi and Beaufort seas remained static since they were last surveyed; instead, there is good evidence that the fish resources of the Chukchi Sea are adjusting their distribution and abundance to the climatic warming occurring there, and that fish resources of the Beaufort Sea are adjusting as well, although presumably not as measurably as those fish resources inhabiting the Chukchi Sea.

Climatic warming in the Chukchi and Beaufort seas LME's, if it continues, is likely to result in impacts, potentially significant, to fish/fishery resources and EFH at various points in the future. These likely will occur at different intervals depending upon the respective populations. Some fish/fishery resource populations will expand their distribution and abundance, while others will contract. The rate at which climate change leads to significant impacts to fish/fishery resource populations is variable and uncertain; however, most of the main agents identified in the cumulative activity scenario may result in population reductions and/or habitat degradation or loss. Each year that a population is decreased by one of the main agents influences how rapidly that population also responds to climate change. For some fish resource populations, the cumulative impacts of the main agents are likely to synergistically interact with climate change impacts and accelerate the onset of significant impacts to the population. Ecological theory, supported by field studies, indicates that moderate to significant adjustments in one population typically produce a cascading effect in the ecosystem whereby competitors, prey, and predator populations also adjust.

Climate change likely will modify habitats (e.g. EFH), making some areas more or less suitable habitat than in the past (e.g., spawning habitat for Pacific salmon), depending on the type of climate change. Anthropogenic disturbances associated with the main agents identified in the cumulative activities scenario synergistically may interact with climate change and accelerate potential impacts to habitat; changes may be beneficial, adverse, or both.

One beneficial aspect of climate change to peoples of the North Slope is the likelihood that fish/fishery resource diversity and biomass is expected to increase. However, some fish/fishery resource populations that seabirds, marine mammals, and subsistence users depend on are expected to contract, potentially triggering a variety of cascading impacts.

III.H.1.m. Conclusion. Fish/fishery resources and EFH in the Chukchi and Beaufort seas potentially are affected by a variety of activities including seismic surveys on the OCS and in State waters; vessel and air traffic; oil and gas exploration, development, and production activities on the OCS and in State waters; subsistence activities; military activities; industrial and community development; and arctic warming. Seismic surveys, especially as mitigated under the Proposed Action alternatives, are not expected to add significantly to the impacts from past, present, and future activities.

III.H.2. Marine and Coastal Birds.

III.H.2.a. Seismic-Survey Activities. Marine and coastal birds may be slightly affected by the Proposed Action and other seismic-survey activities in the Proposed Action area. The MMS requires that seismic-survey vessels not operate within 15 mi of each other at any one time. This limits signal interference and can provide movement corridors for fish, marine mammals, and marine birds. The total number and distribution of seismic-survey vessels operating in the area would result in a relatively small portion of the total Proposed Action area being ensonified at any one time. It is unlikely that fish prey species for marine birds would be affected by seismic activities to the degree that would adversely affect marine birds' foraging success. If fish prey species leave the area of seismic-survey activity, that effect would be transitory and limited to small portions of the Proposed Action area. Because seismic-survey activities are temporary and geographically dispersed, the cumulative impacts to marine birds would not be significant.

III.H.2.b. Vessel Traffic and Movements. Up to six seismic-survey vessels and their attendant support vessels would be added to the existing level of vessel traffic in the Chukchi and Beaufort seas. There may be localized, temporary displacement and disruption of feeding for some offshore species, but such impacts to marine birds would be similar to those caused by other larger vessels passing through the area. Any cumulative adverse impacts to marine birds would be negligible.

III.H.2.c. Air Traffic. Aircraft needed to support seismic-survey vessels and possibly to conduct aerial monitoring for marine mammals would be a relatively small addition to existing commercial air traffic servicing local communities. No adverse cumulative impacts to marine birds are anticipated from air traffic required to support seismic-survey activities or related aerial monitoring.

III.H.2.d. Conclusion. Seismic surveys on the OCS and in State waters and by vessel and air traffic have a collective potential to affect marine and coastal birds in the Chukchi and Beaufort seas; however the incremental increased potential for impacts from the proposed action, including the inclusion of mitigation measures, is not expected to add significantly to the impacts from past, present, and future activities.

III.H.3. Threatened and Endangered Marine Mammals.

III.H.3.a. Bowhead Whales. 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 Seas 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 Action. However, currently available information indicates that at the population level, bowheads that use the Beaufort Sea and Chukchi Sea Planning Areas currently are 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 already may 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 Alaskan 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. Because 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 also is 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 planning 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, the Biological Evaluation (BE) prepared for consultation with NMFS on Beaufort Sea Sale 195, and the recent BE prepared for NMFS on Arctic Region OCS activities (http://www.mms.gov/alaska/cproject/cproject.htm), the MMS 2006 PEA on Arctic Seismic, and the MMS 2006 DEIS on lease sale 193 and seismic activity in the Chukchi, 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' *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). Information is also available in the 2005 Alaska Marine Mammal Stock Assessment report (Angliss and Outlaw, 2005).

III.H.3.a(1) Introductory Information Relevant to Evaluation and Interpretation of Potential Cumulative Effects on Bowheads. 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.

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.

III.H.3.a(2) 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 near-term future oil- and gas-related activity;
- previous, present and near-term future non-oil and gas industrial development within the range of the bowhead;
- past, current and near-term 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.

III.H.3.a(2)(a) Historical Commercial Whaling. 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. 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. 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. As noted in the Section III.F.3, 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. 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. Commercial whaling also may have caused the extinction of some subpopulations and some temporary changes in distribution.

III.H.3.a(2)(b) 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 NMFS (NOAA) (see Appendix 9.5 of NMFS, 2003b). Additional discussion of the cumulative impacts of subsistence hunting on bowheads can be found in NMFS' Arctic Region Biological Opinion on oil and gas development, production and exploration (NMFS, 2006a).

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. 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.

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. 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 status of the population is closely monitored, and these activities are closely regulated.

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.).

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.

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.

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.

III.H.3.a(2)(c) Climate Change. Climate change also is referred to as arctic warming, global warming, or climate warming. We note that environmental effects compatible with climate warming already have occurred in the Arctic. There is a growing consensus that more such changes are likely to occur. Additional discussion of the cumulative impacts of climate change on bowheads can be found in NMFS’ Arctic Region Biological Opinion (NMFS, 2006a).

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 (Maslanki 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.

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.

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 premeeting 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.

III.H.3.a(2)(d) Commercial Fishing, Marine Vessel Traffic, and Research Activities. Based on available data, previous incidental take of bowhead whales apparently has occurred only rarely. Additional discussion of the cumulative impacts of commercial fishing, vessel traffic, and research activities on bowheads can be found in NMFS' Arctic Region Biological Opinion (NMFS, 2006a).

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.

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. 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.

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. NMFS (2003b) also concluded 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.

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. SEARCH SSC (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.

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."

There has been speculation recently that commercial shipping through the Northwest Passage is likely to substantially increase in the coming decades. 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.

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. 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.

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).

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.

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..

In addition to acting as a source of noise and disturbance, marine vessels could potentially strike bowhead whales, causing injury or death.

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.

III.H.3.a(2)(e) 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.

III.H.3.a(2)(f) Offshore Oil- and Gas-Related Activities and other Industrial Activities. We provide a description of past, current, and reasonably foreseeable oil and gas activities in Section III.C. Additional discussion of the cumulative impacts of offshore oil and gas activities and other industrial activities on bowheads can be found most recently in NMFS' Arctic Region Biological Opinion (NMFS, 2006a) and in MMS' DEIS on Lease Sale 193 and seismic surveying in the Chukchi (MMS, 2006c).

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 since 1979. 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. Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea.

Many offshore activities 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 (although studies have not specifically focused on addressing this issue). However, there are no long-term oil and gas developments in the offshore within bowhead high use areas. 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, however, are 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 1990's 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 1990's (Wainwright, 2002). Table 4 of Wainwright (2002:45) gives information about the kinds and levels of seismic and acoustic activity in the 1990's. Figure 11 of Wainwright (2002:41) summarizes that except in 1990 and 1998, seismic surveying activity was completed by September 30, 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 are 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 1990's, 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 also are incomplete for the Chukchi Sea, we reach the same general conclusions.

Potential Impacts of Noise from Production Facilities. 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. Northstar is built on an artificial gravel island in State of Alaska waters 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.

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 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.

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 even from a distance.

Future Activities. Potential cumulative effects to bowhead whales from near-term future oil and gas activities could include behavioral responses to seismic surveys; aircraft and vessel traffic; exploratory drilling, and production that take place at varying distances from the whales. As discussed in Section IV, impacts from noise would be greater if icebreakers attended seismic vessels. 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, Wells, and Würsig, 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.

Overall, bowhead whales exposed to noise-producing activities associated with offshore oil and gas exploration 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.

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."

There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in bowheads. 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 *Exxon Valdez* oil spill, 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.

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 North Aleutian Basin Planning Area currently is under Presidential withdrawal from leasing. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-year OCS leasing program.

In the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a), 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 1990's. 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 1990's. GX Technology Corporation plans a similar seismic survey in late summer and autumn this year in the Mackenzie Delta of the Canadian Beaufort Sea. Section III.F.3(f)(6)(b) describes the study on the behavioral response of bowhead whales in feeding areas to the 2001 seismic survey (Miller and Davis, 2002). Potential effects from the GX Technology Corporation survey could be similar. 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-1970's 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. NMFS and MMS will continue to explore ways to determine the potential for cumulative impacts on these whales.

Overall, the Proposed Action seismic surveys are likely to result in incremental cumulative effects to bowhead whales through the potential exclusion or avoidance of bowhead whales from feeding or resting areas and disruption of important associated biological behaviors. The impact analysis (see Section IV) of the likely range of effects and the likelihood of exposures resulted in a likelihood of adverse behavioral effects that may rise to the level of significance if not properly mitigated. Mitigation measures included in the Alternatives 3 through 8 and those imposed through the MMPA authorizations process are designed to avoid Level A Harassment (injury), reduce the potential for population-level significant adverse effects on bowhead whales, and avoid an unmitigable adverse impact on their availability for subsistence purposes. We also developed additional measures to help reduce the level of uncertainty during the conduct of the seismic-survey activities, which provide yet another level of mitigation and protection. All of these efforts are meant to further reduce impacts and avoid significant effects. Therefore, NMFS and MMS conclude that seismic surveys under the Proposed Action, especially as mitigated under Alternatives 3 through 8, are not expected to add significantly to the cumulative impacts on bowhead whales from past, present, and future activities.

III.H.3.b Fin Whales.

III.H.3.b(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, Silber, and Payne, 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.

III.H.3.b(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). 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" and
2. 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, NMFS 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) concluded that the total estimated mortality and serious injury incurred by this stock as a result of interactions with commercial fisheries is 0. Reported instances of fin whale deaths due to vessel strikes are low. 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 North Aleutian Basin Planning Area currently is under Presidential withdrawal from leasing. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-year OCS leasing program. 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.

Overall, the Proposed Action seismic surveys are likely to result in some incremental contribution to effects on fin whales through the exclusion or avoidance of fin whales from feeding or resting areas and disruption of important biological behaviors. These effects would be limited in scope due to the low level of fin whale occurrence in the Proposed Action area. Mitigation measures included in the Alternatives 3 through 8 and imposed through the MMPA authorizations processes are designed to avoid Level A Harassment (injury), reduce the potential for Level B Harassment (disturbance), and reduce the potential for adverse effects on whales. Therefore, NMFS and MMS conclude that seismic surveys under the Proposed Action, especially as mitigated under Alternatives 3 though 8, are not expected to add significantly to the cumulative impacts on fin whales from past, present, and future activities.

III.H.3.c 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 1978b). Unregulated hunting legally ended in the North Pacific in 1966.

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. NMFS (1991a) reported that at least five photographed humpbacks in southeastern Alaska had gashes and dents probably caused by vessel strikes.

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 ft or 305 m 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).

The North Aleutian Basin Planning Area currently is under Presidential withdrawal from leasing. The MMS is considering whether to request amendment of the withdrawal to allow the North Aleutian Basin Planning Area to be included in the 2007-2012 5-year OCS leasing program. 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 impacters 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.

Potential cumulative effects on both the North Pacific stock and on the Western North Pacific stock warrant concern and monitoring. Overall, the Proposed Action seismic surveys are likely to result in some incremental contribution to effects on humpback whales through the exclusion or avoidance from feeding or resting areas and disruption of important biological behaviors. Mitigation measures included in Alternatives 3 though 8 and imposed through the MMPA authorizations processes are designed to avoid Level A Harassment (injury), reduce the potential for Level B Harassment (disturbance), and reduce the potential for adverse effects on humpback whales. Therefore, NMFS and MMS conclude that seismic surveys under the Proposed Action, especially as mitigated under Alternatives 3 through 8, are not expected to add significantly to the cumulative impacts on humpback whales from past, present, and future activities.

III.H.4. Other Marine Mammals.

We identify ice-dependent pinnipeds as being particularly vulnerable to the impacts of continued climate change and, therefore, conclude that the potential cumulative effects on them are a primary concern and warrant continued close attention and effective mitigation practices.

Oil and gas activities, increasing concentrations of contaminants in the Arctic, and large volume fish removals in the Bering Sea also may be affecting marine mammal populations (Quakenbush and Sheffield, 2006). Marine mammals also face increased industrial development and increased human activity in the Arctic, which likely will interact synergistically in a cumulative fashion. There is a high degree of uncertainty regarding the spatial scope of potential industry activities on the Alaskan OCS. However, the Proposed Action would increase the overall industry footprint and add to the amount of industry activity in the project area.

The main effects of concern to polar bears are climate change, overharvest, and oil and fuel spills. Considering ongoing assessments of climate change in the Arctic (Sec. III.C.5.e), we conclude that the potential effects of climate change on polar bears are a primary concern, and warrant continued close attention and effective mitigation practices. Polar bears also face increased industrial development and increased human activity in the Arctic, which will likely interact synergistically in a cumulative fashion. Quantitative data are lacking that specifically addresses the potential cumulative impacts of development on polar bears and the effects of disturbance related to human activities on polar bear habitat use, as well as recruitment and survival (Perham, 2005).

III.H.4.a Seismic Surveying. Noise-producing activities are associated with some research, military, commercial, or other vessel use of the Beaufort and Chukchi seas. Such systems include multi-beam sonars, sub-bottom profilers, and acoustic Doppler current profilers. 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).

An assessment of the cumulative impacts of seismic surveys must consider the decibel levels used, location, duration, and frequency of operations from the Proposed Action as well as other reasonably foreseeable seismic-survey activity (see Sec. III.C - Cumulative Scenario). In general, the high-resolution, on-lease site-clearance seismic surveys are of lesser concern regarding impacts to cetaceans than the 2D/3D surveys. High-resolution and 2D/3D seismic surveys usually do not occur in proximity to each other, as they would interfere with each others' information collection methods. This indirectly minimizes the potential for effects on nonthreatened and nonendangered cetaceans.

For 2D/3D seismic operations under the Proposed Action, the potential for significant cumulative impacts to cetaceans from all seismic surveying (Federal and state waters and research) is limited through: (1) the required 15-mi separation for MMS-permitted surveys; (2) the mitigation and monitoring measures imposed for permits (see Section IV); and (3) requirements imposed under MMPA authorizations obtained by the seismic operators for mitigation to reduce impacts to species (i.e., no negligible impact) and subsistence (i.e., no unmitigable adverse impact). The potential for impacts to nonthreatened and nonendangered cetaceans exists from these survey activities. However, the contribution of the Proposed Action to existing or reasonably foreseeable seismic activities is expected to have an adverse but not significant impact on nonthreatened and nonendangered marine mammals in the Proposed Action area.

The University of Texas at Austin's Institute for Geophysics plans to conduct a scientific seismic survey to collect seismic reflection and refraction data and sediment cores to reveal to crustal structure and composition of submarine plateaus in the western Amerasia Basin in the Arctic Ocean. Surveys took place from the U.S. Coast Guard cutter *Healy* during part of the 2006 open water season but activities were stopped shortly into the season due to human fatalities associated with the survey. It is unknown if the *Healy* will conduct surveys in future seasons.

On-ice seismic operations may impact bearded and ringed seals and polar bears. However, bearded seals generally are associated with the pack ice and only rarely use shorefast ice. Because they normally are found in broken ice that is unsuitable for on-ice seismic operations, bearded seals likely would not be encountered during this activity, and any disturbance to them would be distant and transient in nature. Impacts to ringed seals and polar bears would depend on where proposed activities occur.

III.H.4.b Vessel Traffic and Movements. Increasing vessel traffic in the Northwest Passage, which includes the Proposed Action area, increases the risks of oil and fuel spills and vessel strikes of marine mammals. The Proposed Action is not expected to contribute substantially to these risks, as seismic exploration will occur in ice-free seas and because most marine mammals will actively avoid close proximity to seismic operations.

Vessel traffic in the Alaskan Arctic generally occurs within 20 km of coast and usually is associated with fishing, hunting, cruise ships, icebreakers, Coast Guard activities, and supply ships and barges. No extensive maritime industry exists for transporting goods. Traffic in the Beaufort and Chukchi seas at present is limited primarily to late spring, summer, and early autumn.

For cetaceans, the main potential for effects from vessel traffic is through vessel strikes and acoustic disturbance. Regarding sound produced from vessels, it is generally expected to be less in shallow waters (i.e., background noise only by 10 km away from vessel) and greater in deeper waters (traffic noise up to 4,000 km away may contribute to background noise levels) (Richardson et al., 1995b). Aside from seismic-survey vessels, 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 typically is at a higher frequency, around 300 Hz (Richardson et al., 1995b).

In addition, Shell plans to conduct drilling operations in the Beaufort Sea in 2007-2009, which will involve at least two drill ships, two ice-breakers, a geo-technical coring vessel, at least 3 ice-strengthened support ships, and other assorted support vessels. Overall, the level of vessel traffic in the Proposed Action area, either from oil- and gas-related activities or other industrial, military or subsistence activities, is expected to be greater than in the recent past.

Ships using the newly opened waters in the Arctic likely will use leads and polynas to avoid icebreaking and to reduce transit time (USDOI, FWS, 1995). Leads and polynas are critical habitat for polar bears and belugas, especially during winter and spring, and heavy shipping traffic could disturb polar bears (USDOI, FWS, 1995)and belugas during these critical times.

III.H.4.c. Air Traffic. The Proposed Action is expected to generate some aircraft traffic, as helicopters may be used to transport personnel and supplies to and from the seismic survey vessels and aerial monitoring may be required to monitor for the presence of bowhead whales. These activities are not expected to add significantly to the amount of commercial and recreational air traffic already existing in the Beaufort and Chukchi Seas during the period of the Proposed Action.

The effects of air traffic on pinnipeds in the action area are expected to be local and transient in nature. Some groups of pinnipeds may be disturbed and leave their haulouts to enter the water, although their responses will be highly variable and brief in nature. Mitigation measures (see Section IV) prohibiting aircraft overflights of hauled out walrus below 1,000 ft will lessen aircraft impacts to these pinnipeds.

The effects of air traffic on polar bears in the action area also are expected to be local and transient in nature. Polar bears often, but not always, run away from aircraft passing at low altitude. Their responses also will be highly variable and brief in nature. However, if helicopters will be working out of Kaktovik, mitigation measures should be developed to prevent the disturbance/stampeding of the polar bears that utilize the barrier islands around Barter Island as a resting refuge.

Richardson et al. (1995a) suggest that airborne sounds (and visual stimuli) from aircraft may be less relevant to toothed whales than baleen whales but reactions are variable. For example, beluga responses in offshore waters near Alaska ranged from no overt response to abrupt diving and avoidance, and generally increased with decreasing flight altitude. Reactions to aircraft include diving, tail slaps, or swimming away from the aircraft track. Gray whale mother-calf pairs seem to be sensitive, while migrating gray whale responses are not as detectable. In other cases, both baleen and toothed whales showed no reaction to aircraft overflights. In summary, responsiveness depends on variables, such as the animal's activity at the time of the overflight or altitude level of aircraft, and most animals quickly resume normal activities after the aircraft has left the area. Richardson et al. (1995a) state that there is no indication that single or occasional overflights can cause long-term displacement of cetaceans.

III.H.4.d. Industrial Development (Including Oil and Gas Development in Federal and State Waters) and Related Noise. Oil- and gas-related and other industrial activities anticipated in the Proposed Action area include, but are not limited to, artificial-island construction, operation of drilling barges (onshore and offshore), pipeline construction, seismic surveys, and vessel and aircraft operations. The largest issue for evaluation of impacts is the effect of noise produced from these activities on marine mammals. The main noise-producing activities would include: (1) air-traffic noise; (2) construction; (3) drilling; (4) seismic surveys; and (5) vessel noise. The potential effects from these activities then must be considered in light of other existing noise levels within the Proposed Actions area (e.g., shipping noise, sounds of physical and biological environment) to determine if the Proposed Action and these additional noise impacts could cumulatively result in significant impacts to nonthreatened and nonendangered marine mammals. Details on source- and received-sound levels for many of these activities can be found in the MMS *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)* and Richardson et al., 1995a) and are considered in the analysis below.

The main areas of concern regarding the effects on marine mammals of industrial development are the potential for contamination and for disturbance caused by industrial noise in the air and water. Although the effects are unknown, industrial development has caused the development of a substantial amount of arctic haze in the Prudhoe Bay region, which likely precipitates into the marine environment as it drifts over the Arctic Ocean. As far as is known, marine mammals have not been affected by oil spilled as a result of North Slope industrial activities, although at least one polar bear fatality has resulted from ingestion of industrial chemicals (Amstrup, Myers, and Oehme, 1989). Unfortunately, it has not been possible to predict the type and magnitude of marine mammal responses to the variety of disturbances caused by oil and gas operations and industrial developments in the Arctic. More importantly, it has not been possible to evaluate the potential effects on populations.

Existing onshore and offshore facilities and their associated pipelines have the potential to release industrial chemicals or spill oil. Oil spills from offshore production activities are of concern because as additional offshore oil exploration and production, such as the Liberty, Oooguruk, and Nikaitchuq projects, occurs, the potential for large spills in the marine environment increases. However, environmental, safety, and operations procedures for these facilities and mitigation and monitoring requirements imposed in permits are designed to lessen the potential for oil and industrial chemicals to be introduced into the environment. In addition to potential oil spills from industry infrastructure, under the Proposed Action the potential also exists for oil/fuel spills to occur from associated support vessels, fuel barges, and even aircraft. However, this risk is considered slight in ice-free waters, and any spills which result from the proposed action will most likely be of small volume, and are not considered a major threat to marine mammals in the action area. Even if a small oil/fuel spill were to occur, it would be easily avoidable by marine mammals. Any impacts to them most likely would include temporary displacement until cleanup activities are completed and short-term effects on health from the ingestion of contaminated prey. The potential impacts of a larger spill are similar to those discussed in the Sale 202 EA (USDOI, MMS, 2006c).

Spilled oil can have a dramatic and lethal effect on marine mammals, as has been shown in numerous studies, and a major oil spill would have major effects on polar bears and seals. Offshore oil development represents a large proportion of reasonably foreseeable future development in the Arctic. In Canada, oil and gas developments in the Mackenzie River Delta and in the Beaufort Sea would extend oil and gas development along virtually the entire Beaufort Sea coast occupied by the Southern Beaufort Sea polar bear population. Devon Canada Exploration has identified nine offshore drilling targets within the landfast ice zone of the southern Beaufort Sea. According to Canadian law, Devon must drill at least one well in each of four areas by the end of the license period in 2009, or lose their license to the area. As a result, Devon plans to drill one well per winter through 2009 (Devon Canada Corporation, 2004). A detailed description of the potential effects of an oil spill on polar bears in the Southern Beaufort Sea can be found in the Sale 202 EA (USDOI, MMS, 2006c). It seems likely that an oil spill would affect seals in the arctic the same way the *Exxon Valdez* affected harbor seals (Frost et al., 1994) and the number of animals killed would depend largely on the season and size of the spill.

Drilling for oil and gas generally occurs from natural and artificial islands, caissons, bottom-founded platforms, and ships and submersibles. With varying degrees, these operations produce low-frequency sounds with strong tonal components. Drilling occurs once a lease has been obtained for oil and gas development and production and may continue through the life of the lease.

Underwater sound from vessels operating near the Northstar facility in the Beaufort Sea often were detectable as far as 30 km offshore, while sounds from construction, drilling, and production reached background values at 2-4 km. BPXA began to use hovercraft in 2003 to access Northstar, which have proven to generate considerably less underwater noise than similar-sized conventional vessels and, therefore, may be an attractive alternative when there is concern over underwater noise (Richardson and Williams, 2004). Richardson and Williams (2004) concluded that there was little effect from the low-to-moderate level, low-frequency industrial sounds emanating from the Northstar facility on ringed seals during the open-water period, and that the overall effects of the construction and operation of the facility were minor, short term, and localized, with no consequences to the seal populations as a whole.

Currently, there are no active offshore leases in the Chukchi and 181 active offshore leases in the Beaufort. Drilling activities are expected to occur in the near future on Beaufort leases and the Northstar facility and within the Hammerhead leases and shoreline within the Point Thomson unit. Drilling in State waters is also expected to occur.. Other active drilling will take place on land but at sites away from coastlines. Given this information, the duration and frequency of drilling within marine mammal habitat is anticipated to be relatively minimal. Therefore, the combination of the Proposed Action and current or reasonably foreseeable drilling operations is expected to have a negligible impact on nonthreatened and nonendangered marine mammals in the Proposed Action area.

Future industrial developments along Alaska's arctic coast undoubtedly will increase the number of polar bear-human conflicts that occur, as the frequency with which polar bears come into contact with people and structures is a function of the amount of activity in their habitats. Even with the best mitigation measures in place, it is certain that some bears will be harassed or killed.

Industrial developments onshore also have the potential to disturb female polar bears in their maternal dens, where they are most sensitive to noise and vehicular traffic. Undisturbed denning habitat is critical to their reproductive success. More human activity along the coast and nearshore could reduce the suitability of some areas for use by denning female bears.

Because the marine waters of the Beaufort and Chukchi seas have seen only limited and sporadic industrial activity, it is likely that there have been no significant effects or accumulation of effects on pinnipeds or fissipeds from industrial development in the Proposed Action area. Careful mitigation can help reduce the effects of future industrial developments and their accumulation through time. However, the effects of full-scale industrial development of the waters of the Chukchi and Beaufort seas likely would accumulate through displacement of polar bears and ringed seals from their preferred habitats, increased mortality, and decreased reproductive success.

Noise introduced into the environment from industrial activities, including drilling and seismic operations, is expected to have an adverse but not significant impact on nonendangered and nonthreatened marine mammals.

III.H.4.e Human Harvest. Basic calculations indicate that annual subsistence harvest of ringed, spotted, ribbon, and bearded seals account for approximately 1.0%, 8.9%, 0.2%, and 2.7% of their lowest estimated Alaskan population sizes, respectively. For walrus, annual subsistence harvest is estimated to account for 2.9% of their total population. It should be noted, however, that due to the lack of recent and accurate population data, these are rough estimates only.

Because the polar bear is a classic *K*-selected species, populations pushed below their level of maximum sustained yield can become unstable due to stochastic environmental processes and require a long recovery time; thus they are particularly vulnerable to overharvest (Amstrup, 2000). Sport hunting for polar bears has been banned in Alaska since 1972, although bears still are taken for subsistence, recreation, and handicrafts by Alaska Natives. In 1988, the Inuvialuit Game Council from Canada and the NSB from Alaska implemented the Polar Bear Management Agreement for the Southern Beaufort Sea, a voluntary agreement that limited the total harvest from the SBS population to within sustainable levels (Brower et al., 2002). The stipulations contained in this voluntary agreement are actually more stringent than those contained in the MMPA. Sustainable quotas under the agreement are currently set at 80 bears per year, of which no more than 27 may be female. This quota is believed to be at or near sustainable levels. Recent harvest levels (2000-2005) from the SBS stock averaged 37 individuals in the U.S. and 25 individuals in Canada, for an average harvest of 62 bears per year, well within the agreement's quotas (USDOI, FWS, unpublished data). However, recent information suggests that the SBS population may be smaller than previously estimated, which would indicate that current harvest levels may no longer be appropriate. For the same period, reported U.S. harvest levels of the CBS stock averaged 41 bears, while average Russian harvests of the CBS stock are believed to be much higher (Ovsyanikov, 2003; USDOI, FWS, 2003; USDOI, FWS, unpublished data).

A reliable estimate for the CBS stock of polar bears, which ranges into the southern Beaufort Sea, does not exist, and its current status is in question. In 2002, the IUCN/SSG Polar Bear Specialist Group estimated the size of the CBS population at 2000+ bears, though the certainty of this estimate was considered poor (Lunn, Schliebe, and Born, 2002). Russia prohibited polar bear hunting in 1956 in response to perceived population declines; however, both sport and subsistence harvest continued in Alaska until 1972. During the 1960's, hunters took an average of 189 bears per year from the CBS population, an unsustainable rate of harvest that likely caused significant population declines. With the passage of the MMPA in 1972, which prohibited sport hunting of marine mammals, the average annual Alaska harvest in the Chukchi Sea dropped to 67 bears per year. However, with the collapse of the Soviet empire in 1991, levels of illegal harvest dramatically increased in Chukotka in the Russian Far East (Amstrup, 2000; USDOI, FWS, 2003). While the magnitude of the Russian harvest from the CBS is not precisely known, some estimates place it as high as 400 bears per year, although the figure is more likely between 100 and 250 bears per year. Models run by the FWS indicate that this level of harvest of the CBS population is most likely unsustainable, and that an average annual harvest of 180 bears (4.5% of the starting population) potentially could reduce the population by 50% within 18 years (USDOI, FWS, 2003). This simulated harvest level is similar to the estimated U.S./Russia annual harvest for the period 1992-2006, as well as to the unsustainable harvest levels experienced in Alaska in the 1960's, indicating that the CBS stock of polar bears may well be in decline due to over harvest. The FWS calculations were based on a starting population of 4,000 bears, which is believed to fairly characterize a healthy CBS population. However, because of the unknown rate of illegal take currently taking place, in 2006, the IUCN/SSG Polar Bear Specialist Group (PBSG) designated the status of the CBS stock as "declining" from its previous estimate of 2000+ animals (IUCN/SSG Polar Bear Specialist Group, 2006). Therefore, the current levels of illegal harvest of the CBS polar bear stock, in conjunction with climate change effects, probably are the greatest current threats to this population.

Compared to harvest levels from the 1980's, Alaskan Native subsistence harvests of polar bears have declined substantially in the Chukchi Sea over the last decade. This decline may be due to a declining polar bear population, which provides fewer animals for harvest, changing environmental conditions, changing demographics among hunters resulting in decreased hunter effort, or a combination of these factors.

In the Proposed Action area, there are lethal takes of beluga whales by Alaskan Natives for subsistence purposes. The Proposed Action is not expected to result in lethal takes of belugas.

III.H.4.f Military Activities. Current and foreseeable military activities in the Proposed Action area are not expected to be extensive; therefore, their potential to cause impacts to marine mammals is considered slight.

In the past, individual marine mammals, particularly polar bears, likely were subjected to increased hunting pressure due to the military presence in the Arctic, particularly at the DEW-Line sites. However, sport hunting of marine mammals was banned with the passage of the MMPA in 1972, and polar bear populations are believed to have recovered in the subsequent 34 years. One male polar bear is known to have been killed in Defense of Life and Property in 1993 at the Oliktok DEW-Line station after it severely mauled a resident worker there.

III.H.4.g Community Development. No significant community developments are foreseen in the near future in the nearshore environments of the Beaufort and Chukchi seas during the open-water period in 2006. The Proposed Action would add a slight amount of community development needs to support increased personnel and would involve mainly socioeconomic impacts. Community development activities are not expected to introduce any additional sounds into the action area during the proposed activities.

III.H.4.h Climate Change. Sea ice is changing in thickness, persistence, and distribution (Sec. III.A.4, Sea Ice). As explained in Section III.A.4, analysis of long-term data sets indicate that substantial reductions in both the extent and thickness of the arctic sea-ice cover have occurred during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 200; NASA, 2005). In Alaska and western Canada, winter temperatures have increased by as much as 3-4 °C (5.4-7.2 °F) over the last 50 years, and rain events have increased substantially across much of the Arctic (ACIA, 2004). Evidence indicates that oceanographic conditions have been changing in the Bering Sea, which suggests changes in the ecosystem may be occurring as well (Quakenbush and Sheffield, 2006).

Many authors have reported climate-change effects on marine mammals. For marine mammals adapted to life with sea ice, the effects of reductions in sea ice are likely to be reflected initially by shifts in range and abundance (Tynan and DeMaster, 1997), particularly for seals, gray whales, and walrus. This is due not only to the changing sea-ice habitat, but also to concurrent shifts in their prey distributions, such as fish, bivalves, and amphipods. Ice-associated pinnipeds, which rely on suitable ice substrate for resting, pupping, and molting, may be especially vulnerable to such changes. Indirect effects of climate change include regional or seasonal shifts in prey availability, which can affect nutritional status, reproductive success, and geographic range, and alterations in the timing or patterns of migrations, which may produce changes in species distribution and stock structure. Changes in the extent and concentration of sea ice may alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and stock structure of some species, including beluga and gray whales. Alteration in the extent and productivity of ice-edge systems may also affect the density and distribution of important ice-associated prey of marine mammals, such as arctic cod and sympagic ("with ice") amphipods" (Tynan and DeMaster, 1997).

In the past decade, geographic displacement of marine mammal-population distributions has coincided with a reduction in sea ice and an increase in air and ocean temperatures in the Bering Sea (Grebmeier et al., 2006). As a result, between 1981 and 2002, gray whales relocated their primary foraging area from the Chirikov Basin, adjacent to the north shore of St. Lawrence Island, northward into the Chukchi Sea (Moore, Grebmeier, and Davies, 2003). Similar displacements of key walrus foraging areas could result from recent population declines of bivalves, the primary prey item of walrus, in the Bering Sea (Lovvorn et al., 2003). Continued warming is likely to increase the occurrence and resident times of subarctic species (spotted seals, walrus, and beluga whales) in the Chukchi and Beaufort seas. Negative effects on truly arctic species (polar bears, ringed seals, and bearded seals) also are likely to result from climate warming. Polar bears and ringed seals depend on sea ice for their life functions, and continued reductions in the extent and persistence of ice in the Beaufort and Chukchi seas will almost certainly have negative effects on their populations (USDOI, FWS, 1995).

Climate change also has been implicated in the mortality of marine mammals. In early May 2005, a powerful storm blew more than 40 km for a 3-day period in the Bering Sea west of St. Lawrence Island. Because of the early breakup of the pack ice and reduced sea-ice cover, the ocean in the immediate vicinity of Gambell was nearly ice free, which allowed enough fetch for large waves to form, and forced migrating walrus herds to concentrate onto small icefloes. The large waves generated by the storm broke over all but the largest icefloes in the area. Local hunters indicated that the herds were negatively impacted by the severe weather. After the storm, hunters reported seeing only one or two calves among hundreds of females and harvesting many lactating females without calves. Walrus were so exhausted after the storm that they would not leave the ice when the hunters approached them, or even when animals on the same floe were harvested (USDOI, FWS, 2005b). This event has negative implications for future walrus recruitment and reproductive success. Similarly, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in the fall of 2004. They attributed this phenomenon to longer open-water periods and reduced sea-ice cover.

The main impacts of climate change on cetaceans would result from habitat changes (e.g., ice melting) that might impact prey migration, location, or availability as well as potentially impacting existing migratory routes and breeding or feeding grounds.

Because of the Arctic Ocean's relatively low species diversity, it may be particularly vulnerable to trophic-level alternations caused by global warming (Derocher, Lunn, and Stirling, 2004). For example, Mecklenburg et al. (2005) and others show that changes in the arctic ice cover are affecting arctic fish (Loeng, 2005). In Hudson Bay for instance, Gaston, Woo, and Hipfner (2003) concluded that the decline in arctic cod and increase in capelin and sand lance were associated with a general warming of the waters and a significant decline in the amount of ice cover. In fact, their evidence suggests that the fish community in northern Hudson Bay shifted from Arctic to Subarctic from 1997 onwards, which was reflected in dramatically altered diets of thick-billed murres (*Uria lomvia*) in the region. Likewise, fish assemblages and populations in Alaska have undergone observable shifts in diversity and abundance during the last 20-30 years. Changes in distributions of important prey species, such as arctic cod, could have cascading effects throughout the ecosystem.

The arctic cod is a pivotal species in the arctic food web, as evidenced by its importance as a prey item to belugas, narwhals, ringed seals, and bearded seals (Davis, Finley, and Richardson, 1980). In arctic regions, no other prey items compare with arctic cod in abundance and energetic value. Arctic cod are believed to be adapted to feeding under ice and ice-edge habitat is critical to cod recruitment (Tynan and DeMaster, 1997). Indeed, hydroacoustic surveys of fish have recorded the highest densities immediately below landfast sea ice (Crawford and Jorgenson, 1990). Because the life history of arctic cod is closely linked to sea ice, regional changes in the extent of sea ice may lead to a redistribution of this key prey species, and consequently to redistributions and altered migrational patterns of the marine mammals that feed on it, such as belugas, ringed seals, and spotted seals. For example, belugas are known to forage at ice edges and ice cracks (Bradstreet, 1982; Crawford and Jorgenson, 1990), presumably to feed on arctic cod, and beluga feeding aggregations primarily occur in nearshore areas, where dense schools of arctic cod concentrate in late summer. As a result, the IWC considers all stocks of beluga whale to be particularly vulnerable to arctic climate change.

Reduction in the extent of the ice edge and its associated biota may have deleterious consequences for marine mammals that have evolved with these unique systems (Tynan and DeMaster, 1997). For example, there is a linkage between ice algal production and benthic communities. Ungrazed ice algae that settle to the bottom provide a flux of carbon to the benthic community on which many marine mammals depend (Tynan and DeMaster, 1997). This sedimentation of carbon on shallow arctic shelves is critical to the benthic foraging success of walruses, bearded seals, and gray whales, and regional changes in this carbon flux could affect the distribution and reproductive success of these animals. In addition, the juxtaposition of the ice edge with shallow-shelf habitat suitable for benthic feeding is critical to walruses and bearded seals.

Species such as walrus and bearded seals feed on benthic prey, and are therefore found on ice cover over shallow continental shelf areas (Derocher, Lunn, and Stirling, 2004). Arctic warming may move the summer position of the ice edge over deep water unsuitable for these shallow water adapted species; the effects of such changes on their populations could be substantial (Tynan and DeMaster, 1997). As sea ice declines, these species are forced further offshore to find suitable habitat for feeding and pupping, making these activities more difficult if not impossible, which may ultimately lead to a net reduction in their abundance (ACIA, 2004; Derocher, Lunn, and Stirling, 2004). Recent trends have resulted in seasonal sea-ice retreating off the continental shelf and over deep Arctic Ocean waters. This trend poses adaptive challenges for the walrus population (Tynan and DeMaster, 1997). For example, in the summer of 2004, nine motherless walrus calves were observed stranded on icefloes in deep waters off of northwest Alaska. These calves may have been abandoned by their mothers due to lack of food, and the authors speculate that many more motherless calves than the nine observed were present in their study area. Walrus calves are dependent on maternal care for 2 years or more before they are able to forage for themselves and females with calves are not normally observed in deep Arctic basin waters due to the lack of food and depth limits to their diving. Thus, such events could have negative implications for the Pacific walrus population if they become more common (Cooper et al., 2006).

Phocid seals also may be particularly vulnerable to habitat loss from changes in the extent or concentration of Arctic ice, because they depend on pack-ice habitat for pupping, foraging, molting, and resting (Tynan and DeMaster, 1997; ACIA, 2004; Derocher, Lunn, and Stirling et al., 2004). The ringed seal, a species intricately entwined with the sea ice, likely would be among the first marine mammals to show the negative effects of climatic warming (Ferguson, Stirling, and McLoughlin, 2005). This species depends on the stability of ice for the successful rearing of its young (Burns, Shapiro, and Fay, 1981), and arctic warming likely would reduce its abundance and distribution. In the eastern Beaufort Sea, Harwood, Smith, and Melling. (2000) found that early breakup of the ringed seals' landfast-ice breeding habitat had significant negative impacts on growth, condition, and survival of nursing pups. Although earlier spring breakup and an increased open-water season initially may benefit growth and reproduction of seals and, hence, recruitment, a continued trend toward earlier breakup eventually could be detrimental to ringed seals (Ferguson, Stirling, and McLoughlin, 2005). For example, young seal pups that are forced into open water at an early age may be exposed to increased risks of predation and thermal challenges (Smith and Harwood, 2001). Swimming exacts a high energy cost from pups (Smith, Hammill, and Taugbol, 1991), and they require access to ice for resting after they have molted and weaned (Smith, 1987).

Unseasonal warming and unusual rainfall events due to climate change both have been implicated in lower ringed seal reproduction and pup survival (Smith and Stirling, 1975; Hammill and Smith, 1991; Stirling and Smith, 2004). In WHB, spring breakup has occurred earlier each year over the past 30 years (Ferguson, Stirling, and McLoughlin, 2005) and decreased snow depth, particularly below 32 centimeters, has corresponded with a significant decrease in ringed seal recruitment there. Pups in subnivean birth or haulout lairs with thin snow roofs are more vulnerable to predators than those in lairs with thick roofs (Smith and Stirling, 1975; Hammill and Smith, 1991; Furgal, Innes, and Kovacs, 1996), as well as to death by exposure and hypothermia due to den collapse (Smith, Hammill, and Taugbol, 1991). For example, during a mild period with some rain in Canada in 1979, hunting success of polar bears was three times greater than previously recorded in the high Arctic, largely because many ringed seal-pup lairs melted open, exposing them to predation (Hammill and Smith, 1991; Stirling and Smith, 2004). Researchers suspected that most of the pups in the affected area eventually were killed by polar bears, arctic foxes, and possibly gulls. Earlier spring breakup of sea ice together with snow trends suggest continued low pup survival in WHB (Ferguson, Stirling, and McLoughlin, 2005). If early-season rains become regular and widespread in the future, the mortality of ringed seal pups will increase, and populations may be significantly reduced, which likely also would produce negative effects on the reproduction and survival of polar bears (Stirling, 2002; Stirling and Smith, 2004; IUCN/PBSG Polar Bear Specialist Group, 2005).

In contrast, gray whales may benefit from arctic climate change. For example, sightings data of gray whale calves suggest that higher calf counts in the spring are associated with years of delayed onset of freezeup in the Chukchi Sea. During years of earlier freezeup, pregnant females must leave their feeding grounds sooner, having less time to nourish the developing fetus and store the fat necessary to support lactation during their stay in Mexican waters and long migration back to Alaska. Therefore, a warmer Arctic may be beneficial to gray whales (Tynan and DeMaster, 1997).

However, the relationship between the expanding gray whale population to amphipod community dynamics is unknown but is of considerable interest. In 1992, Highsmith and Coyle (1992) described how amphipod crustaceans dominated the benthic community in vast areas of the northern Bering Sea, and described them as one of the "most productive benthic communities in the world." However, during the late 1980's, the abundance and biomass of the amphipod community experienced a 30% decline in production. High-latitude amphipod populations are characterized by low fecundity and long generation times. Large, long-lived individuals are responsible for the majority of amphipod secondary production. Thus, a substantial reduction in the density of large individuals in the population will result in a significant, long-term decrease in production (Highsmith and Coyle, 1992). Such a trend could occur if, for example, the gray whale population reached its carrying capacity and began to "overgraze" its own habitat. If whale predation reached the point where amphipod populations declined, the amphipods would be slow to recover because of their low fecundity and long generation times. Such a long-term alteration in food webs and energy flow through the ecosystem could alter the ecosystem structure, leading to colonization by other benthic species, further impeding amphipod recovery (Highsmith and Coyle, 1992). This could force gray whales to extend their foraging activities into new regions or habitats, which seems to be what is happening.

In 2005, researchers tagged 17 adult gray whales with satellite-monitored radio tags (Mate and Urban-Ramirez, 2006). Of six whales tracked for longer than 100 days, all spent most of their time in the Chukchi Sea:

> The most favored area during the feeding season was NNW of Bering Straits in the Chukchi, where three whales spent August through mid-November in roughly the same area before simultaneously heading south…Historically, gray whales have fed extensively over the shallow eastern Bering Sea shelf with only an estimated 10-15% of the population traveling into the Chukchi and Beaufort Seas.

Therefore, extensive use of the high-latitude regions of the Chukchi Sea appears to be a recent phenomenon and likely reflects changes in available food for gray whales in their traditional feeding areas. "This is likely the result of both top-down predation pressure from the recovered eastern gray whale population's increased foraging requirements and bottom-up pressure as the growth of benthic amphipod species has been stifled by a recent Bering Sea regime shift" (Mate and Urban-Ramirez, 2006).

According to the FWS, the status of polar bears worldwide is declining as a result of climate changes, loss of ice habitat, and unregulated hunting pressures (USDOI, FWS, 2005b). The recent release of the Arctic Climate Impact Assessment's report on *Impacts of a Warming Arctic* (ACIA, 2004), combined with a peer-reviewed analysis of the effects of climate change on polar bears by three of the world's foremost polar bear experts (Derocher, Lunn, and Stirling, 2004) indicate that polar bears are facing a cascading array of effects as a result of dramatic changes to their habitat. Observed changes to date include reduced sea-ice extent, particularly in summer, and progressively earlier sea-ice breakup dates, especially in more southerly areas. Bears at the southern edge of the species' range already are showing the impacts of these changes. Breakup of the annual ice in WHB in Canada is now occurring more than 2 weeks earlier than it did 30 years ago (Stirling, Lunn, and Iacozza, 1999; Stirling et al., 2004), which is causing declining reproductive rates, subadult survival, and body mass in polar bears there. There is a highly significant correlation between this earlier breakup of the sea ice and condition of bears when they come to shore (Derocher, Lunn, and Stirling, 2004) that, in turn, is correlated with their reproductive success. Stirling, Lunn, and Iacozza (1999) correlated decreased body condition and reproductive performance in WHB bears with the trend toward earlier sea ice breakup, which shortens their feeding season and increases the length of their fasting season. Stirling, Lunn, and Iacozza (1999) also reported a significant decline in the body condition of both male and female adult polar bears in WHB, as well as a statistically significant relationship between the date of sea-ice breakup and the condition of adult female polar bears and natality. The earlier the breakup, the poorer the condition of females coming onshore, and the lower their natality level. Because body mass in adult females is correlated with reproductive success, females with lower fat stores likely will produce more single-cub litters, fewer cubs overall, and smaller cubs with lower survival rates (Derocher, Lunn, and Stirling. 2004). Poor hunting conditions in the early spring could also lead to increased cub mortality (Derocher, Lunn, and Stirling, 2004).

This is directly related to the effects of the sea-ice condition on ringed seals. For example, ringed seals often give birth to and care for their pups on stable, shorefast ice; therefore, changes in the extent and stability of shorefast ice or the timing of breakup could reduce their productivity. Because of the close predator-prey relationship between polar bears and ringed seals, decreases in ringed seal abundance can be expected to cause declines in polar bear populations (Stirling and Oritsland, 1995). In fact, a new analysis of the WHB subpopulation confirms that it has declined by almost 20% in the last 30 years (IUCN Polar Bear Specialist Group, 2005), and that this decline is linked to significant reductions in the apparent survival of ringed seal pups coincident with larger amounts of open water earlier in the summer. Similar impacts also may be occurring in other polar bear populations but have either not yet been documented or have not yet been published.

Derocher, Lunn, and Stirling (2004) predict that adverse demographic effects from climate change will first be manifest as lowered female reproductive rates and juvenile survival rates. Adult female survival rates likely will be affected only under more severe conditions. In spring 2006, USGS researchers observed three adult female polar bears (2 with radio collars and 1 without) dead along Alaska's Beaufort Sea coast. A third collared adult female "disappeared from the airwaves" but her yearling cub (1 of 3) subsequently was found dead in a starved condition. Field necropsy confirmed that two of the three adult females died of starvation. The cause of death of the third was undetermined, due to the degree of scavenging of the carcass. Because only 14% of yearling polar bears accompanied by their mothers fail to survive until weaning (Amstrup and Durner 1995), there is an 86% probability that the collared mother of the emaciated yearling also died. Radio-collared females previously have not been found dead of apparent starvation and overall, these observations are unprecedented in the 25 years that polar bears have been radio-collared in Alaska (Amstrup, USGS, pers. commun.).

Climate change also may explain why coastal communities in WHB and other areas recently have experienced increased bear-human conflicts prior to freezeup each fall. It has been suggested that sea-ice availability and the amount of time that bears are forced on land may be an important variable in the amount of bear-human interactions which occur (Clark, 2003). With earlier sea ice breakup, polar bears are forced ashore earlier, in poorer nutritional condition, and remain without access to seals for a longer time. As they exhaust their fat reserves towards the end of the ice-free period, they are more likely to encroach on human settlements in search of alternative food sources and come into conflict with humans. Starving bears are particularly dangerous, because they will risk death in an attempt to obtain food. For example, recent events in Russia indicate that many bears have been congregating outside of northern villages during the fall open-water season, and several people have been killed by polar bears there in recent years (C. Johnson, NSB, pers. commun.). Similarly, in October 2004, a very young polar bear in "poor" condition was killed by homesteaders in what was described as a "predatory" interaction at the mouth of the Colville River on Alaska's North Slope (USDOI, FWS, unpublished data). As a result of such increased bear-human interactions, defense kills of bears increase during periods of low food availability. For example, in the eastern Beaufort Sea in spring 1974, seal populations were greatly reduced. Researchers predicted that subadults would be in poorer condition, interact more with humans, and suffer a higher death rate in the winter of 1974. These predictions were subsequently borne out. Once seal populations recovered, defense kills dropped from a high of seven bears killed per winter back down to the average of two. Thus, the increase in polar bear-human interactions in WHB and other areas probably reflect an increase in nutritionally stressed bears searching for food (Amstrup et al., 2006). If climate change continues, more such events can be expected to occur in Alaska. In the absence of ice, the majority of bears will move to land during the open-water period and be distributed on the islands and the coast of Alaska and Chukotka (Kochnev, In prep).

Polar bear use of coastal areas during the fall open water period has, in fact, increased in recent years in the Beaufort and Chukchi seas. This change in distribution has been correlated with the distance to the pack ice at that time of year (i.e. the further from shore the leading edge of the pack ice is, the more bears are observed on shore)(Kochnev et al., 2003; Ovsyanikov, 2003; Schliebe et al., 2005; Kochnev, In prep.).

Climate change has also affected the severity of autumn storm events as a result of reduced sea-ice cover. In 2001 rough weather prevented scouting about one-third of the time that whaling crews were on Cross Island (Galginaitis and Funk, 2004:24) and about half of the time during 2003 (Galginaitis and Funk, 2005:18). The unusually rough water that restricted the scouting for whales might have been related to changes in the summer ice cover during recent years. As explained in Section III.A.4, analysis of long-term data sets indicate that substantial reductions in both the extent and thickness of the arctic sea-ice cover have occurred during the past 20-40 years, with record minimum extent in 2002 and again in 2005, and extreme minima in 2003 and 2004 (Stroeve et al., 2005; NASA, 2005). Further and more dramatic decreases are predicted for the near future (Holland et al., 2006).

As the distance between the southern edge of the pack ice and coastal areas increases, it will become increasingly difficult and more hazardous for pregnant bears to reach their denning areas (Derocher, Lunn, and Stirling, 2004). Polar bears will face increased energetic costs as a result of less ice and more open water. When the ice cover is reduced, particularly during late summer, the available open-water surface area increases, and waves are able to grow in height. Typical wave heights are up to 1.5 m during summer and up to 2.5 m during fall. Expected maximum wave heights are 7-7.5 m in the Beaufort Sea (Brower et al., 1988), and a late-summer storm in the Beaufort in September 2000 developed waves 6-7 m high at Point Barrow (Lynch et al., 2003). Such large waves undoubtedly would induce energetic stress, or worse, in any swimming bears unfortunate enough to be caught in them. Despite being strong swimmers, energetically stressed bears are susceptible to misfortune on long-distance swims. For example, Monnett and Gleason (2006) reported unprecedented polar bear mortalities following a severe storm event in the Beaufort Sea in fall 2004. They estimated that at least 27 bears may have died as a result of this one storm, and they attributed the phenomenon to longer open-water periods and reduced sea-ice cover.

The increased temporal and spatial extent of late summer and early autumn open water in northern Alaska also has led to the dramatic erosion of coastal shorelines and bluff habitats, which often are preferred den sites for maternal polar bears (Durner, Amstrup, and Ambrosius, 2006). Polar bear terrestrial denning likely will become more important in the near future. The southern Beaufort Sea polar bear population is unique in that approximately 50% of its maternal dens occur annually on the pack ice (Amstrup and Garner, 1994), which requires a high level of sea-ice stability for successful denning. Reproductive failure is known to occur in polar bears that den on unstable ice (Lentfer, 1975; Amstrup and Garner, 1994). If climate change continues to decrease sea ice in the Arctic, and increases the amount of unstable ice, a greater proportion of polar bears may seek to den on land (Durner, Amstrup, and Ambrosius, 2006). Those that do not may experience increased reproductive failure, which would have population-level effects. Considering that 65% of confirmed terrestrial dens found in Alaska from 1981-2005 were on coastal or island bluffs, the loss of such habitats, through storm-surge erosion, likely would alter future denning distributions (Durner, Amstrup, and Ambrosius, 2006) that, in turn, could affect reproductive success.

Polar bears also are susceptible to mortality from den collapse resulting from warmer temperatures and unusual rain events during late winter (Clarkson and Irish, 1991). In Alaska and western Canada, winter temperatures have increased by as much as 3-4 °C (5.4-7.2 °F) over the last 50 years, and rain events have increased substantially across much of the Arctic (ACIA, 2004).

In contrast to other species that may be able to shift northwards as the climate warms, polar bears are constrained to productive sea-ice habitat over relatively shallow waters. There is limited scope for a northward shift in distribution, as deep-water habitats likely would provide an unsuitable prey base for these large carnivores (Derocher, Lunn, and Stirling, 2004). There is also limited scope for polar bears to move to terrestrial habitats. Though polar bears are known to feed occasionally on vegetation, berries, kelp, caribou, muskoxen, ptarmigan, sea birds, crabs, and even ground squirrels, they remain the apical predators of the arctic marine ecosystem (Amstrup, 2003) specialized in preying on phocid seals in ice-covered waters (Derocher, Lunn, and Stirling, 2004). Polar bears are very susceptible to overheating and are very inefficient walkers and runners, expending about twice the average energy of other mammals when walking (Best, 1982). This inefficiency helps explain why polar bears are not known to regularly prey on muskoxen, caribou, and other land animals, as the energy required to catch such animals almost certainly would exceed the amount of energy a kill would provide. For these reasons, polar bears are unlikely to be able to compensate for reduced ring seal availability by switching to terrestrial food sources (Derocher, Lunn, and Stirling, 2004).

Projected impacts to polar bears from climate change would affect virtually every aspect of the species' existence. The timing of ice formation and breakup will determine how long and how efficiently polar bears can hunt seals. Reductions in sea ice will result in increased distances between the ice edge and land; this, in turn, will lead to increasing numbers of bears coming ashore during the open-water period, or drowning in the attempt. Reductions in sea ice also would increase the polar bears' energetic costs of traveling, as moving through fragmented sea ice and open water is more energy intensive than walking across consolidated sea ice. Reductions in sea ice may result in reduced availability of ringed seals, and will result in direct mortalities of bears from starvation. Continued climate change also likely will increase the occurrence of bear-human interactions on land. All of these factors are likely to result in impacts to polar bear populations and distribution, similar to what has already been documented in more southerly areas, such as WHB, and is being documented along the coast of Alaska (Regehr et al., 2006).

Due to the ongoing effects of climate change in the Arctic, and because of the observed and predicted impacts that climate change can have on them, we conclude that continued close attention and effective mitigation practices with respect to non-endangered marine mammals populations and distributions are warranted, particularly with respect to ringed seals and polar bears, which will likely be among the first marine mammals to show the negative effects of climatic warming.

III.H.5. Subsistence-Harvest Patterns.

This section focuses on those activities and events that could introduce noise into the marine environment and potentially impact subsistence resources and activities during the 2006 open-water season. The main agents of the cumulative activities scenario are past, present and foreseeable: (1) marine seismic survey; (2) vessel traffic; (3) aircraft traffic; (4) oil and gas development in Federal, State, and Canadian waters; and (5) miscellaneous activities and factors and industrial development.

III.H.5.a. Marine Seismic Surveys. Up to four marine seismic surveys could occur in both the Chukchi and Beaufort seas in 2006; in the Beaufort Sea OCS, up to three high-resolution site-clearance surveys also are expected on oil and gas prospects, and one MMS and one State permit are likely to be issued in 2006 for ocean-bottom-cable (OBC) seismic survey in the Beaufort Sea. The MMS is aware of at least one non-oil- and gas-related scientific seismic survey that will be conducted in and near the Proposed Action area in 2006. The University of Texas, Austin, with research funding from the National Science Foundation, plans to conduct a marine seismic survey in the western Canada Basin, Chukchi Borderland, and Mendeleev Ridge, Arctic Ocean, from July 15 to August 25, 2006.

Given the growing interest of oil and gas companies to explore and develop oil and gas resources on the Arctic Ocean OCS, there is the potential that seismic surveys will continue in the Chukchi and Beaufort seas beyond 2006. Surveys beyond 2006 are dependent on: (1) the amount of data that is collected in 2006; (2) what the data indicate about the subsurface geology; and (3) the results of Beaufort Sea Sale 202 and Chukchi Sea Sale 193. Table III.C-1 provides information about the potential level and type of seismic-survey activities that may occur in the Beaufort and Chukchi seas between 2006 and 2010. Potential seismic-survey activity beyond 2006 will be addressed in the draft EIS for the OCS Oil and Gas Leasing Program, 2007 to 2012.

III.H.5.b. Vessel Traffic and Movements. Aside from vessels associated with supporting the Proposed Action, vessel traffic in the Proposed Action area is limited. The majority of other vessels transiting through the Proposed Action area travel within 20 km of the coast would include, at a minimum, vessels used for fishing and hunting, cruise ships, icebreakers, Coast Guard vessels, supply ships, tugs, and barges that would include the seasonal supplying of local communities (usually one large fuel barge and one supply barge visit local villages each year); Prudhoe Bay sealifts (anywhere from 0-3 per year); West Dock vessel traffic for Northstar personnel (although crewboat traffic largely has been replaced by hovercraft and helicopter traffic) and resupply transport; barging for NPR-A drilling equipment; and, Canadian vessel traffic (LGL Alaska Research, 2006).

Arctic marine transport in the Proposed Action area is likely to increase: from 1977 through 2005, there have been 61 North Pole transits (17 in the last year alone) and 7 trans-Arctic voyages (Brigham, 2005). Increased cargo transport in the Arctic (primarily outside the Chukchi and Beaufort seas area) also is expected due to increased petroleum and mining activities and the need for future supplies for these industries (PAME, 2000).

III.H.5.c. Aircraft Traffic. Aircraft are used in the Beaufort and Chukchi seas for transporting supplies and personnel to local communities and industrial complexes (e.g., Deadhorse, Prudhoe Bay, Alpine, and Red Dog Mine), conducting research (e.g., marine mammal and marine bird surveys), recreation and tourism, monitoring weather and oceanographic conditions, and military exercises and surveillance. In 2006, MMS will continue its annual bowhead whale aerial survey program, which usually begins September 1 and ends October 20. All surveys would be conducted at an elevation between 1,000 and 1,500 ft. Other marine mammal research-related aerial surveys are likely to occur in the Arctic Ocean in 2006, and possibly at elevations lower than 1,000 ft. The Proposed Action is expected to generate some aircraft traffic, as helicopters may be used to transport personnel and supplies to and from the seismic-survey vessels.

III.H.5.d. Oil and Gas Development in Federal, State, and Canadian Waters. In 2006, Pioneer Natural Resources Co. will begin the development of its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit. Pioneer will begin construction in the winter of 2006 by installing an offshore gravel drilling and production site as soon as an ice road is completed, which will be used to haul gravel to the construction site. Some open-water activities in summer 2006 will involve placing armor (gravel bags) on the side-slopes of the constructed gravel island to protect it from erosion.

In Canadian waters, Devon Canada Corporation is planning to do exploratory drilling off the Mackenzie River Delta in August 2006 GX Technology Corporation will conduct a 2D seismic survey in the Mackenzie River Delta area in late summer and fall.

III.H.5.e. Miscellaneous Activities, Factors, and Industrial Development. On the Chukchi Sea, west of the North Slope industrial complex and outside the southern boundary of the Proposed Action area, the major industrial developments have been and continue to be associated with Red Dog Mine and the Delong Mountain Terminal (DMT). These facilities are included in the cumulative activities scenario, because about 250 barge lightering trips per year are needed to transfer 1.5 million tons of concentrate to bulk cargo ships anchored 6 mi offshore. About 27 cargo ships are loaded each year. These activities have the potential to affect the PEA’s biological resources of concern (e.g., marine mammals and marine birds) that migrate just offshore of the facilities into the marine waters of the Proposed Action area..

III.H.5.f. Effects of Noise and Traffic Disturbances. Seismic-exploration activity would increase somewhat under the cumulative scenario, but impacts to subsistence resources or practices are not expected to increase over those already described for the Proposed Action. Other noise and traffic disturbance from offshore facilities may affect marine-subsistence activities. In the cumulative case, the increased amount of oil-related traffic makes it likely that subsistence-harvest activities could be disrupted occasionally by boat and air traffic. Because most marine-hunting activity occurs within a wide area of open water, such interruptions typically may cause boat crews to hunt longer or take extra trips but are not expected to significantly reduce overall harvests of marine mammals or seabirds. The one exception could be walrus where, in recent years, local hunters have noted that the abundance of walrus in retreating spring pack ice has declined coincidental with the appearance of large tugs pulling supply barges (USDOI, FWS, 2006).

Because of their short and ice-condition-dependent seasons, bowhead whale harvests are more likely to be affected by noise and traffic disturbance than are other forms of marine mammal hunting (other than beluga whaling). Because the bowhead whale harvest in all communities except Barrow tends to be quite small—one to two whales per year—noise disturbance from icebreakers and other vessels could cause this small harvest to become locally unavailable for the entire season. Such activities already occasionally have affected subsistence hunting. For example, Kaktovik whalers stated that their 1985 fall whaling season was adversely affected by vessels related to oil development operating in open-water areas. Effects from noise and disturbance on the beluga whale harvest could increase under the cumulative scenario. Increased air traffic and vessel activities in the Chukchi Sea could impact the beluga harvest by causing beluga whales to become locally unavailable for certain critical periods.

Access to subsistence resources and subsistence-hunting areas and the use of subsistence resources could change if cumulative noise and traffic disturbance reduces the availability of resources or alters distribution patterns. Cumulative effects to bowhead whales are a serious concern. If increased noise affected whales and caused them to deflect from their normal migration route, they could be displaced from traditional hunting areas, and the traditional bowhead whale harvest could be adversely affected. Historically, bowhead whales have been exposed to multiple sources of human-caused noise disturbance and are likely to be exposed to similar sources of noise disturbance in the foreseeable future, but required protective mitigation is expected to reduce these noise disturbance impacts.

In any areas where the subsistence hunt could be affected, stipulations, required mitigation, and conflict avoidance-type measures under IHA requirements, as defined by NMFS and FWS, have, in the past, worked toward avoiding unreasonable conflicts or disturbance to subsistence activities and have required operators to demonstrate that no unmitigable adverse impacts occur to subsistence resources and practices. Conflict avoidance agreements between operators and the AEWC ensure that seismic operations are seasonally timed and monitored to prevent conflicts with the bowhead whale migration and the subsistence hunt.

Limited monitoring data of past activities prevents effective assessment of subsistence-resource damage; resource displacement; changes in hunters' access to resources; increased competition; contamination levels in subsistence resources; harvest reductions; or increased effort, risk, and cost to hunters. We cannot project effects properly without monitoring harvest patterns and the effectiveness of mitigation measures. Monitoring must include serious attention to traditional Inupiat knowledge of subsistence resources and practices. Development already has caused increased regulation of subsistence hunting, reduced access to hunting and fishing areas, altered habitat, and intensified competition from nonsubsistence hunters for fish and wildlife (Haynes and Pedersen, 1989). These trends show why monitoring of subsistence resources and harvests is important.

III.H.5.g. Native Views Concerning Cumulative Effects on Subsistence-Harvest Patterns.

III.H.5.g(1) Nuiqsut's Views on Cumulative Effects. Cumulative effects from oil development have been, and continue to be, paramount concerns for North Slope residents. Sam Taalak, Nuiqsut's Mayor in 1982, saw the onslaught of cumulative activity 18 years ago: "We presently live at Nuiqsut and for the moment we're hemmed in from all sides by major oil explorations, even from the coast front" (Taalak, 1983, as cited in USDOI, MMS, 1983). Leonard Lampe, another former Mayor of Nuiqsut, noted that the village has begun to consider the long-term effect of oil development on their subsistence lifestyle and Inupiat culture: "It's time to look at things seriously and ask if it's worth it. That's what the town is asking itself" (Lavrakas, 1996).

Thomas Napageak, Nuiqsut Native Village President and Chairman of the AEWC, recently clarified some of these concerns. In a January 10, 1997, meeting with MMS in Anchorage over a possible Nuiqsut Deferral for Sale 170, Mr. Napageak explained that the people of Nuiqsut have begun to focus on cumulative effects because they are concerned that when the Northstar resources for 15-20 years. Such development directly affects Nuiqsut. Mr. Napageak wanted Sale 170 stipulations to deal with cumulative effects from the sale, and from other projects, and clear language about cumulative effects in the EIS. He wanted to see protective language developed for leases in the Sale 170 area that would extend to, and bind lessees with, leases from past sales (Casey, 1997, pers. commun.).

At a scoping meeting in Nuiqsut for the Northeast NPR-A Integrated Activity Plan (IAP) EIS, Mr. Napageak noted again the importance of assessing cumulative effects on subsistence resources and harvests, especially the cumulative and indirect effects of existing and potential oil development on Nuiqsut. He remarked: "Federal leasing cannot be examined in isolation as though none of this other development and potential development were going on" (USDOI, BLM, 1997a). At a BLM symposium on the NPR-A held later the same month, he reaffirmed this concern: "Accumulated impact effects that would hinder the community and the socioeconomics of the community, how it will be affected by Alpine and presumably by NPR-A, these...really need to be considered" (Napageak, as cited in USDOI, BLM, 1997b). At an information update meeting in November 1999 for the Liberty Development Project, Elders Ruth Nukapigak and Marjorie Ahnupkana reaffirmed local concern for ongoing effects from oil development, saying that Eskimo traditions of long ago were going away with the oil companies coming in (Ahnupkana, as cited in USDOI, MMS, 1999).

III.H.5.g(2) Kaktovik's Views on Cumulative Effects. Kaktovik resident Michael Jeffrey, testifying for the first MMS lease sale of offshore oil and gas, saw a social impact from government actions. He said there was a cumulative effect on the villagers from having to participate in hearings and meetings. People knew the issues were important, so they had to take time off from working and hunting to attend. Jeffrey believed assessment documents are too technical. To help villagers with them, he suggested extending deadlines in communities that do not speak English, so there would be enough time for agencies to translate documents (Jeffrey, 1979, as cited in USDOI, BLM, 1979b).

III.H.5.g(3) Barrow's Views on Cumulative Effects. The North Slope Borough sent written scoping comments and recommendations on the BLM's Northeast NPR-A IAP in April 1997. Their comments articulated concerns about potential effects to subsistence hunting and:

> …about the cumulative impacts of all industrial and human activities on the North Slope and its residents. Consideration of these impacts must take into account industrial activities occurring offshore and at existing oil fields to the east; scientific research efforts; sport hunting and recreational uses of lands; and the enforcement of regulations governing the harvest of fish and wildlife resources by local residents. To date, no agency has addressed the concerns of Borough residents over how cumulative impacts might affect life on the North Slope (North Slope Borough, 1997).

Barrow Mayor Ben Nageak, spoke at public hearings for the NPR-A IAP/EIS in Barrow in January 1997. He said one of the key issues in developing the Reserve was to identify "a mechanism for recognizing and mitigating the potential cumulative impacts of multiple industrial operations" (Nageak, as cited in USDOI, BLM, 1997b). At a Liberty Development Project information update meeting in November 1999, Ron Brower, head of the Inupiat Heritage Center in Barrow, asked about future leasing and development plans and noted that MMS seemed to be doing projects piece by piece when instead it should be studying cumulative impacts. He believed new data and new development projections were needed and wanted to see a "new blueprint [for development] from aerial flights to underwater impacts" (Brower, as cited in USDOI, MMS, 1999). At the same meeting, Maggie Ahmaogak, Executive Director of the Alaska Eskimo Whaling Commission, asked that MMS take into account cumulative risks.

III.H.5.g(4). Chukchi Sea Communities' Views on Cumulative Effects. Native bowhead and beluga whale hunters in communities in the Chukchi Sea region maintain that they, too, will be affected if important marine mammals are harmed. Just as in the Beaufort Sea communities of Barrow, Nuiqsut, and

Kaktovik, the potential tainting of bowhead and beluga whales and seals, in any portion of their respective ranges and habitats, could taint these culturally important resources. Even if these species were available for the spring and fall seasons, traditional cultural concerns of tainting could make them less desirable and alter or stop subsistence harvests.

The disruption of bowhead whale harvests could result from any potential diversion of the whale migration further offshore, or from other behavior changes by the animals—making them more skittish, for example—in reaction to OCS activities. The greater the degree of activity onshore and on the OCS, as measured by increases in seismic noise, vessel traffic, east-to-west development, increased activity in the Chukchi Sea, Canadian activities in the Mackenzie Delta, or some other metric, the more probable and more pronounced cumulative effects are likely to be. To a large extent, stipulations, required mitigation, and conflict avoidance agreements between subsistence whalers and oil operators have mitigated such potential effects and may continue to do so.

III.H.5.h. Climate Change. Because of rapid and long-term impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, communities in the Arctic could experience significant cultural stresses in addition to major impacts on population, employment, and local infrastructure. If subsistence livelihoods are disrupted, communities in the Arctic could face increased poverty, drug and alcohol abuse, and other social problems (Langdon, 1995; Peterson and Johnson, 1995; National Assessment Synthesis Team, 2000; IPCC, 2001c; Callaway et al., 1999; ARCUS, 1997).

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet could be expected (Johannessen, Shalina, and Miles, 1999; IPCC, 2001c; NRC, 2003).

III.H.5.i. Conclusion. Seismic surveys, especially as mitigated under the Proposed Action alternatives, would not be expected to add significant impacts to overall cumulative effects on subsistence-harvest resources and harvest practices from past, present, and future activities. Protective mitigation measures and conflict avoidance-type measures under IHA requirements incorporated into seismic survey permits are expected to reduce potential impacts on subsistence resources and harvest practices.

III.H.6. Sociocultural Systems.

Cumulative effects on sociocultural systems include effects of seismic activity during the 2006 open-water season in the action area and other past, present, and reasonably foreseeable projects in the Chukchi and Beaufort seas. Cumulative effects on sociocultural systems would come from changes to subsistence-harvest patterns, social organization and values, and other issues, such as stress on social systems. Potential effects could be experienced by the Inupiat communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope (see Impact Assessment Inc., 1990a,b,c; 1998; Human Relations Area Files, Inc., 1994; State of Alaska, Dept. of Fish and Game, 1995b).

III.H.6.a. Social Organization and Cultural Values. Because of the limited magnitude of the Proposed Action, significant changes to social organization and cultural values, such as stress on social systems due to changes in population and employment, are not expected to occur. On the other hand, potential significant impacts could result from changes to subsistence-harvest patterns. Such potential cumulative effects on subsistence-harvest patterns would affect Inupiat social organization through disruptions to kinship ties, sharing networks, task groups, crew structures, and other social bonds.

Adverse affects on sharing networks and subsistence-task groups could break down family ties and the communities' well-being, creating tensions and anxieties that could lead to high levels of social discord. The NSB's institutional infrastructure, the AEWC, community whaling organizations, regional and tribal governments, and regional and village corporations work diligently to develop programs to protect these cultural values. The NSB, the AEWC, and local whalers have set precedents for negotiating agreements with the oil industry to protect subsistence-whaling practices. Such cooperation is expected to continue (Impact Assessment Inc., 1990a,b,c, 1998; Human Relations Area Files, Inc., 1995; State of Alaska, Dept. of Fish and Game, 1995b).

Some of the vectors of sociocultural change that have been commonly noted in studies of arctic Alaska (Klausner and Foulks, 1982; Kruse et al., 1983a,b; Galginaitis et al., 1984; Luton, 1985; Worl and Smythe, 1986; Kevin Waring Associates, 1988; Chance, 1989; Impact Assessment, Inc., 1989a,b; Jorgensen, 1990; Human Relations Area Files, 1992), lease sale documents (USDOI, MMS, 1990b, 1996a, 1998, 2001), or testimony during the lease sale process (numerous USDOI documents, 1978 to the present time) can be briefly summarized as follows:

- Changes in community and family organization (availability of wage labor opportunities locally or regionally, ethnic composition, factionalism, household size);
- Institutional dislocation and continuity (introduction of new institutions, "loss" or de-emphasis of older or more traditional ones, and adaptation of new forms to old content or values, and vice versa);
- Changes in the pattern of overall subsistence activity (time allocation, equipment and monetary needs) and the potential disruption of subsistence harvest activities by industrial development;
- Changes in health measures, which are a combination of increased access to health care, changes in diet, increased exposure to disease, substance use and abuse, concern over possible exposure to contaminants of various sorts, and perhaps other factors;
- Perceived erosion of cultural values and accompanying behaviors (increased social pathologies such as substance abuse, suicide, and crime/delinquency in general; decreased fluency in Native languages; decreased respect for Elders; less sharing); and
- Cultural "revitalization" efforts such as dance groups, Native language programs, and official and regular traditional celebrations (such as the reestablishment of Kiviaq, or the Messenger Feast, in the NSB).

While these are all in some sense generalizations and "analytical constructs," all are supported also by specific testimony of Native residents of the region. These dynamics are not generally viewed as oil and gas (let alone OCS) development specific, but rather as the overall context within which Inupiat culture must continue to exist.

More specifically, OCS activities could affect subsistence (and thus sociocultural systems) in a potentially major way. Lease stipulations should mitigate many of these effects to the degree discussed in the subsistence section. Because subsistence is to a large extent the ideological idiom of Inupiat (and Alaskan Native) culture, this is a fundamental and important category of potential effects and extends very broadly. Increases in seismic activity in the Beaufort Sea, and the reinitiation of seismic exploration in the Chukchi Sea are significant vectors for potential effects.

Because of rapid and long-term impacts from climate change on long-standing traditional hunting and gathering practices that promote health and cultural identity, and considering the limited capacities and choices for adaptation and the ongoing cultural challenges of globalization to indigenous communities, Arctic communities could experience significant cultural stresses in addition to major impacts on population, employment, and local infrastructure. If subsistence livelihoods are disrupted, communities in the Arctic could face increased poverty, drug and alcohol abuse, and other social problems (Langdon, 1995; Peterson and Johnson, 1995; National Assessment Synthesis Team, 2000; IPCC, 2001; Callaway et al., 1999; ARCUS, 1997).

If the present rates of climate change continue, changes in diversity and abundance to arctic flora and fauna could be significant. Because polar marine and terrestrial animal populations would be particularly vulnerable to changes in sea ice, snow cover, and alterations in habitat and food sources brought on by climate change, rapid and long-term impacts on subsistence resources (availability), subsistence-harvest practices (travel modes and conditions, traditional access routes, traditional seasons and harvest locations), and the traditional diet could be expected (Johannessen et al., 1999; IPCC, 2001b; NRC, 2003).

In this cumulative analysis, effects on social institutions (family, polity, economics, education, and religion) could result from changes in subsistence-harvest patterns.

III.H.6.b Conclusion: Seismic surveys, especially as mitigated under the Proposed Action alternatives, would not be expected to add significant impacts to overall cumulative effects on subsistence resources and harvest practices from past, present, and future activities. Protective mitigation measures and conflict avoidance-type measures under IHA requirements incorporated into seismic survey permits are expected to reduce potential impacts on subsistence resources and harvest practices; thus, consequent impacts to sociocultural systems would be reduced, as well.

III.H.7. Environmental Justice.

Alaskan Inupiat Natives, a recognized minority, are the predominant residents of the North Slope and Northwest Arctic Boroughs, the areas potentially most affected by activities assessed in the Arctic Seismic PEA. Cumulative effects on Inupiat Natives could occur because of their reliance on subsistence foods, and impacts from noise and vessel traffic from past, present, and foreseeable activities in the Chukchi and Beaufort Seas could affect subsistence resources and harvest practices. The EIS defines “significant” effects on environmental justice as: disproportionate, high adverse impacts to low-income and minority populations. Potential effects could be experienced by the Inupiat communities of Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope.

Inupiat Natives could be disproportionately affected because of their reliance on subsistence foods; and actions under this PEA could affect subsistence resources and harvest practices. Stipulations, required protective mitigation measures, and conflict avoidance measures under IHA requirements would serve collectively to mitigate disturbance effects on Native lifestyles and subsistence practices and likely would mitigate any consequent impacts on sociocultural systems. These measures would reduce the potential for adverse effects on subsistence-harvest patterns, sociocultural systems, and environmental justice. The above mitigating measures incorporate traditional knowledge and the cooperative efforts between MMS, the State, the people of the North Slope, and tribal and local governments. Effects to environmental justice are expected to be mitigated substantially but not eliminated. The IHA process requires that operators demonstrate that their action will cause no unmitigable adverse impacts on subsistence uses of marine mammals.

The MMS acknowledges sociocultural cumulative impacts on the North Slope and that Inupiat culture has undergone significant change. The influx of money and a changing landscape due to wage employment has added many benefits and raised the standard of living, but these influences also have given rise to an array of social pathologies that include increased alcoholism. However, cumulative effects are difficult to separate and, by far, most cumulative effects result from onshore development, as the oil patch spreads outward from Prudhoe Bay/Deadhorse.

One point that was made numerous times at a Research Design Workshop for the Bowhead Whale Subsistence Hunt and OCS Oil and Gas Activities convened by MMS in April 2001 in Anchorage, was that any realistic analysis of cumulative effects on the North Slope needs to consider both onshore and offshore effects. To date, the most obvious cumulative effects have occurred and continue to occur onshore, although no adequate monitoring or comprehensive baseline data gathering has ever been undertaken onshore by responsible Federal and State agencies and industry. Most of the stress factors mentioned by local stakeholders normally can be associated with onshore impacts. Until a serious onshore-monitoring program is developed, causal linkages to impacts from onshore or offshore sources will be problematic.

For a discussion of proposed mitigation measures and other ongoing mitigating initiatives that relate to environmental justice concerns, see Section III.G.6. While the projects discussed in Section III.G.6 in themselves would not resolve the larger problems of ongoing cultural challenge to Inupiat traditions from increasing development in the region and from the powerful influences of modernity, such as cable television, the Internet, and an increasing dependence on a wage-based economy, they provide processes for information sharing and opportunities for mutual decisionmaking and remediation of cumulative social and subsistence impacts.

Potential impacts on human health from contaminants in subsistence foods and long-term climate change impacts on marine and terrestrial ecosystems in the Arctic—affecting subsistence resources, traditional culture, and community infrastructure of subsistence-based indigenous communities in the North Slope and Northwest Arctic Boroughs—would be an expected and additive contribution to cumulative environmental justice impacts. Potential disproportionately high adverse effects on low-income, minority populations in the region effects are expected to be mitigated substantially but not eliminated. Seismic surveys, especially as mitigated under the Proposed Action alternatives, would not be expected to add significant impacts to overall cumulative effects on subsistence-harvest resources and harvest practices from past, present, and future activities.

III.H.8. Archaeological Resources. The greatest cumulative effect on archaeological resources in the Beaufort Sea and Chukchi Sea region is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative, they have affected and will continue to affect archaeological resources in this area. These natural processes would cause artifacts to be dispersed and the site context to be disturbed or even completely destroyed, resulting in the loss of archaeological information. Overall, a significant loss of data from submerged and coastal prehistoric sites probably has occurred, and will continue to occur, from the effects of natural geologic processes in the Beaufort and Chukchi Sea region. It is assumed that some of the data lost have been significant and/or unique, resulting in a major level of impact.

Ocean-bottom-cable seismic surveys potentially could impact both prehistoric and historic archaeological resources in waters inshore of the 20-m isobath or in deeper water, if cables are laid from shallow to deep water. Such offshore seismic-exploration activities evaluated in this PEA could disturb these resources and their in situ context. Assuming compliance with existing Federal, State, and local archaeological regulations and policies and the application of MMS' G&G Permit Stipulation 6 (regarding the discovery of archaeological resources), CFR 251.6 (a) (5) regarding G&G Explorations of the Outer Continental Shelf to not "disturb archaeological resources," and MMS' Notice to Lessees, NTL 05-A03, "Archaeological Survey and Evaluation for Exploration and Development Activities," and NTL 05-A02, 'Shallow Hazards Survey and Evaluation for Alaska Outer Continental Shelf (OCS) Pipeline Routes and Rights-Of-Way," bottom-cable surveys and site-clearance surveys for drilling activities proposed for the 2007 open water season in the Beaufort Sea would be expected to identify and avoid any potential prehistoric and historic archaeological resources. Therefore, no impacts or only minor impacts to archaeological resources are anticipated; cumulatively, proposed projects are not likely to disturb the seafloor. Under the cumulative scenario, the impact to both prehistoric and historic archaeological sites should be negligible. The incremental contribution of the Proposed Action to the cumulative impacts on archaeological resources should be negligible.

III.I Unavoidable Adverse Effects.

Even with embedding mitigation measures within the Proposed Action alternatives, unavoidable adverse effects are likely to occur from conducting 2D/3D and high resolution seismic surveys in the Beaufort and Chukchi seas, and involve: (1) accidentally spilled petroleum products into the marine environment; (2) wildlife being unexpectedly exposed to airgun-generated near-field pressure waves; and (3) uncontrolled noise and vessel traffic generated by seismic survey operations.

Despite every attempt by the seismic survey operators to prevent spilling petroleum products into the marine environment, accidental spills are expected to occur due to mechanical malfunctions and/or human error. The quantity of each spill event is expected to be low (approximately 5 gallons) and to form a temporary oil slick on the water surface. Fuel spills affect marine birds by direct contact, and mortality is caused by ingestion during preening as well as hypothermia from matted feathers. Marine mammals coming in contact with the subject spills are not expected to develop health problems or die; however, a change in behavior could be expected as they attempt to flee the spill area. Small spills are not expected to have an unavoidable adverse impact on subsistence-harvest activities.

The near-field pressure wave effects from firing airguns are expected to unavoidably and adversely impact fish eggs and larvae on a very small scale and negligible when extrapolated to the population level for the species affected. Seismic shooting is also expected to temporarily alter the behaviors and movements of fish species when received sound pressure levels are sufficiently high. Seismic sounds have the potential to cause masking of the sounds normally used by fish in their usual acoustic behaviors at levels as low as 60 to 80 dB. Continuous, long-term exposure to levels above 180 dB has been shown to cause damage to the hair cells of ears of some fish under some circumstances. It seems likely that most fished exposed to airgun shots at a distance of a few meters could receive inner ear damage as a result of source levels in the range between 210 and 240 dB. Near-field pressure waves might impact those offshore species of birds that spend large quantities of time underwater, either swimming or plunge diving while foraging for food; however, there is no data indicating such impacts exist.

The mitigation measures currently embedded in the alternatives are designed to prevent marine mammals from being adversely impacted from the near-field pressure wave generated by seismic survey operations. However, despite every attempt to prevent marine mammal injuries (e.g. hearing loss) and changes in behavior (e.g. discomfort and abandoning feeding areas and diverting away from migration routes), instances may arise where marine mammals unexpectedly enter the near-field pressure wave area (i.e., the area within the 160 dB zone). NMFS has defined the 160 dB zone as Level B harassment (behavior change) and the 180/190 dB zone as Level A harassment (injury). Because of mandatory shut-down procedures, any unavoidable adverse affect should be insignificant.

The non-airgun-generated noise (repetitive, intermittent, and localized sounds from ship operations, e.g. engines, navigation equipment, and electrical generators) and vessel traffic originating from seismic survey operations could harass fish and wildlife resources away from the surrounding area. Vessel collisions with marine mammals, although unlikely, could cause injuries and mortalities. Despite mitigation measures being in place to prevent otherwise (e.g. minimizing the use of bright deck lights in poor weather conditions), some bird collisions with vessels are likely. Noise from vessel operations and ice breaking activities, although unlikely, could cause major changes in marine mammal behavior to the extent that feeding activities could be adversely impacted.

Collectively, the unavoidable adverse impacts expected to occur will not cause long-term or significant environmental impacts.

III.J Relationship Between Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity.

This section addresses this subject from a broad perspective incorporating the information and conclusions from detailed analysis provided in previous sections of the draft PEIS. No construction activities are associated with the Proposed Action; therefore, short-term uses of the environment will primarily relate to seismic survey operations. Short- and long-term commitments of labor and capital and the use of non-renewable materials for power and maintenance would be employed to achieve the long-term goal of discovering and developing oil and gas resources in the Beaufort and Chukchi seas.

Bowhead whales may be temporarily affected by noise from seismic surveys, vessel and aircraft traffic, and small oil spills on a short-term basis. Molting eiders and spectacled eiders may be negative affected by frequent vessel and aircraft disturbance and collisions with vessels and aircrafts. The Proposed Action would also be expected to have both short- and long-term adverse effects on fishery resources within the zone of esonification. Some fish may be temporarily "stunned" by the sound pressure wave while some other fish nearest to the firing airgun may be killed. The long-term productivity of fish populations, however, would not be expected to be significantly impacted.

Short- and long-term effects on Inupiat subsistence-harvest activities could be considered disproportionate adverse if seismic survey operations are not sufficiently mitigated. Short-term effects of the seismic survey operations on social systems, cultural values, and institutional organization are not expected to have long-term adverse consequences. Archaeological resources finds discovered as a result of the seismic surveys would enhance long-term knowledge. Overall, such finds could help fill gaps in our knowledge of the history and early inhabitants of the area; but any destruction of archaeological sites or unauthorized removal of artifacts would represent long-term losses.

With respect to the short-term uses of the environment and the maintenance and enhancement of long- term productivity, the following would be expected to occur to the economy...Federal revenues would increase, local and State employment would increase, and personal income would be generated. The discovery, development, and production of oil and gas resources in the Proposed Action area would also provide short-term energy and, perhaps, provide time either for the development of long-term alternative-energy sources or substitutes for petroleum.

In conclusion, the environmental effects of Proposed Action would be temporary in nature and would have no significant adverse long-term impacts on the long-term productivity of the Beaufort and Chukchi seas, if properly mitigated as proposed. No losses of marine habitats are expected to occur from seismic survey operations. However, the quality of marine habitat surrounding seismic survey operations would be adversely affected in the short-term as airguns are fired to esonify the area. Other noises originating from seismic survey operations (e.g. vessel traffic, the operation of ship-board equipment, and aircraft traffic) will also cause a temporary degradation of the marine environment, especially for marine mammals, marine birds, and fish. The benefits offered to the Nation by the long-term productivity of the Proposed Action are expected to off-set the short-term use of the environment, if properly mitigated as proposed.

III.K. Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources associated with implementing the alternatives of the Proposed Action. Resources include renewable and nonrenewable natural resources, including fish and wildlife habitat.

A commitment of resources is irreversible when project impacts limit the future options for a resource or cannot be reversed, except perhaps in the extreme long-term. It applies primarily to the effects of use of nonrenewable resources, which are those resources that cannot be replenished by natural means, such as oil, natural gas, iron ore, and cultural resources. An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations or is lost for a period of time. It applies to the loss of productivity, harvest, or use of natural resources (USFS, 1992).

No resources would be irreversibly and irretrievably committed (i.e. affected) by construction activities because none of the Proposed Action alternatives have construction activities associated with them. Any irreversible and irretrievable commitments of resources would be limited to the planning and implementation of seismic survey operations.

Irreversible and irretrievable nonrenewable resources committed for use by seismic survey vessels, support vessels, and support aircraft include any seismic survey equipment that could not be recovered or recycled diesel fuel, gasoline, aviation fuel, and lubricating oil. The Proposed Action would require a commitment of human and financial resources (time and labor) as well. Water is the only renewable natural resource used to implement the alternatives. Water would be used on the seismic survey and support vessels for cooking, drinking, and processing human wastes.

Any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of threatened or endangered species would violate the Endangered Species Act, unless such commitment was made to help protect and aid in its conservation and recovery. Under certain circumstances bowhead whales, Steller's eider, and spectacled eiders could be subjected to temporary non-lethal effects of disturbance due to noise from seismic survey activities and vessel and aircraft traffic, and from small petroleum spills. It is unlikely that such effects would lead to permanent (irreversible) losses of these resources, particularly for the bowhead population, as their population is increasing.

IV. DESCRIPTION OF MITIGATION AND MONITORING MEASURES AND DISCUSSION OF THEIR EFFECTIVENESS

NMFS and MMS have documented that the Beaufort and Chukchi Sea Planning Areas support a wide variety of fish and wildlife resources, many of which support the Inupiat community's subsistence-harvest culture and lifestyle. The conclusion generated by NMFS' and MMS' collective analysis of the Proposed Action and alternatives indicates that operating high-energy acoustic equipment, i.e., airguns, in the marine environment has the potential to cause adverse, and sometimes potentially significant (as defined under Section III.E), environmental impacts on the proposed project area's biological resources. For example, bowhead whales could be harassed by the acoustic environment generated around the airgun source which could result in the disruption of biologically significant behaviors or whales' exclusion from important habitats. Any potential adverse effects on marine mammals also might adversely impact subsistence activities that rely on marine mammals. Marine birds, although not thought to be directly injured by the generated sounds of an airgun, potentially could be harassed away from feeding and resting areas by the acoustic sounds and repeated vessel and aircraft movements. Fish and fishery resources might be harassed away or blocked from desired spawning and feeding habitat under certain circumstances, and shellfish potentially could be harmed directly by the high-energy sound source. However, the potential for these impacts can be reduced, minimized or eliminated with the appropriate mitigation measures.

IV.A. Mitigation Measures Incorporated into the Alternatives.

As noted in Section II, all seismic-survey operations in the Beaufort and Chukchi Sea Planning Areas will be required to comply with MMS' regulations governing G&G explorations of the OCS (30 CFR 251 Parts 1–15) and NMFS' regulations implementing the ESA and MMPA (50 CFR 216-226). Furthermore, the protective measures in Section IV.A.1 would be incorporated into all authorized 2D/3D seismic surveys under alternatives 3-8. Unless otherwise specified in each section, the protective measures in sections IV.A.2 and IV.A.3 also apply to Alternatives 3 through 8. Section IV.A.4 then provides a discussion of the general effectiveness of mitigation and monitoring measures imposed during the 2006 open water season in the Proposed Action Area, many of which are also being considered within this PEIS for implementation during the open water season.

IV.A.1. Standard MMS G&G Permit Stipulations. The following stipulations are standard for MMS-permitted seismic activities and would be included for all seismic activities considered under Alternatives 2 through 8:

- No solid or liquid explosives shall be used without specific approval.
- Operations shall be conducted in a manner to ensure 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 uses of the area or any conditions that 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 Regional Supervisor/Resource Evaluation. Serious or emergency conditions shall be reported without delay.
- Operators must maintain a minimum spacing of 15 miles between the seismic-source vessels for separate operations. The MMS must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permit applicants shall use the lowest sound levels feasible to accomplish their data-collection needs.
- 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.

- 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.
- 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.
- 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.
- 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 NMFS 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.

IV.A.2. Measures to Mitigate Seismic Exposure to Marine Mammals. The measures outlined below are based on: (1) measures in the July 1999, August 2001 and July-August 2006 MMPA authorizations from NMFS related to MMS-issued G&G permits in the Beaufort and Chukchi Sea Planning Areas; (2) protective measures in MMS' most recent G&G permits; (3) Open Water meetings in 1999, 2001 and 2006; (4) the NMFS' Biological Opinion on Arctic Region OCS activities dated June 16, 2006 (NMFS, 2006); and (5) the analysis contained within the PEA for 2006 Arctic open water season seismic surveys (MMS, 2006a). Unless otherwise specified, these protective measures apply to Alternatives 3-8.

- **Implementation and Monitoring of the 180/190-dB Exclusion Zone –** A 180/190-dB exclusion zone from the seismic-survey-sound source shall be free of marine mammals before the survey can begin and must remain free of marine mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from potential Level A harassment (injury). NMFS has set the 180-dB (Level A Harassment-injury) for cetaceans and the 190-dB (Level A Harassment-injury) for seals and sea lions. FWS has set the 180-dB (Level A Harassment-injury) for Pacific walrus.

  Individuals (marine mammal biologists or trained observers approved by NMFS) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the monitoring programs and observers.

- **Implementation and Monitoring of the 120-dB Safety Zone –** Alternatives 3, 5, and 7 all contain a requirement for the implementation and monitoring of a 120-dB safety zone. For Alternative 3, this 120-dB zone would be implemented and monitored *at all times for all marine mammals*. However, under Alternatives 5 and 7, the 120-dB would only be implemented and monitored in specific circumstances as described below.

  - A 120-dB safety zone for bowhead whales in the Beaufort Sea will be established and monitored when four or more fall-migrating bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program within the area to be seismically surveyed during the next 24 hours. No seismic surveying shall occur within the 120-dB safety zone around the area where the whales were observed, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.

  - A 120-dB safety zone for bowhead whales in the Chukchi Sea will be established and monitored: (1) when four or more fall-migrating bowhead whale cow/calf pairs are observed at the surface during the vessel research-monitoring program; (2) when Barrow whalers notify NMFS or MMS that bowhead whale cow/calf pairs are passing Barrow; or (3) on September 25, whichever is earliest. Once notified by NMFS or MMS, a daily survey will occur (weather permitting) within the area to be seismically surveyed during the next 24 hours. Whenever four or more migrating bowhead whale cow/calf pairs are observed at the surface during a monitoring program, no seismic surveying shall occur within the 120-dB safety zone around the area where the whales were observed until two consecutive surveys indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.

  - The threshold of four or more fall-migrating bowhead whale cow/calf pairs was set based on the following: (a) cow/calf pairs are identified in Section III.F.3.f(1) as the most vulnerable portion of the population and disruption of their biologically significant behaviors or their avoidance of important habitats is more likely to lead to population level impacts; (b) mitigation measures for this portion of the population should be cautiously developed to ensure that takings are at the lowest practicable level (as required by MMPA Section 101(a)(5)(D)(ii)) and that significance is avoided (as defined in Section III.E); (c) bowhead whale cow/calf pairs migrate in groupings or pulses and the observed presence of cow/calf pairs by surveys generally indicates that additional cow/calf pairs are present but unseen; (d) using professional judgment, NMFS and MMS have determined that the presence of four or more cow/calf pairs (as observed during surveys) indicates that enough cow/calf pairs are likely present (but some unseen) in the area in numbers equal to or greater than 12 animals; and (e) the potential for significance to occur (as defined in Section III.E) therefore increases when four or more bowhead whale cow/calf pairs are observed.

  - Dedicated aerial surveys, vessel surveys and/or acoustic monitoring, if determined by NMFS to be appropriate and necessary, would be conducted in the Beaufort and Chukchi seas during the fall bowhead whale-migration period to detect bowhead whale cow/calf pairs and to detect aggregations of bowhead or gray whales. The protocols for these monitoring programs would be specified in the MMPA authorizations granted by NMFS.

  - Survey information, especially information about bowhead whale cow/calf pairs or feeding bowhead or gray whales, would be provided to NMFS as required in MMPA authorizations and will form the basis for NMFS determining whether additional mitigation measures, if any, could be required over a given time period.

- **Implementation and Monitoring of the 160-dB Safety Zone** – Alternatives 4, 5, 7 and 8 all contain a requirement for the implementation and monitoring of a 160-dB safety zone. For Alternative 4, this 160-dB zone would be implemented and monitored *at all times for all marine mammals*. However, under Alternatives 5, 7 and 8, the 160-dB would only be implemented and monitored in specific circumstances as described below.

  - A monitoring program based on a 160-dB safety zone will be established and monitored in both the Beaufort and Chukchi Sea Planning Areas during all seismic surveys sufficient to detect the presence of an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a nonmigratory, significant biological behavior [e.g., feeding, socializing]). Should 12 or more bowhead or gray whales occur within the 160-dB safety zone around the seismic activity, the seismic operation will shut down immediately or not commence until two consecutive surveys indicate the 12 or more bowhead or gray whales are no longer present within the 160-dB safety zone surrounding seismic-survey operations.

- The threshold of 12 is based on the following premises: (a) whales aggregate in order to communicate and perform "*biologically significant*" behaviors (as defined by NRC (2005:3)), such as feeding, resting, socializing, mating, and calving; (b) aggregations of animals can also indicate an area of preferred habitat and locations where biologically significant behaviors are likely occurring; (c) disruptions of these biologically significant behaviors and important habitats have a greater potential to lead to population level effects (i.e., result in limiting reproductive potential or recruiting success, impeding important mother/calf bonding); (d) protective measures should be designed to reduce the potential for disruption of biologically significant behaviors or help ensure whales do not avoid important key habitat areas (and thus potentially negate a negligible impact finding under the MMPA); (e) criteria defined in Section III.E for bowhead and gray whales sets significance at the effective loss of animals to move the stock below its Optimum Sustainable Population Level (in consideration of PBR, subsistence quota, and commercial fishery interactions); and (f) standard scientific acceptance that the presence of observed whales (i.e., at the surface) during monitoring surveys indicates that additional whales are also present in the area but non-detectable (i.e., below the surface).

  Specifically for bowhead whales, Section III.E defines significance at a level that may affect the survival and reproduction of 12 or more bowhead whales (of an affected species and/or stock) annually. Although NMFS and MMS do not expect the seismic surveys to result in direct serious injury or death of bowhead whales, Level B harassment (behavioral disturbance) may occur and affect biologically significant behaviors and/or deter whales from important habitats. Significance could then be reached if these behavioral disturbances resulted in the indirect removal of animals from the stock, limiting reproductive potential or recruiting success, impeding important mother/calf bonding, etc. As analyzed in Section III.F.3.f., females (and calves) are more susceptible to this type of disturbance than males. Theoretically, NMFS and MMS would define an aggregation as 12 or more females or calves in order to protect the more vulnerable portion of the population and not reach significance (which may then negate a negligible impact determination under the MMPA). However, vessel and aerial surveys are not able to distinguish between males and females and therefore the level of 12 is set at individual whales, regardless of their sex or age.

  For gray whales, the significance criteria defined in Section III.E is "an adverse impact that results in an abundance decline and/or change in distribution requiring three or more generations (or having an impact lasting 10 or more years) for the indicated population to recover to its former status." Several studies have shown that gray whales are subject to behavioral disturbance from the presence of anthropogenic noise at received levels of impulses at 160-170 dB re: 1 μPa rms (see Section III.F.4.d(2) for further discussion). In addition, gray whales are believed to aggregate in larger groups along offshore shoals in the northern Bering and Chukchi Seas for feeding during the summer months. As these groupings may indicate that these areas are important feeding grounds for the gray whale population as it expands its range and avoidance of these areas due to seismic activity may result in greater than normal effects to this population, additional protection of these aggregations/areas is warranted at this time. Again, females and calves would be the most vulnerable portion of the population and NMFS and MMS would theoretically set an aggregation at 12 or more females or calves. However, monitoring surveys are not able to distinguish between male and female whales and also may not be able to discern between gray and bowhead whales (particularly when whales are engaged in active behaviors or infrequent surfacing), so an aggregation is therefore defined at 12 individual whales regardless of their sex, age, or species.

- Dedicated aerial surveys, vessel surveys, and/or acoustic monitoring programs if determined by NMFS to be appropriate and necessary would be conducted in the Beaufort and Chukchi seas during the fall bowhead whale-migration period to detect bowhead whale cow/calf pairs and to detect aggregations of bowhead or gray whales. The protocols for these aerial and vessel monitoring programs would be specified in the MMPA authorizations granted by NMFS.

- Survey information, especially information about bowhead whale cow/calf pairs or aggregates of bowhead or gray whales, would be provided to NMFS as required in MMPA authorizations and will form the basis for NMFS determining whether additional mitigation measures, if any, could be required over a given time period.

- **Shut Down –** The survey shall be suspended until the exclusion/safety zone is free of marine mammals. All observers shall have the authority to, and shall instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the zone. If the airgun array is completely shut-down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.

- **Ramp Up –** Ramp up is the gradual introduction of sound from airguns to deter marine mammals from potentially damaging sound intensities and from approaching the specified zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at least 20-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated at night or when monitoring the zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the zone before the airgun array is again ramped up to full output.

- **Field Verification –** Before conducting the survey, the operator shall verify the radii of the exclusion/safety zones within real-time conditions in the field. This provides for more accurate radii rather than relying on modeling techniques before entering the field. Field-verification techniques must use valid techniques for determining propagation loss. The methodology chosen must be approved in advance by NMFS. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the zones by applying a sound-propagation series.

- **Monitoring of the Seismic-Survey Area –** Aerial-monitoring surveys or an equivalent monitoring program acceptable to the NMFS may be required through the MMPA authorization process. Field verification of the effectiveness of any monitoring techniques may be required by NMFS.

- **Reporting Requirements** – Reporting requirements provide the regulating agencies with specific information on the monitoring techniques to be implemented and how any observed impacts to marine mammals will be recorded. In addition, operators must report immediately any shut downs due to a marine mammal entering the exclusion/safety zones and provide the regulating agencies with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the zones.

- **Temporal/Spatial Restriction –** Seismic surveys must not occur in the Chukchi Sea spring lead system before July 1, unless authorized under the MMPA by NMFS, to provide bowhead cow/calf pairs additional protection.

IV.A.3. Additional Proposed Mitigation Measures for MMS G&G Permits.

The following measures are considered spatial/temporal/operational restrictions and are specific to Alternatives 3-8. They were included as conditions within the MMS G&G permits for the 2006 Arctic open water season and are considered for inclusion in MMS G&G permits issued under this Proposed Action. Several of these measures concern FWS species and were developed in close coordination between MMS and the FWS for MMS-authorized surveys as described under the Proposed Action. In addition, several of these measures were included in the FWS biological opinion issued to MMS (USDOI, FWS, 2006) covering 2006 seismic surveys in the Beaufort and Chukchi Sea Planning Areas.

- No seismic activity, including re-supply vessels and other related traffic, will be permitted within the Ledyard Bay spectacled eider critical habitat area following July 1 of each year, unless human health or safety dictates otherwise.

- Seismic survey support aircraft must avoid overflights across the Ledyard Bay spectacled eider critical habitat area below an altitude of 1,500 feet (450 meters (m)) after July 1 of each year, unless human health or safety dictates otherwise.

- Survey operations shall use the lowest sound levels feasible to accomplish their data-collection needs.

- Seismic-survey support aircraft would maintain at least a 1,500 ft (305 m) altitude over beaches, lagoons, and nearshore waters as much as possible.

- Seismic operations shall be shut down if walruses are sighted within the 180-dB (Level A harassment-harm) acoustical safety/exclusion zone.

- Seismic-survey and associated support vessels shall observe a 0.5-mile (~800-meter) safety radius around Pacific walrus groups hauled out onto land or ice.

- Aircraft shall be required to maintain a 1,000-foot minimum altitude within 0.5 miles of hauled-out Pacific walruses.

- Seismic-survey operators shall notify MMS and NMFS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals.

- To avoid significant additive and synergistic effects from simultaneous seismic-survey operations that might hinder the migration of bowhead whales, NMFS and MMS will review the seismic-survey plans and may require special restrictions, such as additional temporal or spatial separations.

- Seismic cables and airgun arrays must not be towed in the vicinity of fragile biocenoses, unless MMS determines the proposed operations can be conducted without damage to the fragile biocenoses. Seismic-survey and support vessels shall not anchor in the vicinity of fragile biocenoses (e.g., the Boulder Patch, kelp beds) as identified by MMS or may be discovered by the operator during the course of their operations, unless there is an emergency situation involving human safety and there are no other feasible sites in which to anchor at the time. Permittees must report to MMS any damage to fragile biocenoses as a result of their operations.

- Seismic-survey and support vessels will minimize operations that require high-intensity work lights, especially within the 20-m-bathymetric contour. High-intensity lights will be turned off in inclement weather when the seismic vessel is not actively conducting seismic surveys. However, navigation lights, deck lights, and interior lights could remain on for safety.

- All bird-vessel collisions shall be documented. Reporting information will include, but not be limited to, species identification, date/time, location, weather, and operational status of the survey vessel when the strike occurred. If eiders or murrelets that are injured or killed through collisions with vessels are recoverable, seismic-survey personnel should recover them and immediately contact the Fairbanks Fish and Wildlife Field Office, Endangered Species Branch, Fairbanks, Alaska, at 907-456-0499 for instructions on the handling and disposal of the injured or dead bird(s).

IV.A.4. Discussion of Mitigation and Monitoring Measures Proposed in the PEIS and Previously Implemented during the 2006 Open Water Season. Sections IV.A.1-3 note a number of mitigation and monitoring measures that are being considered as part of several alternatives. Section IV.A.1 outlines standard stipulations included in all MMS G&G permits, and this will apply to all Alternatives 2 through 8. Section IV.A.2 lists additional mitigation, monitoring and reporting measures specific to marine mammals, and these will be considered for Alternatives 3 through 8. Section IV.A.3 lists additional measures being considered for inclusion in MMS G&G permits, and these measures also apply to Alternatives 3 through 8.

The implementation of mitigation measures is only a first step in ensuring that permitted or otherwise authorized activities meet the requirements under such statutory authorities as the OCS Lands Act (i.e., they are environmentally sound) and the MMPA (i.e., has the least practicable adverse impact on the species or stock and its habitat and not have an unmitigable adverse impact on subsistence use of these species). The next step is to develop effective monitoring and reporting requirements that will provide useful information on environmental compliance, feasibility and applicability of the measures and the overall effectiveness of the management plans.

As part of the MMPA authorization process, applicants are required to provide detailed mitigation and monitoring plans that outline what efforts will be taken to reduce negative impacts to marine mammals, and their availability for subsistence use, to the lowest level practicable. In addition, MMPA authorizations require that operators conduct monitoring, which should be designed to result in an increased knowledge of the species and an understanding of the level and type of takings that result from the authorized activities. Under the MMPA, NMFS further requires that monitoring be designed to provide information and data verifying (or disputing) that the taking of marine mammals are, in fact, negligible and there are no unmitigable adverse impacts on the availability of marine mammals for subsistence uses. Within the MMPA seismic survey authorizations, NMFS generally includes standard mitigation (i.e., shut down, ramp-up, exclusion zones) and may include supplemental measures (i.e., aerial monitoring) when safety/exclusion zones are beyond effective visual monitoring. Standard reporting requirements then require this information to be provided to NMFS and, where applicable, MMS. Final decisions on inclusion of standard and supplemental mitigation and monitoring measures are made on a case-by-case basis.

In most cases, the measures contained in Sections II and IV.A.1-3 were also required during the 2006 Arctic open water season in MMS G&G permits, NMFS MMPA authorizations, and/or the CAA between industry and Alaska Native groups. As such, it is worthwhile here to discuss what is currently known about the effectiveness of measures during the 2006 season. In order to provide some focus, the discussion to follow only reviews mitigation and monitoring plans where NMFS and MMS are aware of questions being raised regarding their feasibility (i.e., based on stakeholder comments and feedback from the 2006 open water season). However, it is important to note the following is based on preliminary and mostly verbal communication as all final written reports from 2006 operations have not been submitted to NMFS and MMS at the time of printing the draft PEIS. A review of those final reports, once received, will be instrumental in helping MMS and NMFS to further assess the feasibility and effectiveness of mitigation and monitoring measures.

Exclusion/safety zones (predicted vs. verified radii). During 2006, operators were required to verify the radii of the exclusion/safety zones within real-time conditions in the field. This is a frequent mitigation measure employed by NMFS and MMS when authorizing certain sound-producing activities. The issue from the 2006 season appears to center around whether the models relied upon for predicting the radii were supported by the actual verifications in the field and whether field verification will be necessary in future seasons.

Preliminary information provided by industry at the October 2006 Arctic Open Water Meeting (held October 23-25, 2006 in Anchorage, AK) suggests that field-verified radii for some zones were actually much greater than suggested in the predictive modeling. Industry felt that some of this was due to variables, such as sea floor composition, that will be known for 2007 and beyond. They suggested that NMFS consider whether new data needed to be collected and if field verification was necessary in future seasons.

NMFS and MMS recognize there were some variations in the predictive and actual modeling of the radii. However, both agencies believe that actual field verification will remain a part of the mitigation package until future seasons allow for more commonalities between the predicted and field-verified radii in various parts of the Chukchi Sea. Otherwise, accurate estimation and implementation of exclusion/safety zones which mirror those required in permits/authorizations will not be possible.

- **Monitoring of exclusion/safety zones.** Within NMFS' MMPA authorizations issued for the 2006 open water season, there was a requirement for the monitoring of the various implemented exclusion/safety zones. This monitoring is necessary to ensure the probability that marine mammals entering the zones will be detected and the necessary shutdown, ramp up and other requirements will be met. Dependent upon the size of the zone, monitoring occurred through aerial and vessel surveys and towed passive acoustics and included trained marine mammal observers. In general, vessel-based monitoring occurred for the 180/190-dB and 160-dB zones. Aerial monitoring was required for the 120-dB zone. Passive acoustic monitoring (PAM) was implemented across all zones.

  - <u>Vessel-based monitoring</u>: At least 3-4 trained marine mammal observers and an Inupiat observer onboard a support vessel and/or the seismic vessel 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 or whenever the seismic array's operations have been suspended for more than 10 minutes. The use of four observers allows two observers to be on duty simultaneously for up to 50 percent of the active airgun hours. The use of two observers increases the probability of detecting marine mammals, and two observers are required to be on duty whenever the seismic array is ramped up. When mammals are detected within or about to enter the zone designated to prevent injury or behavioral disturbance to the animals, the geophysical crew leader is notified so that shutdown procedures can be implemented immediately. To date, MMS and NMFS are not aware of any concerns from industry on vessel-based monitoring of the applicable zones from the 2006 open water season.

  - <u>Aerial monitoring</u>: In 2006, and under several alternatives proposed in this PEIS, operators were required to implement a 160-dB or 120-dB safety zone under the conditions outlined in IV.A.2 above. Issues, however, were raised by operators on the feasibility and safety of aerial monitoring of the 120-dB zone. These concerns were based on: (1) the safety of putting people in the air in the offshore areas of the Chukchi; (2) loss of survey time and opportunity should planes break down or suddenly become unavailable; (3) getting needed authorizations from the Federal Aviation Authority; and (4) whether unmanned aerial systems (UASs) can meet the goals of the monitoring program and be suitable replacements for manned flights.

There appears to be some disagreement among the various stakeholders as to the extent safety is an issue for offshore flights in the Chukchi. (Concern does not appear to exist for the Beaufort or nearshore in the Chukchi.) Industry states that there are few or no planes available in Alaska that meet the fuel load and other conditions necessary for transit and survey time in the offshore Chukchi and that use of other planes would pose an additional safety risk. Also, industry states that a suitable airport does not exist on the coast of the Chukchi (therefore transit from the Beaufort is necessary) and that rescue operations in the offshore

Chukchi, if needed, would not be possible. During the October 2006 Open Water meeting, other stakeholders stated that there have previously been aerial surveys of marine mammals for distribution and abundance studies in the offshore Chukchi environment (as late as 1999 and 2000) without incidence and safety is not an issue. Further, there is at least one alternative airport in the Chukchi where planes can be housed rather than flying from the Beaufort airport. (The increased flight distance was cited by operators are contributing to the safety issue.)

For 2006, the disagreements regarding whether a safety issue existed or not for aerial surveys in the offshore Chukchi ultimately resulted in at least one operator ceasing seismic survey activities in the Chukchi before September 25 due to concerns over flight safety. (September 25th was the date required by NMFS where operators would need to implement the 120-dB safety zone and associated aerial monitoring for migrating bowhead whales in the Chukchi). One operator continued surveys without aerial monitoring by obtaining a stay of the 120-dB requirement by a Federal Court (see section I.A.2). One operator continued to work in the Chukchi using passive acoustics (see discussion on PAM below) since their survey area was outside flight range for aircraft.

At least two operators are investing resources in the development of UASs which, depending on the outcome of testing and FAA approvals, have the potential to replace manned aircraft during aerial survey requirements. However, MMS and NMFS recognize that UASs can only be used for marine mammal monitoring once they have been adequately tested to ensure their probability for sighting marine mammals meets or exceeds that of traditional manned aerial surveys. In the meantime, tests are ongoing and results will be considered by NMFS and MMS as they become available.

Ultimately, there still remains a question on the feasibility of aerial monitoring (manned or unmanned) of the 120-dB safety zone. However, additional methodologies for monitoring this larger safety zone are currently limited to passive acoustic monitoring. During the 2006 open water season, NMFS provided the operators with a choice in using PAM rather than aerial survey monitoring. Two operators did employ this technology but feedback provided during the October 2006 Open Water meeting stated that only a few or no marine mammals were detected through PAM. Questions were then raised regarding the effectiveness of this monitoring technology. It is unclear if the lack of marine mammal detection resulted from operator error, faulty equipment, challenges of using the equipment in the Arctic environment (PAM has been used with success by seismic operators in the Gulf of Mexico), vessel noise masking baleen whale communications and/or no baleen whales were in the range of the PAM. Selection of the appropriate type of towed PAM array is believed to be essential. NMFS has not yet received information from the 2006 operators to determine if the appropriate array was used or if other issues were affecting the use of PAM. Until the time that information is received, it is difficult to assess the feasibility and effectiveness of using PAM for Arctic open water surveys and especially whether PAM can be used as a replacement for aerial survey monitoring.

To further gather information on the effectiveness of marine mammal monitoring programs, NMFS has suggested convening a group of scientists and technicians to review the 2006 monitoring reports and draft operator monitoring plans for 2007 (submitted as part of the MMPA authorization applications). Feedback will then be provided to operators so that final draft monitoring plans can be presented at the April 2007 Open Water meeting for review by attendees at that meeting. This process will help ensure that monitoring methodologies are adequate and being used correctly, but this process is dependent upon the timely submission of 2006 operator reports and panel review of the information.

- **Research monitoring**. During the 2006 open water season, authorized operators were required to conduct all research described in the "Final Monitoring Plan for Seismic Exploration in the Chukchi Sea, 2006" (see Appendix D). This plan essentially included the establishment of: (a) an acoustic program to measure sounds produced by seismic vessels; (b) an aerial monitoring and reconnaissance of marine mammals available for subsistence harvest along the Chukchi Sea and Beaufort Sea coast; (c) research ship surveys of the Chukchi Sea, including a towed hydrophone passive acoustic monitoring system to collect data on the distribution and abundance of marine mammals; and (d) deployment, and later analysis of the data from, bottom-founded autonomous acoustic recorder arrays along the coast of the Chukchi Sea to record ambient sound levels, vocalizations of marine mammals, and received levels of seismic operations should they be detectable.

Due to various factors, such as complications from sea ice presence and errors in communication on logistics, portions of this research plan were not fully implemented successfully in 2006. NMFS scientists will carefully review the final operator reports and the industry's comprehensive monitoring report for 2006 to gain an understanding of why successful implementation was not possible and, where appropriate, suggest modification to current research or alternative research for 2007 and beyond.

V. CONSULTATION AND COORDINATION

V.A Background.

NMFS and the MMS announced their intention to prepare a seismic survey-related PEIS on November 17, 2006 (71 FR 66912). Publication of the notice began the official scoping period that helped clarify previously identified issues and alternatives to be considered. The notice of intent (NOI) requested comments from state, local, and tribal governments; Native Alaskan organizations; Federal agencies; environmental and fish and wildlife organizations; the oil and gas industry; and other interested organizations and parties in order to assist in the preparation of this draft PEIS. The comment period ended on December 18, 2006. See section V.B for a summary of NOI-related scoping comments.

In addition to the NOI, the NMFS and MMS pursued other avenues for scoping seismic survey issues. At the October 2006 Open Water Meeting, industry representatives; the MMS and NMFS and other federal and state agencies; tribal government representatives; subsistence stakeholders; and other interested parties participated in presentations and discussions about the 2006 open water seismic survey season. Highlighted were the lessons-learned and opportunities to improve coordination and communication between all interested parties. During public hearings for the MMS Chukchi Sea Lease Sale 193 draft EIS and Draft Proposed Program for 2007-2012 OCS Oil and Gas Leasing (5-Year Program), MMS personnel discussed how seismic surveys are conducted. The presentations highlighted the desire to receive input on the resources, issues, alternatives, and mitigation measures to be included in the environmental analysis. The MMS took testimony from the public on a variety of topics including their concerns about seismic survey activities in the Chukchi and Beaufort seas and their impact on subsistence-harvest activities and the fish and wildlife resources they rely on. MMS emphasized that any input received in these meetings would be considered in all analyses, and that any statements made concerning seismic activities would be considered.

The MMS and NMFS jointly developed the draft PEIS alternatives and mitigation measures; identified issues of concern; described the spatial and temporal scope of the cumulative analysis; and assessed environmental impacts. As part of the public process, NMFS and MMS plan to hold information meetings on the PEIS in Anchorage, Barrow, Kaktovik, Nuiqsuk, Wainwright, Point Lay, and Point Hope. All of the information received at the meetings will be considered in preparing the Final PEIS.

The following is a list of the Federal, State, Tribal and local government agencies; academic institutions; members of the oil and gas industry; special interest groups; other organizations; and private citizens who will be sent copies (hard copy and/or CD) of the draft PEIS for review:

Federal – Executive Branch

Department of Commerce

- National Marine Fisheries Service
  - Bowhead Whale Project
  - Regional Administrator, Juneau
  - Alaska Regional Office, Anchorage
- National Oceanic and Atmospheric Administration
  - Program Planning and Integration

Department of Defense

- U.S. Army Corps of Engineers
  - Regulatory Branch, Alaska District
- Deputy Under Secretary of Defense for Installations and Environment

Department of the Interior

- Bureau of Indian Affairs
  - Environmental Services
  - West Central Alaska Field Office
- Bureau of Land Management
  - State Director
  - Northern Field Office, Fairbanks
- U.S. Fish and Wildlife Service
  - Federal Activities Branch
  - Regional Office
  - Anchorage Ecological Services
  - Fairbanks Ecological Services

Department of Energy

Technical Information Center

Department of Transportation

Office of Pipeline Safety

U.S. Coast Guard

Migratory Bird Management

Subsistence and Fisheries

U.S. Geological Survey

Alaska Science Center

Environmental Affairs Program

National Park Service

Regional Director

Division of Environmental Quality

Subsistence Division

Office of Environmental Policy and Compliance

Special Assistant to the Secretary for Alaska

Federal – Legislative Branch

U.S. Senate

Alaska delegates

U.S. House of Representatives

Alaska delegates

Federal – Administrative Agencies and Other Agencies

Arctic Research Commission

Marine Mammal Commission

Environmental Protection Agency

Office of Federal Activities

Region 10, NPDES Permit Unit

Alaska Operations Office, Anchorage

State of Alaska

Alaska Oil and Gas Conservation Commission

Department of Community and Regional Affairs

Department of Environmental Conservation

Anchorage District Office

Northern Alaska District Office

Department of Fish and Game

Region II, H&R

Subsistence Division

Habitat Division

Department of Natural Resources

Citizen's Advisory Commission on Federal Areas

Division of Geological and Geophysical Surveys**{** XE "Seismic:Surveys" **}**

Division of Oil and Gas

Division of Water, Fairbanks

Dept. of Transportation and Public Facilities

State Pipeline Coordinator, Joint Pipeline Office

Office of the Governor

Governor

Division of Governmental Coordination

Office of Budget and Management

Tribal and Local Governments - Native Organizations

Alaska Eskimo Walrus Commission, Barrow
Alaska Eskimo Walrus Commission, Nome
Alaska Eskimo Whaling Commission
Alaska Federation of Natives
Alaska Inter-Tribal Council
Alaska Native Science Commission
Arctic Development Council, Barrow
Arctic Slope Native Association
Arctic Slope Regional Corporation
Atqasuk Inupiat Corporation, Atqasuk
Barrow Whaling Captains Association
Bering Straits CRSA, Unalakleet
City of Anaktuvuk Pass, Mayor
City of Barrow, Mayor
City of Kaktovik, Mayor
City of Kotzebue, Planning Dept.
City of Nome, City Manager
City of Nuiqsut, Mayor
City of Point Hope, Mayor
City of Wainwright, Mayor
Cully Corporation, Point Lay
Inupiat Community of the Arctic Slope (ICAS)
Kaktovik Inupiat Corporation
Kaktovik Whaling Captains Association
Nagsragmuit Tribal Council, Anaktuvuk Pass
Kuukpik Village Corporation, Nuiqsut
NANA Regional Corporation Inc., Kotzebue
Native Village of Barrow
  Wildlife Director
  Tribal Council President
Native Village of Kaktovik
Native Village of Nuiqsut
Native Village of Point Hope
Native Village of Point Lay
Native Village of Wainwright
North Slope Borough
  Department of Wildlife Management
  Mayor's Office
  Planning Department
  Public Information Office
  Village Coordinator, Anaktuvuk Pass
  Village Coordinator, Atqasuk
  Village Coordinator, Kaktovik
  Village Coordinator, Nuiqsut
  Village Coordinator, Point Hope
  Village Coordinator, Wainwright
Nunamiut Corporation, Anaktuvuk Pass
Olgoonik Corporation, Wainwright
Tigara Corporation, Point Hope
Ukpeagvik Inupiat Corporation

Libraries

Alaska Pacific University
  Academic Support Center Library
Alaska Resources Library and Information Service (ARLIS)
Alaska State Library
  Government Publications, Juneau
American Petroleum Institute Library, D.C.
Canadian Circumpolar Library, Edmonton AB
Canadian Joint Secretariat Librarian, Inuvikon NT
Department of Indian and Northern Affairs, Canada Yellowknife, NT
Environmental Protection Agency, Region 10
  Librarian, Seattle
Fairbanks North Star Borough
  Noel Wien Library
George Francis Memorial Library
National Oceanic and Atmospheric Administration
  Information Services Division, Seattle, WA
North Slope Borough School District
  Library/Media Center, Barrow
Northern Alaska Environmental Center Library
Tikigaq Library, Point Hope
Trapper School Community Library, Nuiqsut
Tuzzy Consortium Library, Barrow
University of Alaska, Anchorage
  Elmer E. Rasmuson Library
  Government Documents
University of Alaska, Fairbanks
  Geophysical Institute
  Government Documents
  Institute of Arctic Biology
University of Alaska, Southeast (Juneau)

Ilisaavik Library, Shishmaref
Juneau Public Library
Kaveolook School Library, Kaktovik
Kegoyah Kozpa Public Library, Nome
U.S. Army Corps of Engineers Library, Anchorage
U.S. Fish and Wildlife Service Library, Anchorage
Valdez Consortium Library
Z.J. Loussac Library, Anchorage

Canada

Department of Fisheries and Oceans
  Institute of Ocean Sciences, Sidney, BC
Canadian Wildlife Service
  National Wildlife Research Division, Hull, PQ
Department of Indian and Northern Affairs
  Natural Resources and Economic Development, Ottawa

Special Interest Groups

Alaska Conservation Foundation
Alaska Native Knowledge Network, Fairbanks
Alaska Natural Heritage Program
Alaska Public Interest Research Group
Arctic Connections
Arctic Marine Resource Commission
Arctic Sounder, Kotzebue
Barrow Cable TV
Bering Air, Inc., Nome
Center for Biological Diversity
Defenders of Wildlife
EarthJustice, Juneau
Exxon Valdez Oil Spill Trustee Council
Greenpeace
Ilisagvik College, Barrow
Indigenous Peoples Council for Marine Mammals**{** XE "Marine Mammals" **}**
KBRW News, Barrow
Living Resources, Inc. Fairbanks
Marine Advisory Program
National Audubon Society
National Parks Conservation Association
Natural Resources Defense Council
National Wildlife Federation
Northwest and Alaska Fisheries Center
Ocean Conservancy
Rural CAP
  Subsistence/Natural Resources Dept.
Sierra Club
Trustees for Alaska
University of Alaska, AEIDC, ENRI
Wilderness Society
Wildlife Federation of Alaska

Petroleum Industry

AEC Oil and Gas (USA) Inc.
Alaska Clean Seas
Alaska Support Industry Alliance
Amerada Hess Corporation
American Petroleum Institute
Amoco Production Co.
Anadarko Petroleum Corporation
Armstrong Oil and Gas Inc.
Atofina Petrochemicals, Inc.
BP Exploration (Alaska) Inc.
  Records Mgmt.
  Lands Mgr.
Chevron U.S.A. Inc.
ConocoPhillips, Alaska, Inc.
Encana Oil and Gas, Inc.
Exxon Mobil Oil Corporation
Exxon Mobil Production Company
Forest Oil Corporation
Marathon Oil Company
Murphy Exploration (Alaska), Inc.
Pennzoil
Petro-Canada (Alaska) Inc.
Shell Frontier Oil & Gas, Inc.
Texaco Inc.
Union Oil Company of California
Western Geophysical Company

Associations, Companies, and Other Groups

Alaska Marine Conservation Council
Alaska Oil and Gas Association
Continental Shelf Associates
Guess and Rudd P.C.
I.H.S. Energy
LGL, Environmental Research
Lynx, Inc.
Oil and Gas Journal
Prince William Sound RCAC
Regional Director, MMS, GOM OCS Region
Regional Director, MMS, Pacific OCS Region
Steven R. Braund and Associates
URS Corporation
Waddell Marine Biotech

The MMS has initiated federally-required consultation processes. On August 12, 2005, MMS requested from NMFS a list of threatened, endangered, and candidate species and critical habitats pursuant to section 7 of the ESA. The NMFS responded (dated September 30, 2005) with a list that included the endangered bowhead whale and noted critical habitat has not been designated for bowhead whale. The NMFS also noted that the endangered humpback and fin whale are found in the Chukchi and Bering seas outside of the OCS Planning Areas. The MMS provided a request for Arctic Regionwide consultation and a biological evaluation (BE) (dated March 3, 2006). The MMS described the anticipated impacts that OCS activities, including exploration seismic surveys, could have on endangered bowhead whales. The MMS also included a discussion of potential impacts to the endangered humpback and fin whale. The BE discussed mitigation measures to avoid and minimize impacts to these species. On June 16, 2006, NMFS provided their Arctic Region Biological Opinion (ARBO) stating that the activities associated with seismic surveys in the Beaufort and Chukchi seas may adversely affect but not jeopardize the continued existence of any species listed under the ESA that is under the jurisdiction of NMFS. MMS is currently consulting with NMFS regarding the seismic survey activities associated with this PEIS.

On December 13, 2005, MMS requested from the FWS a list of threatened, endangered, and candidate species and critical habitats pursuant to section 7 of the ESA. The FWS responded with a list that included the threatened spectacled and Steller's eiders and the Kittlitz's murrelet (a candidate species), and the critical habitat area from Point Hope eastward to the Canadian border (dated January 5, 2006). The MMS provided a request (dated March 13, 2006) for consultation and a BE for proposed seismic surveys during 2006 in the Chukchi Sea and Beaufort Sea Planning Areas. The MMS described the anticipated impacts the proposed seismic-survey program for 2006 would have on threatened spectacled and Steller's eiders and Kittlitz's murrelets, including mitigation measures to avoid and minimize impacts to coastal and marine birds. Subsequent discussions resulted in the decision by MMS to change a mitigation measure to exclude seismic survey activities from the Ledyard Bay critical habitat area instead of allowing these activities to occur there prior to July 1 or after October 15. On May 11, 2006, the FWS, assuming revised mitigation measures are implemented, concurred with MMS' conclusion that no adverse effects are likely to occur to listed or candidate species under their jurisdiction. MMS is currently consulting with the FWS regarding the seismic survey activities associated with this PEIS.

In addition, during the preparation of the 2006 Arctic PEA and for the development of this PEIS, MMS coordinated with the FWS regarding mitigation measures for the Pacific walrus (most recent correspondence dated January 9, 2007). These measures (as described in Sections II and IV) were included as conditions in MMS G&G permits issued during the 2006 Arctic open water season and are being considered for inclusion as conditions in MMS permit issued in 2007 and beyond. As stated in the January 9, 2007 correspondence from FWS to MMS, the measures are consistent with existing guidelines for transportation and fishing operations occurring near walrus aggregations in Bristol Bay, and in the absence of new information regarding the sensitivity of walruses to seismic operations, these measures can be considered state-wide standards. However, their inclusion does not preclude the FWS from requiring additional mitigation measures through any authorizations (e.g. incidental harassment authorizations) they may issue separately under authorities such as the MMPA and/or ESA.

The 1996 reauthorization of the MSCFMA amendments require consultation between the Secretary of Commerce and Federal and State agencies on activities that may adversely impact essential fish habitat (EFH) for those commercial fish species managed by fish management plans and managed under the Act. According to the final EFH Consultation Agreement, dated April 4, 2003, between the MMS and NMFS, the MMS incorporates EFH consultation into the NEPA process. Measures recommended by NMFS to protect EFH are advisory, not proscriptive. The MMS is currently in the EFH-consultation process with the NMFS.

As required by the National Historic Preservation Act of 1966, the MMS asked for concurrence by the State of Alaska Office of History and Preservation (AOHP) on our determination that the Proposed Action of the 2006 PEA would have no adverse effect on the archaeological resources in the Beaufort and Chukchi seas. The AOHP responded on June 13, 2006, stating that they concur with MMS' finding that no historic properties would be affected by marine-streamer 3D and 2D seismic surveys or high-resolution site surveys. However, because ocean-bottom-cable surveys potentially could adversely affect historic properties, they recommend—and MMS will—conduct additional consultation regarding any applications for ocean-bottom-cable surveys. The MMS is currently in the Section 106 consultation process with the AOHP for the seismic survey activities associated with the 2007 PEIS.

V.B Summary of Scoping Comments

On November 17, 2006 (71 FR 66912), NMFS published a notice of intent to prepare a Draft PEIS on Arctic Seismic Surveys and opened scoping for this action. During the 30-day public comment period on the notice, NMFS received comments relevant to its request for NEPA scoping from the Environmental Protection Agency (EPA), the Natural Resources Defense Council (NRDC), the Olympic Coast Alliance (OCA), the North Slope Borough (NSB), the Alaska Eskimo Whaling Commission (AEWC), Shell Oil, ConocoPhillips, BP, the Alaska Oil and Gas Association (AOGA), and the Center for Regulatory Effectiveness (CRE). The comments of these organizations are summarized below. Comments that were originally submitted as part of the Arctic Seismic Draft PEA, and resubmitted for this action have been addressed in the 2006 Final PEA.

Region 10 (Seattle) of the EPA commends NMFS and MMS for their decision to prepare a PEIS in order to thoroughly evaluate the proposed actions relating to seismic surveys in the OCS and provide for maximum participation and input from the public and tribes. The EPA recommends that, because of the strain being placed on local communities to review the number of documents currently being produced that can directly affect their quality of life, NMFS and MMS should coordinate preparation of the Chukchi Lease Sale 193 Final EIS (LS193 FEIS) and this document. NMFS/MMS should synchronize and schedule preparation of these two documents to allow adequate time to incorporate any new information presented in the LS193 FEIS and allow for adequate public review and comment on the Draft PEIS information prior to its incorporation into both the LS193 FEIS and the Final PEIS for seismic activities. Also, it would be important to describe the criteria that NMFS/MMS used to develop the alternatives and how the alternatives that were initially proposed but not carried forward for full analysis in the EIS were evaluated, including alternatives proposed by the public and tribes during the scoping period. EPA recommends the Draft PEIS document the tribal consultation and coordination process by providing a chronology with the dates and locations of meetings with tribal governments, results of the meetings and a discussion of how the tribes' input was used to develop the PEIS. The Draft PEIS should document how traditional knowledge has been integrated into the NEPA process and used to assist NMFS and MMS in making decisions regarding seismic activities in the Beaufort and Chukchi seas. The PEIS should include a description of the methodology and criteria utilized for identifying low income and people of color communities, the sources of data and the references utilized for establishing the criteria. The PEIS should describe the criteria, methodology, and framework for developing the cumulative effects analysis of proposed action and alternatives presented in the PEIS. It should identify and analyze reasonably foreseeable future actions, not actions that are considered speculative or more distant actions. EPA will look for a detailed analysis of cumulative impacts to subsistence resources to satisfy environmental justice requirements. EPA recommends that, prior to development of the Draft PEIS, NMFS/MMS develop a proactive public participation plan that describes what action will be taken to keep agencies, Tribes and the public informed during the EIS development process and provide opportunities for additional input. The EPA recommends NMFS/MMS prepare a Scoping Summary Report and provide this report to the public for review and comment during the Draft PEIS preparation stage.

The OCA urges NMFS to first begin with a NEPA EIS. That job needs to be done properly before going ahead with a Programmatic EIS. The OCA reviewer, who claims to be a layperson and not a scientist, believes the documents are not convincing that there will be no harmful and damaging effects from seismic activities on the indigenous marine animals – whether these are the several different species of whales, other marine mammals, northern birds, and fish. The documents are not convincing that potential mitigation measures will be adequate to protect the marine inhabitants of the Beaufort and Chukchi seas. The OCA urges the NMFS and MMS to reverse their premature decision to bypass preparation of a proper NEPA EIS before going ahead with your desired PEIS.

The NRDC urges NMFS to undertake its review only in the context of a broader management scheme for what is clearly an environmentally threatened region. The NRDC believes that review and (if appropriate) permitting of oil-and-gas activities should occur only within a broader framework for the management of this region. The Marine Mammal Commission called on NOAA earlier this year to develop such a framework, and NOAA itself placed an "ecosystem approach to management" first among its five strategic goals for 2006-2011. The NRDC therefore urges NMFS/MMS to adopt the "No-Action" alternative and defer permitting seismic exploration in the Arctic until a meaningful framework is developed, one that integrates oil-and-gas activity into a comprehensive management plan. NRDC believes the agencies should consider (1) requiring industry to share data (as it did to a limited degree last season); (2) mandating the purchase of prior data in areas that have previously been surveyed; (3) requiring the use of alternative geophysical survey techniques, as appropriate; (4) setting geographic restrictions apart from the dynamic restrictions described in the notice, which may depend on the effectiveness of real-time monitoring; (5) prescribing the use of passive acoustic monitoring to detect marine mammals; (6) barring surveys in conditions of low-visibility, except in areas where marine mammal densities are known to be low; (7) requiring the use of the lowest practicable source levels and establishing a process for independent verification of that standard; (8) requiring long-overdue research on suppression of higher-frequency noise and other methods of noise reduction; (9) setting forth a plan to prevent the introduction of foreign species through ballast water; (10) establishing an adequate movement corridor for fish; and (11) setting a coastal exclusion zone for fish to at least the 200 m isobath, or 1 km from shore, whichever is greater. It is unclear from the notice whether the agencies intend even to consider a safety zone for marine mammals (other than baleen whales) below 180 dB/190 dB (RMS).

The NRDC continues that it is worth observing that the 120-dB exclusion for bowhead whales remains an important measure not only to the environmental community but to native communities as well. The judicial finding raising "serious questions" about the exclusion came in a preliminary two-page opinion that precluded full judicial review and appeal – a situation that the present programmatic review would avoid. NMFS is correct that the increased activity anticipated by the agencies, together with the longer time frame encompassed by the EIS, requires the agency to reassess the sufficiency of the mitigation measures it prescribed for the 2006 season. Given the clear potential for non-negligible cumulative impacts on marine mammals and other species, NRDC believes stronger mitigation measures are necessary. The NRDC recommends, for example, that the agencies consider an outright exclusion (with buffer zone) of the bowhead whale's historic migration corridors, which would obviate the broad-scale aerial surveys required in last year's incidental harassment authorizations.

The CRE stated that NMFS/MMS are afraid that oil and gas seismic exploration might save some bowhead whales and would disturb their migration patterns enough to prevent Inupiat hunters from killing and eating the whales. In contrast, there is no basis for concluding that seismic operations themselves threaten the lives of whales or any other marine mammal covered by the DEIS, have caused population-level effects or any significant adverse effect on any marine mammal in the area. An estimated 100,000 seals, sea lions, whales and dolphins, and other marine mammals die every year from entanglement or choking in floating plastic debris and an estimated 1,000 whales, dolphins and porpoises drown every day from commercial fishing bycatch. The CRE also notes that there is no basis for concluding that anyone can accurately and reliably monitor compliance with safety radii significantly larger than the traditional 500 m. Neither NMFS nor MMS have approval under the Paperwork Reduction Act to require information collection for safety radii larger than 500 m. OCS oil and gas deposits are necessary to the U.S. energy independence and national security. The CRE concludes that there is no justification for the large resources that are being consumed studying and regulating oil and gas seismic effects on marine mammals.

The NSB states that the Draft PEIS must adequately analyze impacts to marine mammals, particularly the bowhead whale under all proposed alternatives. The bowhead whale is vital to the AEWC, its members and the NSB and its residents. Each of the identified alternatives includes different protective measures for bowhead whales. The evaluation of these alternatives will require a thorough analysis of the potential effectiveness of these (mitigation) measures and of the impacts on all marine mammals, including, but not limited to bowhead whales. The MMPA and ESA both require protection for the bowhead whale and other species and both set standards that require that any uncertainty be interpreted in favor of greater protection for the affected species. Given the importance of the bowhead whale to Inupiat culture, and the high likelihood that the proposed action will have impacts on bowhead whale, the Draft PEIS must provide a thorough analysis of the impacts of the proposed activity on marine mammals, including the bowhead whale.

The NSB states that the Draft PEIS must adequately analyze impacts to marine mammals, particularly the bowhead whale, under all potential mitigation and monitoring requirements. The MMPA requires that any IHA granted include measures to effect the least practicable impact on protected species and on the availability of those species for subsistence use. The Draft PEIS must include measures for protecting all marine mammal species, not just the bowhead and gray whales. NMFS/MMS must ensure that the mitigation and monitoring measures are implemented and performed effectively. In 2006, there was little or no oversight to confirm that the required mitigation measures were implemented or effective.

The NSB recommends that the Draft PEIS adequately address human health and sociocultural impacts, using the best available information and accepted methodology. There is an increasing sense in NSB communities of being overwhelmed by multiple planning processes, both in terms of lack of time and expertise on community and individual levels and in terms of a perceived inability to influence meaningfully the decisions being made. Measures must be identified and implemented that will mitigate this impact. Both the NSB and AEWC recommend that since uncertainty addressed in the Final PEA is likely to remain, NMFS should adopt a cautious approach in its evaluation of impacts to bowhead whales and other species and in choosing its preferred alternative.

The AEWC supports the comments of the NSB. The AEWC recommends that the Draft PEIS include in its environmental review all geophysical activities that occur as part of offshore oil and gas exploration and development process. The AEWC recommends that NMFS provide an alternative that addresses the need to limit the number of high-level noise generating activities authorized in a given time period where subsistence resources and activities might be adversely affected. A comprehensive cumulative effects analysis must be undertaken. The Chukchi Polyna must remain off limits to all industrial activity, just as the spring lead system in the Beaufort is protected. Coastal residents called for an industry-free zone of a minimum of 60 mi in width along the coast.

The AOGA commends NMFS/MMS for undertaking this important PEIS. However, AOGA encourages NMFS/MMS to develop a contingency plan for permitting by July 1, 2007, should the PEIS not be finalized within the necessary timeframe. Shell believes that it is ambitious for NMFS and MMS to complete this PEIS in time to issue permits for the 2007 open water season beginning about July 1. Shell, therefore, urges NMFS and MMS to include language in the PEIS that does not establish exclusivity in its treatment of NEPA. It is important for NMFS and MMS to maintain the ability to utilize the 2006 Seismic PEA to satisfy NEPA requirements if the PEIS is not completed.

AOGA and Shell remain concerned over the mitigation measures imposed in the conditions for seismic permits and IHA authorizations issued for the 2006 season. Shell believes these measures: (1) were not substantiated by the available science, (2) make it very difficult, at best, in some cases unsafe or impossible to implement seismic surveys, and (3) will potentially set unjustified precedent that will negatively impact seismic acquisition and other responsibly conducted marine based operations in the Alaskan OCS, as well as in other areas of the U.S. and worldwide. In so doing, NMFS and MMS went beyond the NEPA requirements and included alternatives (i.e., a 120-dB monitoring safety zone) that are not implementable. As a result, Shell did not attempt to acquire seismic in the Chukchi after September 25th because of concerns about human safety associated with the very extensive over-flight operations far from the coast that would have been required for 120-dB based aerial marine mammal monitoring under the 2006 seismic permit as set out by NMFS. Shell performed a quantitative risk assessment which showed that the risk of a fatality resulting from aerial surveys in the Chukchi Sea is 53% greater than the risk to a helicopter pilot on an annual basis. This level of risk is unacceptable to Shell, rendering the 120-dB monitoring safety zone inconsistent with the purposes of the OCS Lands Act.

CPAI's objections to the 120-dB and 160-dB mitigation measures imposed in 2006 and identified again in the current NOI are well known to NMFS. As stated in comments on the PEA, CPAI opposed these measures because there is no scientific basis to support them, because they are not safe or implementable, and because such extraordinary restrictions are not justified as mitigation for the minor environmental consequences of seismic operations. CPAI challenged these measures in federal district court and before the Interior Board of Land Appeals (IBLA). The court and IBLA stayed implementation of the 120-dB exclusion zone requirement. CPAI maintains strong objections to the 120-dB and 160-dB mitigation options, as they are based upon supposition and speculation that cannot be reconciled with decades of well-documented data regarding the sustaining health of the BCB bowhead whale population.

CPAI notes that in the 2006 PEA, NMFS and MMS reached the following conclusion regarding the feasibility of the proposed 120-dB mitigation provision(s): "Logistical complications and engineering limitations make effective monitoring of the 120-dB isopleth-exclusion zone (in Alternatives 3 and 5) very difficult and overall not feasible to accomplish." NMFS' conclusion that monitoring the 120-dB isopleth is "overall not feasible to accomplish" is amply supported by the technical problems, safety risks, and costs associated with such an effort. This was supported by the findings of the federal district court. Citing a court case, CPAI notes that NEPA itself does not mandate particular results, but is to ensure that federal agencies take a hard look at the probable environmental consequences of a proposed action and a reasonable range of alternatives and that an agency's choice of alternatives for detailed analysis should be bounded by some notion of feasibility. Consideration of speculative or unreasonable alternatives, including alternatives that are unsafe, technically impractical or economically unviable, is both a waste of resources and provides only the illusion of a thorough analysis. The federal district court's stay decision validates this finding in concluding that the 120-dB measures "pose substantial risks to human health and safety, would impose severe economic harm" and would impair the ability to conduct seismic exploration in the Alaska OCS. These findings cannot be squared with NMFS' listing of three alternatives in the NOI that are predicated in whole or in part upon the imposition of the 120-dB restrictions. Finally, CPAI believes the current abundance of NEPA analyses regarding seismic activity in the Alaska OCS is confusing. A comprehensive NEPA analysis of potential seismic impacts in the Chukchi and Beaufort Seas was performed by MMS and NMFS in 2006. Since the 2006 PEA, MMS has analyzed seismic impacts in an EIS addressing OCS leasing plans for 2007-2012 and in another more targeted EIS in connection with proposed Chukchi Sea OCS Lease Sale 193. All of the referenced EISs rely upon, and incorporate by reference, the 2006 PEA. NMFS' proposed EIS is yet another analysis of the same activities, which yet again incorporates by reference the 2006 PEA.

BP recommends NMFS consider generating separate impact analyses for the Beaufort and Chukchi Seas as they have substantially different bathymetric and oceanographic characteristics (relevant to sound propagation and ambient noise) and support different use and densities of marine mammals. BP also suggests that NMFS consider sound sources other than airguns, including marine vibroseis, explosives and methods other than seismic, such as Controlled Source Electromagnetic Sounding. The "no action" alternative should determine impacts on drilling success and on the economy of Alaska, including the impact on the likely success of both exploration and production drilling programs undertaken without adequate seismic data. In addition, NMFS should assess ways to minimize subsistence hunting community anxiety through research, education and communication. NMS should consider impacts from mitigation monitoring and mitigation-related research, emphasize the importance of mitigation approaches that do not lead to additional potential environmental effects and effectiveness of mitigation measures in terms of marine mammal protection, loss of operational efficiency, impacts to human safety and cost. If a practicable method for monitoring a 120-dB zone cannot be described, this mitigation measure should not be considered as a reasonable alternative.

VI. LIST OF PREPARERS AND CONTRIBUTORS

Minerals Management Service – Alaska OCS Region

Elinore M. Anker	Technical Publications Writer-Editor
Susan Banet	Supervisory Geologist, Resource Analysis Section
Michael Burwell	Socioeconomic Specialist
Doug Choromanski	Geologist
Deborah Cranswick	Supervisory Environmental Specialist, Environmental Assessment Section
Wayne M. Crayton	Biologist and NEPA Team Coordinator
John Goll	Regional Director
Ida Menge	Cartographer
Mazelle O. Parker	EIS Specialist
Mark Schroeder	Endangered Species and Wildlife Biologist
Peter Sloan	Geologist
Caryn Smith	Oceanographer
Jeffrey Walker	Regional Supervisor, Field Operations
Rance Wall	Regional Supervisor, Resource Evaluation Branch
James Wilder	Marine Mammal Biologist

Minerals Management Service – Headquarters

Jill Lewandowski	Protected Species Biologist
Sally Valdes	Fishery Biologist

National Oceanic and Atmospheric Admininstration - Fisheries

Ken Hollingshead	Fishery Biologist

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