

**Supplement to the 2006 Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales (*Balaena mysticetus*), Fin Whales (*Balaenoptera physalus*), and Humpback Whales (*Megaptera novaeangliae*)**

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

U.S. Department of the Interior  
Minerals Management Service  
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## I. INTRODUCTION AND CONSULTATION BACKGROUND

On December 3, 2007, Minerals Management Service (MMS) sent a letter to the National Marine Fisheries Service (NMFS) regarding the possible need to re-initiate consultation under the section 7 of the Endangered Species Act (ESA) on activities associated with oil and gas leasing and exploration in portions of the Beaufort Sea and Chukchi Sea Outer Continental Shelf (OCS) Planning Areas. In their letter dated January 10, 2008, NMFS recommended that we re-initiate formal consultation to address new information on two endangered species of whales (humpback and fin). In the NMFS Arctic Regional Biological Opinion (2006 ARBO) dated June 06, 2006. NMFS stated that "because fin and humpback whales are not likely to occur within the action area (planning areas of the Chukchi and Beaufort Seas) they are not likely to be adversely affected by these actions and will not be addressed in this opinion."

This supplement to the Arctic Region Biological Evaluation dated March 3, 2006 (2006 ARBE) (USDOI, MMS, 2006a) is being prepared to address the issues and circumstances stated below:

- Information now available regarding humpback and fin whales in the Chukchi and Beaufort seas warrants examination to determine if conclusions on these species in the 2006 ARBO remain valid. Except as modified herein, the information and conclusions of the 2006 ARBO remain valid and are incorporated by reference. This Biological Evaluation (BE) specifically addresses new information regarding levels of seismic-survey activity indicated by currently proposed seismic activities and in the NMFS/MMS Draft Programmatic Seismic-Survey Environmental Impact Statement (USDOI, MMS, 2006b).
- This BE addresses seismic-survey activities that may be related to pre- and post-lease exploration, development, production, and abandonment activities. The technologies used and potential effects of seismic-survey activities are virtually identical for each of these phases of oil and gas activities. Our intent here is to complete a programmatic consultation for airgun-supported seismic surveys for all phases of OCS oil and gas activities so that seismic surveys proposed during later stages do not necessitate reinitiating consultation unless changing technologies, methods, or new information not considered in this biological evaluation requires us to do so.
- This BE clarifies and defines the analysis scenario for seismic activity of no more than seven 2-dimensional/3-dimensional (2D/3D) seismic-survey airgun sound sources operating concurrently in the Chukchi Sea Planning Area and/or Beaufort Sea Planning Area. Specific surveys, in the case of deck-load limitations, may employ two sound-source vessels operating in tandem with alternating firing airguns serving as a single sound source. Low-frequency (less than 1 kilohertz [ $<1\text{kHz}$ ]) airgun and sparker sound sources with a 160 decibel (dB) safety zone of 1,000 meters (m) or less would not count toward the seven concurrent surveys noted above. Lower energy, high-resolution and high-frequency profiling acoustic-acquisition system (multibeam sonar, mini-sparker, bathymetric sounder, side-scan sonar, sub-bottom profiler, etc.) surveys with localized footprints would not count toward the seven concurrent seismic airgun operations noted above. The latter surveys are used for site-clearance, shallow-hazard, ice-gouge, and strudel-scour studies for structure placement and other special purposes usually associated with on-lease activities. Sub-bottom profiling and bathymetric sonar systems are considered lower energy surveys. Sub-bottom profilers and side-scan sonars operate at higher frequencies (2-23 kHz and 190-210 kHz, respectively) and are not of major concern related to bowhead, fin, and humpback whales.
- It is anticipated that multiple seismic surveys of all the types noted above could occur simultaneously. Collective noise-exposure footprint during an open-water season is potentially very dynamic temporally and spatially and could effect movement and habitat use by endangered whales. The effects to endangered whales of multiple seismic-survey operations occurring simultaneously in an area depend on specific survey purposes, survey types, timing of airgun operation, collective exclusion and safety zone footprint dynamics, spatial and temporal relationships of sound sources and whales, features of the survey area, and presence or absence of whales.

The ESA consultation would be reinitiated in the case of significant new seismic-survey technologies; to consider new information indicating seismic-survey activities are affecting bowhead, humpback, and fin whales to a degree or in a manner not previously considered; or if new species or critical habitats under the jurisdiction of NMFS become listed under the ESA within the Beaufort Sea and Chukchi Planning Areas.

The 2006 ARBE provided an evaluation of the potential effects on bowhead, fin, and humpback whales that could occur due to reasonably foreseeable oil and gas leasing and pre- and post-lease exploration activities in the Beaufort Sea and Chukchi Sea Planning Areas (Figure 1).

This BE incorporates by reference all information on bowhead, fin, and humpback whales and the potential effects of the proposed actions on these species that was contained within our 2006 ARBE (USDOJ, MMS, 2006a); Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a); Environmental Assessment (EA) for proposed Sale 195 (USDOJ, MMS, 2004); and the BE prepared for consultation for Sale 195 (USDOJ, MMS, 2004:Appendix C).

In a letter to NMFS dated December 3, 2007, MMS proposed to reinstate ESA consultation premised on recent documentation of fin whale occurrence in the Chukchi Sea Planning Area during 2006 and humpback whale occurrence and distribution in the western Beaufort Sea and Chukchi Sea Planning Areas in 2006 and 2007.

The analyses contained in this BE are based on assumptions about seismic-survey activities (and revised seismic-survey scenario as described above) associated with exploration and development scenarios presented in Section II of *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*)* (USDOJ, MMS (2006a). The reader is referred to this section for a discussion of assumptions MMS has made about seismic-survey activities, exploratory drilling, resource-recovery rates and quantities, timing of infrastructure development, platform emplacement, wells that may be drilled, resource production timeframes, and other information about oil and gas activities. These assumptions represent our estimates on the reasonably foreseeable types and levels of activities that may occur.

## **II. NEW INFORMATION ABOUT ENDANGERED WHALES THAT MAY BE AFFECTED BY THE PROPOSED ACTION IN THE ALASKAN BEAUFORT SEA AND CHUKCHI SEA PLANNING AREAS**

### **II.A. Background.**

Before 2006, new information was not readily available on the endangered whales in the Arctic Ocean. However, in 2006 and 2007, marine mammal observer (MMO)-monitoring information recorded sightings of fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) in the Chukchi Sea Planning Area and humpback whales in the Beaufort Planning Area.

Fin and humpback whales, therefore, are addressed in more detail in this BE. We also discuss additional information regarding effects of seismic surveys on bowhead whales. No designated critical habitat has been designated for these three species, for which NMFS has jurisdiction.

From our previous BE consultations and from our own review, the bowhead is the species most likely to be affected by oil and gas activities in the Beaufort Sea and Chukchi Sea Planning Areas because of the seasonal migrations patterns and a larger population compared to humpback and fin whale populations. For this reason, our 2006 ARBE (USDOJ, MMS, 2006a) provided more detail on this species than on humpback and fin whales. Because of new information regarding distribution of fin and humpback whales, additional description and analysis of potential effects of seismic survey activities on these species is provided in this supplemental BE.

## **II.B. Summary of Pertinent Information about Bowhead, Fin, and Humpback Whales.**

### **II.B.1. Bowhead Whale.**

**Summary and Introduction.** This supplemental BE incorporates by reference the detailed evaluation of bowhead biology and the effects of oil and gas activities provided in the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003a); Sale 202 EA (USDOI, MMS, 2006c); the 2006 ARBE (USDOI, MMS, 2006a:Sec. 2.C, pp. 9-25); the 2006 ARBO (NMFS, 2006:Sec. II, pp. 7-27); and Chukchi Sea Lease Sale 193 EIS (USDOI, MMS, 2007a:Sec.II.B.4.A(1), pp. 45-55).

### **II.B.2. Fin Whale.**

**II.B.2.a. Summary.** Additional information indicates that fin whales typically do not occur in the northeast Chukchi Sea and, to date, they have not been observed in the Alaskan Beaufort Sea. In recent years, information on the occurrence of fin whales in Alaskan waters has improved considerably; however, their presence in the Chukchi Sea remains rare. Recent fin whale observations are limited to the two accounts noted below. However, these two sightings do not provide sufficient information to warrant altering the finding of the 2006 ARBO (NMFS, 2006) that fin whales are not expected to occur in the northeastern Chukchi Sea, Chukchi Sea Planning Area, or in the Beaufort Sea.

Thus, we are not analyzing the potential effects to fin whales in this supplement except in the broader cumulative-effects scenario. Continued arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of fin whale-prey species and the seasonal distribution and movements of fin whales. This possibility emphasizes the need for periodic marine mammal monitoring and evaluation of new data regarding potential effects of oil and gas activities within the Chukchi Sea or the Beaufort Sea on this species.

**II.B.2.b. Introduction.** Fin whales are a widely distributed species, and the Northeast Pacific Stock may occur seasonally in the southwestern Chukchi Sea, north of the Bering Strait along the coast of the Russian Chukotka (also referenced as the Chukchi) Peninsula. Their known current summer feeding habitat includes the southern portion, especially the southwestern portion, of the Chukchi Sea along the Asian coast. This species' current use of parts of its historic range probably is modified due to serious population reduction during commercial hunting. However, there is no indication that fin whales typically occur within the Chukchi Sea or Beaufort Sea Planning Areas or in areas directly adjacent. There have been only rare observations of fin whales into the eastern half of the Chukchi Sea. In the southeast Chukchi Sea on September 23, 2006 (in the open-water period), three adult fin whales were seen from a vessel by marine mammal observers (Patterson, et al., 2007). In 1981, three fin whales (two adults, one calf) were observed (Ljungblad, et al., 1982) in the extreme southern Chukchi Sea associated with the aerial surveys of endangered whales in the Beaufort Sea, Chukchi Sea, and northern Bering Sea. These represent the only confirmed observations since 1979 in or near the planning areas (neither of these occurrences occurred within the planning areas). No other sightings of fin whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of lat. 66° N. and east of the International Date Line, and the Alaskan Beaufort Sea from long. 157°01' W. east to long. 140° W. and offshore to lat. 72° N. (Ljungblad et al., 1988). Fin whales have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2007 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002; Monnett, 2008, pers. commun.). During a research cruise in the Chukchi and Beaufort seas (from July 5-August 18, 2003), in which all marine mammals observed were recorded, no fin whales were observed (Bengtson and Cameron, 2003).

Fin whale population estimates from the 1970s for the entire North Pacific range from 14,620-18,630 (Ohsumi and Wada, 1974). A rough estimate of the number of fin whales west of the Kenai Peninsula in Alaskan waters could include the sums of estimates from Moore et al. (2002) and Zebrini et al. (2006), and results in an initial estimate of 5,700. The 5,700 is a minimum estimate for the entire stock, because it was

estimated from surveys that covered only a small portion of the range of this stock (Angliss and Outlaw, 2007a).

### **II.B.3. Humpback Whale.**

**II.B.3.a. Summary.** Vessel-based MMO sightings made in the open-water seasons of 2006 and 2007 confirmed humpback use of the western Beaufort Sea and Chukchi Sea Planning Areas, and adjacent areas in the southeast Chukchi Sea.

- Humpback whales recently have been observed in the western Alaskan Beaufort Sea (2007) and southern and eastern Chukchi Sea (2006, 2007). We assume these areas are a portion of the potentially expanding summer distribution or summer feeding grounds for this species.
- We assume that humpback whales recently encountered in the Chukchi and Beaufort Sea most likely would belong to the Western North Pacific Stock (WNPS), but individual photo-identification and genetic data are needed to confirm stock origin.
- We assume it is unlikely that humpback whales from the Central North Pacific Stock (CNPS) would be present in the northernmost Bering Sea near Bering Strait or seasonally be present within the southwestern, southeastern, or eastern Chukchi Sea or the western Beaufort Sea.
- Humpback whales do not tend to occur farther north but can and do occur within the Chukchi Sea and western Beaufort Sea Planning Areas, and may continue to do so in the future.
- Continued arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of humpback whale-prey species and the seasonal distribution and movements of humpback whales. This possibility emphasizes the need for periodic marine mammal monitoring and evaluation of new data regarding potential effects of oil and gas activities within the Chukchi Sea or the Beaufort Sea on this species.

**II.B.3.b. Introduction.** The northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukotka Peninsula are considered the northern extreme of the range of the WNPS of humpback whales (Angliss and Outlaw, 2007a). 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 whales use of portions of their historic range also has been influenced by severe population reduction due to historic commercial hunting. Data to confirm their use or lack of use of the Beaufort Sea and Chukchi Sea Planning Areas, or adjacent areas to the south, are limited to vessel-based MMO sightings made in the open-water seasons of 2006 and 2007, and represent new information. A summary of historic and current information follows.

No sightings of humpback whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of lat. 66° N. and east of the International Date Line, and the Alaskan Beaufort Sea from long. 157°01' W. east to long. 140° W. and offshore to lat. 72° N. (Ljungblad et al., 1988). They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2007 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002; Monnett et al., In prep.; Monnett, 2008, pers. commun.). During a research cruise in the Chukchi and Beaufort seas (from July 5-August 18, 2003) in which all marine mammals observed were recorded, no humpback whales were observed (Bengtson and Cameron, 2003). Passive-acoustic monitoring of portions of the Beaufort and Chukchi seas to date has not indicated presence of humpback vocalizations in the Beaufort Sea or Chukchi Sea Planning Areas prior to 2007. Objectives of acoustic monitoring for the Joint Monitoring Program, operated by LGL Alaska Research Associates Inc., of Chukchi Sea marine mammals from July through October 2006 did not include the detection of humpback vocalizations as an indicator of occurrence and distribution. Joint Monitoring Program 2007 acoustic-monitoring data have undergone preliminary analysis; however, 2007 passive-acoustic data have not been specifically classified to isolate potential humpback vocalizations at this time. One 2007 acoustic-monitoring record indicates a likely humpback vocalization, and an improved classifier capability will enable improved search for and classification of humpback vocalizations.

The number and distribution of recent (2006-2007) observations of humpback whales in the western Beaufort Sea and the Chukchi Sea are the result of low sampling intensity. The number of observation events, low

sampling effort, distribution of observations over a wide geographic area, and observation records from August 1 through October 15, 2007, may suggest that humpback whales might have been present in greater numbers and wider distribution than the small sample size of observations would indicate. The following humpback observations represent the extent of new information regarding this species.

During the 2006 open-water period, an observation of one humpback whale was recorded in the southern Chukchi Sea approximately 80 miles (mi) south of the Chukchi Sea Planning Area. The observation was made by marine mammal observers aboard a seismic-survey vessel in transit (unpublished MMS marine mammal-observer reports, 2006 and 2007).

During the 2007 open-water period between July 14 and October 16, 2007, humpback whales were observed during eight observation sequences by vessel-based marine mammal observers (unpublished MMS marine mammal-observer reports, 2006 and 2007).

On July 14, 2007, a single humpback whale was observed by marine mammal observers in the southwest portion of the Chukchi Sea Planning Area (unpublished MMS MMO reports, 2006 and 2007). This observation was made prior to the beginning of any MMS authorized activities.

On August 1, 2007, the observation sequence occurred over an 8-minute period in the western Beaufort Sea in the vicinity of Harrison Bay, approximately 4 nautical miles (nmi) east of Cape Simpson, by marine mammal observers associated with barge operations unrelated to MMS-authorized activities. Records indicated a humpback whale initially was observed at approximately 800 feet (ft) and approached to within 200 ft of the observer vessel, at which time a calf was observed and confirmed, and one whale (presumably the adult of the cow/calf pair) was observed minutes later at 500 ft (Tetra Tech EC, Inc, 2007).

On August 8, 2007, two humpback whales were seen by marine mammal observers within the Chukchi Sea Planning Area when no MMS-authorized activities were occurring (unpublished MMS MMO reports, 2006 and 2007).

On September 7, 2007, an observation sequence spanning 63 minutes resulted in nine separate sightings of two humpback whales in the Chukchi Sea Planning Area. It is unknown whether the observations were the same two whales repeatedly observed, if some or all of the observations were separate groups of two whales, or if the observations were of different individuals of a larger group. All of these observations occurred during a seismic-survey operation-shutdown period prompted by walrus within the exclusion zone. Humpback observations required extending the shutdown until dark, and operations were not resumed until the next day.

On October 15, 2007, an observation sequence resulted in the sighting of two humpbacks within 9 minutes of each other by a vessel in transit in the extreme southeastern Chukchi Sea 200 mi south of the Chukchi Sea Planning Area. It is unknown if these were the same two individuals, two separate groups of two individuals, or different individuals of a larger group (unpublished MMS MMO reports, 2006 and 2007).

Also on October 15, 2007, an observation sequence resulted in three sightings within a period of 12 minutes. One of these was of two humpbacks; the other two were of single humpback whales. It is unknown if these observations represent two individuals, three individuals, four individuals, or individuals of a larger group. At the time, the vessel was in transit approximately 90 mi south of the Chukchi Sea Planning Area's southernmost boundary and not engaged in seismic survey activity (unpublished MMS MMO reports, 2006 and 2007).

On October 16, 2007, one humpback whale was seen within the Chukchi Sea Planning Area. The vessel was in transit and not engaged in MMS-authorized activity (Unpublished MMS MMO reports, 2006 and 2007).

Also during the 2007 open-water season between August 5 and 15, one observation sequence noted three humpback whales in the extreme southern Chukchi Sea immediately north of the Bering Strait by marine mammal observers aboard the *Oshoro Maru*, a Japanese research vessel (Sekiguchi, In prep.).

Although the observations above represent new information of fin and humpback whales in the planning areas, they are insufficient to result in increased understanding of abundance, range, and distribution dynamics; foraging and other key habitat areas; movements; stock of origin; and interannual and intra-annual variation or consistency of use patterns in the U.S. Arctic Region. More information is needed before a reliable assessment can be made regarding effects from OCS activities. The MMS recommends and supports research and monitoring efforts to provide for periodic assessment and, if warranted, development of appropriate measures to protect these species.

## **II.C. Rangewide Status, Humpback Whale (*Megaptera novaeangliae*) (Central and Western North Pacific Stocks) – Endangered.**

**II.C.1. Introduction and Summary.** The humpback whale is a medium-sized baleen whale that inhabits a wide range of ocean habitats, including some documented use of the Chukchi Sea. Available information does not indicate that humpback whales typically occur within the Chukchi Sea or Beaufort Sea Planning Areas; however, new information gathered in the open-water periods of 2006 and 2007 indicate this species to have been observed in the Chukchi Sea Planning Area and the western portion of the Beaufort Sea Planning Area.

The MMS previously provided extensive information to NMFS about humpback whales and the potential for humpbacks to be affected by oil and gas activities during our Section 7 consultation concerning potential oil and gas activities in Federal waters within lower Cook Inlet. For that consultation, MMS provided NMFS with our draft EIS for the Cook Inlet OCS Lease Sales 191 and 199 (USDOI, MMS, 2003b), which contained our biological evaluation of potential effects to this species. Information provided herein summarizes and updates that information provided in the 2006 ARBE. We refer NMFS also to the recently revised draft stock assessments for these two stocks (Angliss and Outlaw, 2007a), the WNPS and CNPS, for additional detailed information beyond the scope of this supplemental BE.

**II.C.2. Endangered Species Act Status and Protective Legislation.** The International Whaling Commission (IWC) banned commercial hunting of humpbacks in the Pacific Ocean in 1965 (Perry, DeMaster, and Silber, 1999). Humpback whales were listed in 1973 as endangered under the ESA and as depleted under the Marine Mammal Protection Act (MMPA). All stocks in U.S. waters are considered endangered (Perry, DeMaster, and Silber, 1999, 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, 1991a).

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 (yd) (91.4 meters [m]) of a humpback whale. To prevent disturbance that could adversely affect humpbacks and to reduce threats from whale-watching activities, NMFS also implemented a “slow, safe speed” requirement for vessels transiting near humpbacks. Exemptions to the rule were for commercial-fishing vessels during the course of fishing operations; for vessels with limited maneuverability; and for State, local, and Federal vessels operating in the course of official duty.

**II.C.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, 2005b, 2007b) 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:

- a California/Oregon/Washington and Mexico stock;

- 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
- 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 Kuril Islands, Gulf of Anadyr, and southeastern Chukotka Peninsula (National Marine Mammal Lab (NMML) unpublished data, cited in Angliss and Lodge [2004] and Angliss and Outlaw [2007b]).

Additionally, there is a winter/spring population of humpback whales in the Revillagigedo 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 from which population or stock humpbacks entering the Chukchi and Western Alaska Beaufort seas originate. However, based on the breakdown presented above, it appears most likely that these whales would belong to the WNPS. There are no reliable estimates for the abundance of humpback whale feeding areas for this stock, because surveys of the known feeding grounds are incomplete, and not all feeding areas are known (Angliss and Outlaw, 2007a). The minimum population estimate is 394, and potential biological removal (PBR) estimated at 1.3. Data indicate an annual mortality of 0.2 humpbacks per year incidental to U. S. commercial fisheries; however, data regarding minimum human-caused annual mortality in the waters of Korea and Japan are between 1.1 (using bycatch data only) and 2.4 (using bycatch, stranding, and market data) per year. Because many mortalities pass unreported, the actual mortality rate in these areas is likely much higher (Angliss and Outlaw 2007a). Reports from other portions of the WNPS range are not available. Total human mortality appears to exceed the potential biological removal of 1.3 animals. The WNPS may be considered more vulnerable due to low numbers compared to other stocks. We assume that the California/Oregon/Washington stock would not be affected. We assume it is unlikely that humpback whales from the CNPS would be present in the northernmost Bering Sea near Bering Strait or seasonally be present within the southwestern, southeastern, or eastern Chukchi Sea or the western Beaufort Sea.

**II.C.4. Past and Current Population Abundance in the North Pacific.** The reliability of pre- and postcommercial exploitation and of current abundance estimates is uncertain. Based on whaling records (Perry, DeMaster, and Silber, 1999; Rice, 1978) estimated there were more than 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 (1978) made reported rough estimates of 1,200 and 1,000, respectively, of the humpback numbers surviving in the North Pacific after the cessation of commercial whaling for humpbacks in 1966. However, Perry, DeMaster, and Silber (1999) 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 postcommercial exploitation estimate of 1,400 by Gambell (1976), Calambokidis et al. (1997) concluded that: "...the methods used for these estimates are uncertain and their reliability questionable."

Calambokidis et al. (1997) estimated the abundance of humpback whales in the mid-1990s in the wintering areas to be as follows: 394 (CV = 0.084) for the WNPS; 4,005 (CV = 0.095) for the entire CNPS on the wintering grounds in Hawaii; and about 1,600-4,200 for Mexico. Based on aerial surveys of the Hawaiian Islands, Mobley 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, sightings from a vessel survey in July-August 1999 mostly west of St. Matthew Island, if extrapolated to the entire survey area, an estimated 1,175 humpback whales occur in the central Bering Sea during the summer. Moore et al. (2002) determined these sightings were too clumped in the central-eastern Bering Sea for use to provide a reliable estimate for the area. The survey conducted in the eastern Bering Sea in 2000 resulted in an estimated abundance of 102. It is unknown whether these animals belong to the CNPS or WNPS. Between 1977 and 2001, 315 individual humpbacks have been identified in Prince William Sound (von Ziegeler et al., 2004, as cited in Angliss and Lodge, 2004). Waite et al (1999) estimated that the annual abundance of humpbacks in the Kodiak area to be 651 (95% CI = 356-1523). Based on mark-recapture estimates of humpbacks to the west of Kodiak, Wittveen, 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 (2007b) stated that: "There are no reliable estimates for the abundance of humpback whales at feeding areas for this stock" (the WNPS) "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 (2007b).

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

Angliss and Outlaw (2005b, 2007b) provided a PBR of 1.3 and 12.9 animals for the WNPS humpback population and the entire CNPS, respectively. We note that the PBR for the WNPS is based on the conservative minimum population estimate of 367 for this stock. Angliss and Outlaw (2005b, 2007b) provided a PBR of 9.9 for the northern portion of the CNPS 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  $\pm$  474). Adjusting for the effects of sex bias in their sampling and use of the higher estimate for Mexico, their sampling yielded an estimate of about 8,000 humpback whales in the North Pacific. Perry, DeMaster, and Silber (1999) concluded that the Calambokidis et al. (1997) estimate of about 6,000 probably was too low.

**II.C.5. Reproduction, Survival, and Nonhuman-Related Sources of Mortality.** Humpbacks give birth and presumably mate on their wintering ground. Perry, DeMaster, and Silber (1999) summarized that calving occurs along continental shelves in shallow coastal waters and off some oceanic islands (e.g., Hawaii). Calving and mating for the WNPS of humpbacks occurs within the Asian winter/spring areas in the South China Sea, Philippines, Mariana Islands, Marshall Islands, Ryuku Retto, Ogaswara, and southern Japanese Island group. Calving is documented as far south as the coast of Northern Sierra Madre (Acerbes, et al., 2007). 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, 1999). While calving intervals vary 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, 1999).

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, 1999). Lambertsen (1992) cited giant nematode infestation as a potential factor limiting humpback recovery.

Based on sighting histories of individually identified female humpbacks 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% CI = 0.032, 0.378) and 0.241 (95%CI = 0.103, 0.434), respectively. Although there is no estimate of the maximum net productivity rate for the WNPS, it is reasonable to assume it would be at least 7% for this stock. Mobley et al. (2001) estimated a trend of 7% for 1990-2000, using data from aerial surveys conducted across all of the Hawaiian Islands and developed specifically to estimate a trend for the CNPS. Reliable information on trends in abundance of the WNPS of humpback whales is not currently available.

Human sources of mortality, disturbance, vessel strikes and other effects on humpbacks, including commercial whaling are discussed in the cumulative effects section (IV.D.2) of this BE.

#### **II.C.6. Migration, Distribution, and Habitat Use.**

**II.C.6.a. General Information.** Humpback whales range throughout the world's oceans, with lower frequency use of Arctic waters (Perry, DeMaster, and Silber, 1999; 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, 1999). 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 (lat. 10°-23° N.), where they calve and mate, to more northern regions, where they feed on zooplankton and small schooling fish species in coastal and inland waters from Point Conception, California to the Gulf of Alaska and then west along the Aleutian Islands, the Bering Sea, the Amchitka Peninsula, and to the southeast into the Sea of Okhotsk (Angliss and Lodge, 2002, 2005; Nemoto, 1957). There are reports that during the period of commercial whaling, this species occurred in the southwestern Chukchi Sea (see information provided below in Section II.C.6.b on use of the Beaufort and Chukchi seas). Feeding areas tend to be north of about lat. 30° N., along the rim of the Pacific Ocean basin from California to Japan. In the most recent draft stock assessment for the WNPS, NMFS (as reported by Angliss and Outlaw, 2005) summarized that: "...new information...indicates that humpback whales from the WNPS and CNPS mix on summer feeding grounds in the central Gulf of Alaska and perhaps the Bering Sea" (see Angliss and Outlaw, 2007b:Figure 38, pp. 151). During the open-water season of 2006, one humpback whale was observed by vessel-based marine mammal observers in the Chukchi Sea immediately north of the Bering Strait. During the summer of 2007, between August 1 and October 16, humpback whales were observed in the western Alaska Beaufort Sea on one observation sequence and in the eastern and southeastern Chukchi Sea during six observation sequences (Sekiguchi, In prep.; unpublished MMS marine mammal-observer reports, 2006 and 2007).

Individuals tend not to move between feeding areas. Mizroch et al. (2004) summarized that based on all sightings, fewer than 2% of all individuals sighted were observed in more than one feeding area. Clapham and Zerbini (2007) note that in satellite-monitored movements of two humpbacks: "it is very likely that the movements of humpback whales in summer are principally determined by the abundance of prey available to them within their range." They suggest that periodic excursions out of the two principal aggregation areas represented prospecting trips for the purpose of assessing the abundance and density of food in nearby areas after which, these whales returned to the aggregation areas.

**II.C.6.b. Use of the Beaufort and Chukchi Seas.** The NMFS (1991a) (citing Nikulin, 1946 and Berzin and Rovnin, both in Russian), summarized that the northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula are the northern extreme of the range of the humpback (see also Johnson and Wolman, 1984). Figure 38 of the most recent (Angliss and Outlaw, 2007a) stock assessment for the WNPS depicts the southwestern Chukchi Sea as part of the "approximate distribution" of humpback whales in the North Pacific. Other references indicate that both the historical and current summer feeding habitat of the humpback included, and at least sometimes includes, the southern portion, especially the southwestern portion, of the Chukchi Sea. Mizroch et al. (In prep.) 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:

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.

Until 2007, historic and recent information did not indicate humpback whales inhabit northern portions of the Chukchi Sea or enter the Beaufort Sea. No sightings of humpback whales were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) of 1979-1987 in the Northern Bering Sea (from north of St. Lawrence Island), the Chukchi Sea north of lat. 66° N. and east of the International Date Line, and the Alaskan Beaufort Sea from long. 157°01' W. east to long. 140° W. and offshore to lat. 72° N. (Ljungblad et al., 1988). They have not been observed during annual aerial surveys of the Beaufort Sea conducted in September and October from 1982-2007 (e.g., Monnett and Treacy, 2005; Moore et al., 2000; Treacy, 2002; Monnett, 2008, pers. commun.). During a 2003 research cruise in which all marine mammals observed were recorded from July 5 to August 18 in the Chukchi and Beaufort seas, no

humpback whales were observed (Bengtson and Cameron, 2003). One observation of one humpback whale was recorded in 2006 by marine mammal observers aboard a vessel in the southern Chukchi Sea outside of the Chukchi Sea Planning Area (Patterson et al., 2007; unpublished MMS marine mammal-observer reports, 2006). During summer 2007 between August 1 and October 16, humpback whales were observed during seven observation sequence events in the western Alaska Beaufort Sea (1) and eastern and southeastern Chukchi Sea (6) (unpublished MMS marine mammal-observer reports, 2007) and one other observation in the southern Chukchi Sea in 2007 (Sekiguchi, In prep.).

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

- Humpback whales recently have been observed in the western Alaskan Beaufort Sea (2007) and southern and eastern Chukchi Sea (2006, 2007). We assume these areas are a portion of the potentially expanding summer distribution or summer feeding grounds for this species.
- We assume that the humpback whales recently encountered in the Chukchi and Beaufort seas most likely would belong to the WNPS, but individual photo-identification and genetic data are needed to confirm stock origin.
- We assume it is unlikely that humpback whales from the CNPS would be present in the northernmost Bering Sea near Bering Strait or seasonally be present within the southwestern, southeastern, or eastern Chukchi Sea or the western Beaufort Sea.
- Humpback whales do not tend to occur farther north but can and do occur within the Chukchi Sea and western Beaufort Sea Planning Areas, and may continue to do so in the future.
- Continued arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of humpback whale prey species, and the seasonal distribution and movements of humpback whales. This possibility emphasizes the need for periodic marine mammal monitoring, and evaluation of new data regarding potential effects of oil and gas activities within the Chukchi Sea or the Beaufort Sea on this species.

#### **II.C.6.c. Use of the Bering Sea in Relation to Observations in the Beaufort and Chukchi Seas.**

Observations by Mel'nikov (2000) of humpback whales adjacent to the Chukotka Peninsula indicate that humpbacks whales are present and feeding in the most northerly portions of the northwestern Bering Sea in the summer and autumn prior to ice formation. Thus, for purposes of analyses, we assume that humpbacks do occur seasonally just south of the Bering Strait and that these whales are the source of those observed in the U. S. Beaufort and Chukchi Seas in 2006-2007 and likely to be of the WNPS.

In 2007 humpbacks did occur in the western Beaufort Sea (one documented sighting sequence) and, in 2006 and 2007, were observed in the southern and eastern Chukchi Sea (seven documented sighting sequences); they transit between the Chukchi and Bering seas through the Bering Strait in summer and autumn.

**II.C.7. Feeding.** Humpbacks tend to feed on summer grounds and to not on winter grounds. However, some low-latitude winter feeding has been observed and is considered opportunistic (Perry, DeMaster, and Silber, 1999). 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, 1999). 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. Tagging observations in 2007 represent the only published account of satellite-monitored movements of humpback whales on a feeding ground in the area north of the Aleutians. 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 frequently were observed at the head of several bays where capelin and herring spawn (Wittveen, Wynne, and Quinn, 2005), a pattern similar to that reported to Southeast Alaska where sites occupied in the winter are coincident with areas that have overwintering herring.

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

Because of variability in components of environmental conditions such as sea ice, temperature, wind, and snow; presence of marine mammals; presence of industrial, air/sea transportation, research, recreation, emergency-response activity, military, and subsistence activities; and other factors, the acoustic environment and ambient noise levels in the Beaufort and Chukchi seas can vary dramatically between and within seasons, years, and between specific areas. During much of the year in many marine areas in this region, there are few near-field marine-noise sources of human origin, and limited but increasing land-based sources of noise that affect the OCS. Refer to the 2006 ARBE (USDOI, MMS, 2006a:Section III A-F) for a detailed discussion of the acoustic environment in the Beaufort and Chukchi seas.

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

#### **IV.A. Potential Effects of Noise and Disturbance from Proposed Actions on Fin and Humpback Whales.**

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

**IV.A.1. Background on Noise in the Marine Environment.** Properties of sound that influence how far that sound is transmitted, what species hear it, and what physical and behavioral effects it can have include: its intensity, frequency, amplitude, wavelength, and duration; distance between the sound source and the animal; whether the sound source is moving or stationary; the level and type of background noise; and the auditory and behavioral sensitivity of the species (Richardson et al., 1995a). The frequency of the sound usually is measured in hertz (Hz), pressure level in micropascals ( $\mu\text{P}$ ) (Gausland, 1998), and intensity levels in decibels (dB) (Richardson et al., 1995a; McCauley et al., 2000). McCauley et al. (2000 and references cited therein) express this in terms of its equivalent energy dB re  $1 \mu\text{Pa}^2$ . The perceived loudness of any given sound is influenced by many factors, including both the frequency and pressure of the sound (Gausland, 1998), the hearing ability of the listener, the orientation and location of the receptor animal in the water column, 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 potential effects of sound on marine mammals:

- 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 (e.g., depth, orientation) of the receiver (Richardson et al., 1995a; Gausland, 1998).
- Sound propagation can vary seasonally in the same environment.
- Extrapolation about the likely effects of a given type of sound source in a given location within the Beaufort Sea or Chukchi Sea Planning Areas on a particular marine mammal, based on published studies conducted elsewhere, are somewhat speculative, because characteristics of the marine environment such as bathymetry, sound-source depth, and seabed properties greatly effect the

propagation of sound horizontally from the source (McCauley et al., 2000; see also Richardson et al., 1995a:Chapter 4, 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.

- There is a great deal of naturally occurring noise in the ocean from volcanic, earthquake, wind, ice, and biotic sources (see Richardson et al., 1995a:Chapter 5). Ambient noise levels affect whether a given sound can be detectable by a receiver, including a living receiver, such as a whale. Ambient noise levels can change greatly throughout the course of a season at a particular site and vary from site to site (e.g., see acoustic environment section).
- Because the air-water interface acts as a good reflector, sound generated underwater generally will not pass to the air (Gausland, 1998)

**IV.A.2. General Background on Potential Effects of Noise and Disturbance on Cetaceans.** A detailed discussion of the potential effects of noise and disturbance on cetaceans is found in the 2006 ARBE (USDOI, MMS, 2006b:Section IV, pp. 38-68). Noise from various sources has been shown to affect many marine mammals (e.g., see Olesiuk et al., 1995; Richardson et al., 1995b; Kraus et al., 1997; NRC, 2003; 2005) in ways ranging from subtle behavioral and physiological effects to fatal.

Exposure to increased noise levels could result in the following effects: potential damage to hearing, potential effects on immune function, masking, and behavioral reactions. Richardson et al. (1995a) noted the effects of noise on marine mammals are highly variable and categorized noise effects on marine mammals as follows:

1. Noise may be too weak to be heard at the location of the animal, i.e., lower than prevailing ambient-noise level, the hearing threshold of the animal at relevant frequencies, or both.
2. The noise may be audible but not strong enough to elicit any overt behavioral response, i.e., the animals may tolerate it.
3. The noise may elicit behavioral reactions of variable conspicuousness and variable relevance to the well-being of the animal: these can range from subtle effects on respiration or other behaviors to active avoidance reactions.
4. Upon repeated exposure, animals may exhibit diminishing responsiveness (habituation), or disturbance effects may persist; the latter is most likely with sounds that are highly variable in characteristics, unpredictable in occurrence, and associated with situations that the animal perceives as a threat.
5. Any manmade noise that is strong enough to be heard has the potential to reduce (mask) the ability of marine mammals to hear sounds at similar frequencies, including calls from conspecifics, echolocation sounds of odontocetes, and environmental sounds such as surf noise or ice noise. Intermittent airgun or sonar impulses, however, could cause masking for only a small proportion of the time, given the short duration of these pulses relative to the inter-pulse interval.
6. Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity or other physical effects. Received sound levels must far exceed the animals' hearing threshold for temporary threshold shift to occur. Received levels must be even higher for a risk of permanent hearing impairment.

At present, the lower and upper frequencies for functional hearing in msyticetes (baleen) whales collectively are estimated to be 7 Hz and 22 kHz (Ketten et al. 2007). The suspected vocalization frequency range for humpbacks varies from 10-3,700 Hz. Most baleen whale sounds are concentrated at frequencies less than (<)1 kHz, but humpbacks produce some signals with low level harmonics extending above 24 kHz. The presence of high-frequency harmonics does not necessarily indicate they are audible to the whales, but it does indicate high-frequency energy is present and may need to be reassessed as knowledge emerges.

**IV.A.2.a. Potential Damage to Hearing.** A detailed discussion of potential damage to hearing is found in the 2006 ARBE (USDOI, MMS, 2006a:Section IV.C.2.a, pp. 47-48). Very strong sounds have the potential to cause temporary or permanent reduction in hearing sensitivity or other physical effects. Southall et al. (2007), in *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations*, provides the latest

review by a group of experts in acoustic research disciplines of the expanding literature on marine hearing and on physiological and behavioral responses to anthropogenic sound. The group was convened over a several-year period, employed all relevant data to predict noise levels above which adverse effects on various groups of marine mammals are expected, and proposed exposure criteria for injury and behavioral effects. Southall et al. (2007) recommend criteria for injury (Permanent Threshold Shift or PTS) from exposure to a single pulse, expressed in terms of peak sound pressure level (SPL), are Temporary Threshold Shift (TTS) onset levels plus 6 dB of additional exposure. Expressed in terms of sound-exposure level (SEL), the recommended criteria are TTS-onset levels plus 15 dB of additional exposure. They proposed injury criteria expressed both as SPL and SEL for individual low-frequency cetaceans, including humpback, fin, and bowhead whales, exposed to "discrete" noise events (either single or multiple exposures within a 24-hour period) and multiple pulses. The proposed injury-criteria levels for pulses are SPL of 230 dB re 1  $\mu$ Pa (peak) (flat) and SEL of 198 dB re 1  $\mu$ Pa<sup>2</sup>. Proposed injury criteria for nonpulses are based on recommended SEL criteria for injury (PTS-onset are M weighted exposures 20 dB higher than those required for TTS-onset. For all cetaceans exposed to nonpulses, the recommended SPL for injury is 230 dB re 1  $\mu$ Pa (peak) (flat) and SEL of 215 dB re 1  $\mu$ Pa<sup>2</sup>.

**IV.A.2.b. Potential Effects on Immune Function.** Loud noise also may 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 affect the auditory system of cetaceans, it may affect health by bringing about changes in immune function, as has been shown in other mammals..." Romano et al. (2004:1131) identified neural immune measurements that may be "implicated as indicators 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 watergun. Neural-immune changes following exposure to single pure tones (up to 201 dB re 1  $\mu$ Pa) resembling sonar pings were minimal, but changes were observed over time. A beluga whale exposed to single underwater impulses produced by a watergun had significantly higher norepinephrine, dopamine, and epinephrine levels 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  $\gamma$ -glutamyltransferase increased over the experimental period.

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

Erbe and Farmer (1998:1386) summarize that in "...the human and dolphin ear, low frequencies are more effective at masking high frequencies than vice versa; masking is maximum, if the characteristic frequencies of the masker are similar to those of the signal..." They proposed that the factor most important for determining the masking effect of the noises was their temporal structure. The noise that was the most continuous with respect to frequency and time masked the beluga vocalization most effectively, whereas sounds (e.g., 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 effect 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 (e.g., 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.

**IV.A.2.d. Behavioral Reactions.** Southall et al. (2007) notes that the onset of significant behavioral disturbance from multiple pulses for migrating bowhead whales occurred at received levels (RLs) around 120 dB re 1  $\mu$ Pa (Richardson, Miller, and Greene, 1999). Southall et al. (2007) notes that of all other low-frequency cetaceans (including bowhead whales not engaged in migration), this onset of significant behavioral disturbance occurred at RLs at 140-160 dB re 1  $\mu$ Pa. McCauley (2000) noted humpback females with calves indicated avoidance behavior at 140 dB re 1  $\mu$ Pa and a short term startle response at 112 dB re 1  $\mu$ Pa.

Southall et al. (2007) notes that for non pulsed noise the combined information generally indicates no (or very limited) responses at RLs 90-120 dB re 1  $\mu$ Pa and an increasing probability of avoidance and other behavioral effects in the 120-160 dB re 1  $\mu$ Pa range. However, these data indicated considerable variability in RLs associated with behavioral responses. Contextual variables (e.g., source proximity, novelty, operational features) appear to have been at least as important as exposure level in predicting response type and magnitude.

Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on contextual factors such as 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 age composition; and for nonpulse sound, the source proximity, novelty, and operational features. For example, reaction to sound may vary depending on whether females have calves accompanying them, whether individuals are feeding or migrating (e.g., see discussion of effects of noise on humpback whales in McCauley et al., 2000; USDO, MMS, 2003b:Section IV.B.1.f(3)(d)2). Response may be influenced by whether, how often, and in what context the individual animal has heard the sound before. All of this specificity greatly complicates our ability in a given situation to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, and following recommendations in McCauley et al. (2000) (discussed above), we attempt to take a conservative approach in our analyses and base conclusions about potential effects on potential effects on the most sensitive members of a population. In addition, we evaluate the potential for effects on humpback or fin whales by making the implicit assumptions that sound may travel the maximums observed rather than minimums, and that whales engaged in a particular activity may respond at the maximum, not the minimum, distances observed in studies to date. However, these assumptions may overestimate potential effect in many cases. Because at least some of the airgun arrays being proposed for use in the Chukchi and Beaufort seas in 2006-2008 have greater total output than many of those in previous studies, we also may underestimate effects in some cases.

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

**IV.A.3. Potential Exposure of Threatened and Endangered Whales to Seismic-Survey Activities in the Chukchi Sea and Beaufort Sea Planning Areas.** Bowhead and humpback whales probably are the most likely of ESA-listed baleen whales to be affected by OCS oil- and gas-related seismic surveys in the Chukchi Sea or Beaufort Sea Planning Areas, because they occur seasonally in areas where seismic-survey activity could occur. Bowhead whales have documented use of portions of both the Chukchi Sea and Beaufort Sea Planning Areas for spring and fall migration, feeding, calving, resting, and limited breeding. Most of the calving for this population probably occurs between the Bering Strait and Point Barrow, although some calves have been documented in the migrating whales in the vicinity of St. Lawrence Island in the northern Bering Sea. Humpback whale calving would occur on their wintering grounds prior to their arrival in the Chukchi Sea in the winter and spring range for the stock. Bowhead and humpback whales have a demonstrated sensitivity to some noise and disturbance, including noise and disturbance from seismic surveys.

As summarized in Section II of USDO, MMS (2006a), fin whales are not expected to appear at any time of the year within either the Chukchi Sea or Beaufort Sea Planning Area. Available life-history evidence indicates that humpback whales typically do not breed or calve in these areas, but recent observations indicate humpbacks may feed, rest, and migrate in these areas during summer and fall. It is uncertain whether use of these areas by humpback whales will continue or increase in future years. Both fin and humpback whales

seasonally appear in coastal waters of the southwestern Chukchi Sea adjacent to the Chukchi Peninsula. Thus, it is unlikely that fin whales would be exposed to seismic-survey noise and disturbance. If recent observations are indicative of a trend of increasing abundance and distribution of humpback whales in the U.S. Arctic Ocean, then it would be likely that humpback whales would be exposed to seismic-survey and other oil- and gas-related noise and disturbance that may occur in the Beaufort Sea and Chukchi Sea Planning Areas.

**IV.A.4. Potential Effects of High-Resolution Seismic Surveys on Endangered Whales.** Because high-resolution seismic surveys use relatively lower energy and sound would be less likely to travel as far as sound from 2D/3D seismic surveys, these activities are less likely to have significant effects on endangered bowhead, fin, and humpback whales. Bowheads appear to continue normal behavior at closer distances to high-resolution seismic surveys than to 2D/3D deep penetration seismic surveys. In the study by Richardson, Wells, and Wursig (1985), four controlled tests were conducted by firing a single 40 cubic inch (in<sup>3</sup>) (0.66-metric liter) airgun at a distance of 2-5 kilometers (km) (1.2-3.1 mi) from the whales. Bowheads sometimes continued normal activities (skim feeding, surfacing, diving, and travel) when the airgun began firing 3-5 km (1.86-3.1 mi) away (received noise levels at least 118-133 dB re 1  $\mu$ Pa) root-mean-square (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, pre-dive 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.

Responses of fin and humpback whales to high-resolution surveys are uncertain and data specific to these species is lacking. Because the site-clearance activities are of shorter duration and have a smaller zone of influence than 2D/3D deep penetration seismic surveys, we believe it unlikely they would result in a biologically significant effect on fin and humpback whales, and responses would be similar to that of bowhead whales. Our primary concern with respect to high-resolution surveys is the potential for these activities to add to the noise and disturbance footprint of concurrent 2D/3D seismic survey(s) and/or drilling activities, and to cause local effects within a specific area, if large numbers of whales are present. We are specifically concerned about potential effects that could occur if high-resolution seismic survey activity were inshore of 2D/3D seismic survey activities or drilling operations. A concentration of noise- and disturbance-producing factors may keep humpback whales from high-value areas. Humpback data for the planning areas currently are not sufficient to identify high-value areas. Active in-season management and applied mitigation to temporal and spatial footprint of multiple activities may be necessary to prevent the effects of collective activities from inadvertently "herding," forming temporary traps and barring whale access to, displacing whales from and prevent effective use of high value feeding areas or preferred migration corridors.

#### ***IV.A.5. 2D/3D Deep Penetration Seismic Surveys***

***IV.A. 5.a. 2D/3D Deep Penetration Seismic Surveys - Description and Discussion of the Activity.*** Offshore geophysical exploration seismic surveys conducted in summer, and on-ice seismic surveys conducted in winter, are other sources of noise in the Arctic marine environment. Airgun arrays are the most common source of seismic-survey noise. A typical full-scale array produces a source level of 248-255 dB re 1  $\mu$ Pa -m, zero to peak (Barger and Hamblen, 1980; Johnston and Cain, 1981). These surveys emit loud sounds that are pulsed rather than continuous, and can propagate long distances (in some habitats, very long distances) from their source. However, most energy is directed downward, and the short duration of each pulse limits the total energy. Received levels within a few kilometers typically exceed 160 dB re 1  $\mu$ Pa (Richardson et al., 1995a) depending on water depth, bottom type, ice cover, etc. We provide a full description of typical 2D/3D deep penetration seismic surveying operations in Appendix II of the 2006 ARBE.

In their application for an Incidental Harassment Authorization (IHA), ASRC Energy Services and LGL Alaska Research Associates (2007) describes that during their proposed 2008-2009 Beaufort and Chukchi seas open-water 3D deep penetration seismic survey, the source vessel will tow two source arrays comprising three identical subarrays each, which will be fired alternately as the ship sails downline in the survey area. They specify that the ship will tow up to six streamer cables up to 5,400 m long.

The 2D/3D deep penetration seismic surveys stay active as many days as possible. However, Fontana (2003) states: "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% and 35%." These shooting-time percentages are representative of the industry worldwide and appear to be applicable also to arctic Alaska waters; however, specific operation shooting times can vary widely as a result of many variables. Thus, we anticipate that source vessels in the planning areas would not be operating continuously but rather would have periods when the airguns are silent.

In the Beaufort and Chukchi seas, we anticipate that the source vessels would be accompanied by at least one other vessel, which will be used for supplying and other needs, including refueling. In the case of operations anticipated in the Beaufort and Chukchi seas in 2008-2012, this vessel is likely to be an ice-hardened vessel and classed as an icebreaker.

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

Recent data have been published regarding measured versus modeled noise-level radii associated with different seismic-survey arrays in shallow and very deep water (Tolstoy et al., 2004) that indicate models may have been underestimating noise levels in shallow water. Because we explicitly assume that source surveys could occur anywhere within any portion of the Beaufort Sea or Chukchi Sea Planning Areas, as depicted in Figure 1 and because the characteristics of the surveys themselves are likely to vary from those undertaken previously in either planning area, we assume that the propagation characteristics also might vary from those determined during previous seismic-survey 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).

Based on the best available information, we expect 2D/3D deep penetration and high-resolution seismic-survey activity in Federal waters of the Chukchi and Beaufort seas over the next 5 years. We expect this level of activity to be greater than that during the period of the previous 5 years (2003-2007). As detailed in the scenario section in Appendix II of the 2006 ARBE (USDOI, MMS, 2006a), new seismic-survey activity is expected to be mostly open-water 3D deep penetration seismic surveys using streamers.

**IV.A.5.b. Potential Effects of 2D/3D Deep Penetration Seismic Survey-Related Noise and Disturbance on Bowhead, Fin, and Humpback Whales.** The 2006 ARBE (USDOI, MMS, 2006a:Section IV.C.5.b) is incorporated by reference and provides a comprehensive discussion of potential effects of 2D/3D seismic surveys on bowhead whales.

Humpback whale observations during 2006 and 2007 in the western Beaufort and southern and eastern Chukchi Sea indicate the presence of this species in the planning areas during times that seismic-survey activities would be conducted. Assuming humpbacks continue to use habitats in the Beaufort Sea and Chukchi Sea Planning Areas, they likely would be affected by seismic-survey-related noise and disturbance as well as from oil and gas development, production, and abandonment activities.

We do not rule out that fin whales feeding north of the Chukchi Peninsula could detect noise from seismic surveys, especially sounds from the 2D/3D deep penetration seismic surveys that were occurring in the Chukchi Sea evaluation area. For purposes of analyses, we must assume that seismic surveys could occur anywhere throughout the Chukchi Sea and Beaufort Sea evaluation areas, because we have incomplete knowledge of potential sound propagation in various locations and under specific conditions in these areas and, based on results from other studies in which seismic-survey sound has been detectable hundreds and even thousands of kilometers from the source.

Effects of such noise detection to fin whales, if such detection occurs at all and causes any response, are most likely to be short term and related to minor behavioral changes and, as a result, to be of negligible effect to the fin whale population. The long distances from activity where fin whales currently occur would render the received noise levels below noise-exposure-criteria levels that would cause injury or onset of significant behavioral response. The most likely potential effect, if fin whales hear some components of the seismic survey 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.

Thus, it is unlikely there would be adverse effects from noise and disturbance associated with seismic-survey activities in the Chukchi Sea planning area on fin whales because of their distance from such activities. No population effects are plausible for fin whales, and effects on individuals are considered unlikely. The MMS concludes that fin whales are unlikely to be adversely affected by seismic-survey-related noise.

Fin whales and humpback whales also might be exposed to the seismic-survey vessels or support vessels as they transit to the Chukchi Sea in June and return as ice conditions dictate in the autumn. As noted, survey data indicate that humpback whales leave the most southern part of the Chukchi Sea, the northern part of the Gulf of Anadyr, prior to the start of ice formation (Mel'nikov, 2000). As vessels may be heading south to avoid the same ice, these vessels could overlap in time and space with the whales.

If recent observations are indicative of a trend of increasing abundance and distribution of humpback whales in the U.S. Arctic Ocean, then humpback whales likely would be exposed to sound from aircraft supporting exploration seismic-survey activities. There is little information available regarding humpback whale response to fixed-wing aircraft and helicopter activities.

#### *IV.A.5.c. Potential Differential Responses of Male and Female Humpback Whales to Seismic Surveys.*

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, McCauley et al., (2000) summarized:

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

McCauley et al. (2000) observed a startle response in one instance. Within the key habitat areas where resting females and females and calves occurred, the humpbacks showed high levels of sensitivity to the airgun. The mean airgun level at which avoidance was observed was 140 dB re 1  $\mu$ Pa (rms), the mean standoff range was 143 dB re 1  $\mu$ Pa (rms), and the startle response was observed at 112 dB re 1  $\mu$ Pa (rms). Standoff ranges were 1.22-4.4 km. The levels of noise at which a response was observed were considerably less than those published for gray and bowhead whales (see above). They also were less than those observed by McCauley et al. (2000) in observations made from the seismic-survey source vessel operating outside of the sensitive area where whales were migrating and not engaged in a sensitive activity. Migration was not considered a sensitive activity in McCauley's study, although avoidance was noted. Humpbacks typically did not feed during the migration studied; however, resting areas and groups of nursing cows with calves were considered sensitive activities and areas. In Alaskan arctic waters, feeding, nursing, and resting might be considered sensitive activities as well as migration, especially in narrow corridors such as the Bering Strait. Information is lacking regarding sensitive areas in the Beaufort Sea and Chukchi Sea Planning Areas for humpbacks.

McCauley found that adult male humpbacks were much less sensitive to airgun noise than were females. At times, they approached the seismic survey source vessel. McCauley et al. (2000) speculated that males that did so may have been attracted by the sound because of similarities between a single airgun signal and a whale-breaching event. Malme et al. (1985) noted in Southeast Alaska approaches by humpback whales to a single 100-in<sup>3</sup> airgun source at ranges corresponding to sound exposure levels of up to 172 dB re 1  $\mu$ Pa (rms),

but they did not speculate on sex or similarity of a single airgun noise to and the potential attraction response to the sound to a breaching whale. Playback of recorded representative sounds of drillships, helicopter flyover, drilling platform, production platform, and semisubmersible drill rig were inconclusive. Based on the aforementioned, it is likely that humpback whales feeding or resting in areas within and adjacent to areas within the planning areas could have their movement and feeding behavior affected by noise associated with seismic surveys. The most likely to be affected are females and calves. This potential effect would be seasonal, because humpbacks are present in these areas during the open-water period and absent when ice cover dominates the Arctic Region seas.

Humpbacks make a variety of sounds. Their song is complex, with components ranging from <20 Hz to 4 kHz, and occasionally up to 8 kHz. Songs can be detected by hydrophones up to 13-15 km (Helweg, Frankel, and Herman, 1992). Songs can last as long as 30 minutes. They are typically heard on low-latitude wintering grounds and occasionally have been heard on northern feeding grounds (McSweeney et al., 1989). It is unlikely that seismic-survey noise would interfere with hearing these songs in the open-water season in the Chukchi and Beaufort seas. Humpbacks on high-latitude summer grounds are less vocal. Calls, clicks, and buzzes are made while feeding and may serve to manipulate prey and as "assembly calls" (Richardson et al., 1995b, NOAA, 2007). These calls are at 20-2,000 Hz.

There are no studies that would indicate or not indicate differential responses to seismic surveys by different sex or age class, cow calf groups, or other groups or individuals fin whales at this time.

*IV.A.5.d. Summary of Effects of 2D/3D Seismic Surveys on Endangered Whales.* In summary of scientific studies presented above about the potential effect of 2D/3D seismic surveys on humpback whales, response to 2D/3D seismic surveys varies, sometimes considerably. Specific data on the effects of seismic surveys on humpback whales in their summer grounds are lacking. It is not entirely clear which factor(s) explain the difference in response. There is a consensus, however, that migratory humpbacks may avoid an active seismic-survey sound source at 4 km. Data on other whales and other mammals indicate that females with calves may show even stronger avoidance reaction. Humpback pods containing cows and calves that were involved in feeding and resting behavior in key habitat types, as opposed to migrating animals, were more sensitive and showed avoidance estimated at 7-12 km from a large seismic-survey sound source. The mean airgun level at which avoidance was observed was 140 dB re 1  $\mu$ Pa (rms), the mean standoff range was 143 dB re 1  $\mu$ Pa (rms), and a startle response was observed at 112 dB re 1  $\mu$ Pa (rms). Standoff distance ranges were 1.22-4.4 km.

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

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

In summary of scientific studies and traditional knowledge presented above about the potential effect of 2D/3D seismic surveys on bowheads, bowhead response to 2D/3D seismic surveys varies, sometimes considerably. It is not entirely clear which factor(s) explain the difference in response. However there is a

consensus that migratory bowheads may avoid an active seismic source at 20-30 km in some circumstances; and deflection may start from even further (35 km) and may persist 25-40 km to as much as 40-50 km after passing seismic-survey operations (Miller et al. 1999). Because data on other whales and other mammals indicate that females with calves may show even stronger avoidance, and because it often is unclear what behavior a whale was engaged in, we assume most individuals may avoid an active vessel at received levels of as low as 116-135 dB re 1  $\mu$ Pa (rms) when migrating), but acknowledge this zone avoidance may be considerably less for feeding whales. Richardson (1999) indicates the onset of significant behavioral disturbance for migrating bowheads from multiple pulses occurred at received levels around 120 dB re: 1  $\mu$ Pa.

#### **IV.A.6. Effects from Support Traffic Associated with Seismic Surveys and other Marine Traffic.**

**IV.A.6.a. Effects from Seismic-Survey Support Vessel Traffic.** The Chukchi Sea Planning Area experiences relatively low volumes of marine traffic associated with fishing, recreation, and commercial-shipping traffic at this time, as transit activities normally occur closer to shore than the boundary of the Planning Area. Traffic presently is limited to research vessel cruises, some of which engage in a variety of seismic-survey operations, and energy-related seismic-survey support activity. Increases in support-vessel traffic in habitats occupied by humpback whales would increase the risk of collision. Risk of collision to humpbacks of the WNPS is very low in U.S. waters and is not an important source of injury or mortality. Seismic-survey vessels and accompanying support vessels could adversely affect humpback whales by inducing avoidance responses. Information is sparse regarding humpback response to vessels other than seismic source vessels. The incremental additional marine traffic noise by transiting seismic vessels would remain short term, and total traffic volume would remain low. In the western Beaufort OCS, seismic-survey vessel-transit noise would add incrementally to the volume of marine traffic noise experienced in that area, but it would not add substantially to the current levels of volume of traffic or noise. Currently all vessels (including seismic-survey support vessels) are required to comply with law that forbids a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yd (91.4 m) of a humpback whale in any waters within 200 nmi of Alaska (*Federal Register*, 2001). Vessels (with some exceptions) transiting near humpbacks also are required to adhere to a "slow, safe speed" requirement to prevent disturbance that could adversely affect humpbacks. Vessel interaction and approaches with fin whales and other listed marine mammals are subject to guidelines to meet the requirements of the ESA rather than species-specific regulation in Alaskan waters. Seasonal travel corridors such as the Bering Strait where humpback, fin, and bowhead whales are in areas where increased vessel traffic occurs simultaneously potentially are exposed to greater risk of collision and frequency of oil- and gas-related vessel disturbance, as vessels exit the Arctic before ice formation. Monitoring of vessel strikes and vessel interaction should be monitored.

**IV.A.6.b. Effects from Seismic-Survey Support Aircraft Traffic.** Humpback and fin whales could be disturbed by aircraft noise associated with oil and gas leasing and exploration. Based on their distributions and stock population sizes, humpbacks are more vulnerable to aircraft disturbance than fin whales. Shallenberger (1978) reported some humpbacks were disturbed by overflights at 1,000 ft (305 m), whereas others showed no response at 500 ft (152 m). As with response to airgun noise, pods varied in their response. Humpbacks in large groups showed little or no response, but some adult-only groups exhibited avoidance (Herman et al., 1980). Due to concerns about the effects of helicopters in Hawaiian waters, helicopters are prohibited from approaching within a range of 1,000 ft (305m) from humpbacks (Carlson, 2007). Currently, 1,500 ft (456 m) is the NOAA (2006) guideline and the current mitigation applied to industry-operational aircraft in the Chukchi Sea and Beaufort Sea Planning Areas, and this likely would be applied to seismic-survey monitoring flights to protect the suite of marine mammal species that could be encountered. Fin whale distribution currently does not occur within or immediately adjacent to the planning areas and, as such, they are unlikely to be affected by noise and disturbance from aircraft traffic associated with seismic-survey activity.

Most offshore aircraft traffic in support of the oil industry involves turbine helicopters flying along straight lines and fixed-wing aircraft engaged in monitoring activities. 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 that it passes overhead and is heard underwater. The helicopter sounds measured underwater at depths of 3 m 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 500 ft (152 m) ranged from 117-120 dB re 1  $\mu$ Pa in the 10-500-Hz band. Underwater sound levels at 18 m from a Bell 212 flying overhead at 500 ft (152) m ranged from 112-116 dB re 1  $\mu$ Pa in the 10-500-Hz band.

Information is lacking regarding aircraft noise, humpback behavior responses, and important areas inhabited by humpback whales or cow calf groups in the planning areas and elsewhere. Bowhead whale information is provided here as a surrogate for humpback whales' general response potential from aircraft; however, similar responses to similar aircraft-noise stimuli may not occur and likely indicate species-specific differences in responses. 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 500 ft (152 m). At altitudes below 500 ft (152 m), some bowheads probably would dive quickly in response to the aircraft noise (Richardson and Malme, 1993). This noise generally is audible for only a brief time (tens of seconds) if the aircraft remains on a direct course, and the whales should resume their normal activities within minutes. Patenaude et al. (1997) found that most reactions by bowheads to a Bell 212 helicopter occurred when the helicopter was at altitudes of 500 ft (150 m) or less and lateral distances of 820 ft (250 m) or less. The most common reactions were abrupt dives and shortened surface time and most, if not all, reactions seemed brief. Fixed-wing aircraft flying at low altitude often cause hasty dives. Reactions to circling aircraft sometimes are conspicuous if the aircraft is below 1,000 ft (300 m), uncommon at 1,500 ft (456 m), and generally undetectable at 2,000 ft (610 m). Repeated low-altitude overflights at 500 ft (152 m) 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 200-1,500 ft (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 600 ft (182 m) or less and lateral distances of 820 ft (250 m) or less. There was little, if any, reaction by bowheads when the aircraft circled at an altitude of 1,500 ft (460 m) and a radius of 1 km. The effects from an encounter with aircraft are brief, and the whales should resume their normal activities within minutes.

While the obvious behavioral reaction of a bowhead to a single low-flying helicopter or fixed-winged aircraft flying overhead probably is temporary (Richardson et al., 1995a), most "fleeing" reactions in mammals are accompanied by endocrine changes that, depending on frequency and intensity of exposure and other stressors to which the individual is exposed, could contribute to a potentially adverse effect on health. Such potential fleeing reactions likely would be considered in incidental take authorizations. Flight practices could be structured by the helicopter operators to avoid such interactions. However, if production facilities are sited in areas inhabited by large numbers of whales, and helicopter trip levels are similar to those documented at Northstar (LGL, 2004), it is likely this traffic could be an important added source of noise and disturbance to bowhead whales.

The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead whales exists in areas where bowheads (or humpbacks) are aggregated, especially if such aggregations contain females and calves. Limitations of 1,500 ft (460 m) aircraft altitude and horizontal distance mitigation measures currently in place for bowhead and other sea mammals would appear to prevent harassment of humpbacks whales, until data indicates need for revised mitigation.

#### **IV.A.7. Areas and Situations Where Potential Effects are Likely to be Greater than Typical.**

Humpbacks are not assumed to be randomly distributed throughout the two planning areas; however, data are insufficient to define movements, important habitat areas, and duration of use of particular habitats intra- or interannually. The extent of use of particular habitats likely varies among years, but data are lacking

determine long-term use patterns. Over the past two years (2006-2007), intensive whale surveys have been conducted in nearshore waters adjacent to the Chukchi Sea Planning Area. Surveys in areas farther offshore have not been conducted since the mid-1990s. The MMS recognizes that the Arctic has experienced a warming trend and that changes in oceanographic function are ongoing. Humpback sightings in the last two years may be indicative of that change. Monitoring would be necessary to determine whether recent humpback occurrence is an anomaly or the beginning of a longer term trend in population and range expansion. We cannot predict, in advance of a given year exactly how humpbacks will use the entire area that is available to them. Aspects of their habitat use and factors influencing prey habitat limitations, abundance, distribution, and dynamics in arctic waters are poorly understood. For example, current data are not available on which to typify the current summer use by humpbacks of the Chukchi Sea and the western Beaufort Sea. It is unclear at this time if these humpback whales could be expected to be present each year in the planning areas during the open-water season and, as such, the Chukchi Sea and Beaufort Sea Planning Areas might be considered marginal or intermittent habitat until data indicate consistent use patterns.

It is likely that 2D/3D seismic surveys could not occur unless large areas of open water are available to effectively conduct streamer operations without interference from ice. Thus, seismic surveys are not expected to be conducted in or near the spring lead system because (a) degraded ice conditions would not allow on-ice surveys, (b) insufficient open water is present for open-water seismic surveys, and (c) MMS will not permit surveys in the lead system until July 1 unless authorized by NMFS. As noted, we do not know the timing or routes for humpbacks moving into the planning areas relative to the lead system and open-water period. However, humpbacks have not been observed in the spring lead system when surveys have been conducted for spring migrating bowhead whales or prior to August 1 in the Chukchi Sea Planning Area. Humpbacks, if and when they are present in the planning areas, would not be exposed to 2D/3D seismic survey until after July 1. The 2006 and 2007 information on humpback movement; distribution; type (feeding, resting, nursing, migrating, etc.); and duration of use in the planning areas is insufficient to determine primary open-water period habitat-use areas where or if aggregations, feeding aggregations, or aggregations with large number of humpback cows and calves occur.

If 2D/3D seismic surveys occurred in these areas when aggregations were present, and particularly if multiple 2D/3D seismic surveys occurred concurrently in these areas, humpbacks potentially could be disturbed by the survey activity or could be excluded by avoidance from habitat for the period the surveys were occurring. As we explain in the description of the proposed action in the 2006 ARBE (USDOJ, MMS, 2006b:Appendix II), the timeframe 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 and the percentage of time when the source vessel is inactive. However, it would not be atypical for a seismic-survey vessel to be in a given area for 20-30 days. Following the recommendation of the National Research Council (NRC, 2005) that length of period of a potential disturbance or behavioral effect 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 3D seismic survey could be half or more of the humpback open-water autumn migration/autumn feeding-habitat-use period. If two or more seismic-survey operations are interested in the same area at the same or overlapping time, seismic-survey activities potentially could, through avoidance, exclude humpback whales from areas for the entire open-water migration/feeding period that seismic-survey activity occurred. We do not mean to infer that individual whales do or do not use some of these high-use areas for this entire open-water period. Data are not sufficient to permit us to determine whether or not that is true. However, data do indicate that in some cases, whales could be excluded (through avoidance) from areas for a relatively long portion of the season, or individuals likely would avoid the area as they sequentially came in to use an area, depending on the number, timing, arrangement, and nature of seismic surveys occurring in a season.

This admittedly simplistic scenario does not include any avoidance of support vessels, or the attraction of prey that might be in the area. There is little information available to indicate humpbacks habituate to activity, but information suggests sensitivity to activity may vary depending on sex, reproductive status, and activity whales are engaged in. This simplistic exercise also does not take into account the sizes of the areas being surveyed; numbers of temporal and spatial overlapping surveys; turning requirements of the vessels; or the fact that, unless the vessels all moved in tandem, this area would be larger as they moved further apart. The "seismic-fence" effect could be mitigated by requiring vessels to be more distant from one another, but only if the distance allowed for reduced or near-ambient noise-level corridors through which migrating

bowhead whales easily could transit. Seismic-survey operations, especially in the fall migration period and along access corridors and observed feeding concentrations should be mitigated to allow a pattern or distribution of surveys and other noise sources that provide for free-movement opportunity for whales to access, maintain concentrated life-function activities (feeding) for extended periods of time, and a porous arrangement of movement corridors that allow whale access to major migration corridors, as well as to accommodate what appears to be a more dispersed bowhead fall migration in the Chukchi Sea. We note that available data indicate that, given a scenario where four to six seismic-survey-source vessels were arranged in a line, humpbacks potentially would come into a reduced area of seismic-noise footprint if the end seismic-survey boats were inactive, but the inactivity of one or more of the middle four boats should not necessarily result in increased habitat availability.

Arrangement of up to seven simultaneous airgun seismic survey sound sources would need to be managed so as not to create traps for migrating whales. Examples would be active sound sources forming open V or U shapes, allowing whales to enter and be subjected to a decreasing of ensonified area below behavior and injury levels and require an escape through reversal and rerouting of direction of travel, or temporary shutdowns, as necessary, of constricting portions of the seismic activities. Arrangement also must be managed to not create perpendicular blockades across major migration corridors. Linear arrangements of multiple seismic surveys occurring at acute angles to movement corridors that tend to herd or consistently divert migrating whales toward shore (in effect trapping whales between the line of activity and shore) or out to sea away from established migration corridors and use areas important to feeding or subsistence-hunt areas. Conversely, activities can be arranged to enhance movement of whales toward use areas. Multiple seismic survey sound sources can provide for free movement of whales by maintaining distances between sound sources that allow for corridors of low noise between sound sources. This distance would be determined by the types and sound-verification patterns of each sound source. Multiple seismic-survey-source vessels linearly arranged parallel to migration direction in the Chukchi Sea would allow for passage, as long as distances between parallel lines of surveys were far enough from each other to allow for reduced or near-ambient sound levels in corridors between lines of surveys or shore. Also a consideration in the potential to trap or block movement of whales is the presence of operating drill ships and other OCS noise-generating activities that, in concert with seismic operations, can increase the number, arrangement, and complexity of sound sources that whales may react to. These situations apply more specifically to bowhead whales, but also may apply to humpbacks in the fall movement toward to Bering Strait. Existing information on movement patterns, corridors, and timing is not available to determine the nature of humpback fall movements out of the Arctic.

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 and within a specified geographic area, the total area in the planning areas excluded by avoidance would rise, but the simultaneous geographic effects in a given area would be lessened. This and perhaps other potential strategies and tradeoffs 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 survey vessel, the context in which it is heard, and the motivation of the animal to stay within the area. It also may vary depending on the age and, most likely, the sex and reproductive status of the whale.

Humpback whale-observation data during the summer and autumn in the Beaufort and Chukchi seas are not sufficient to determine important feeding areas. We assume some feeding probably occurs, and that humpback whales may display similar reduced avoidance behaviors bowheads do when in high value feeding habitats. However, as we noted above, it is not clear that reduced avoidance should be interpreted as a reduction in effect. It may be that bowheads and other whales are highly motivated to stay on a feeding ground and remain at noise levels that could, with long-term exposure, cause adverse effects.

Because recent data are not sufficient on which to evaluate current habitat use by season or area in the Chukchi Sea by bowhead, humpback, or fin whales, we cannot rule out the potential for biologically significant effects in this planning area if sufficient mitigation is not imposed to shape the action. Potential effects larger than typical may exist in the Chukchi Sea in autumn (e.g., late September on) as whales migrate

toward the Bering Strait. We do not have sufficient data to determine the current migration timing, paths, or the numbers of whales that might be deflected from those paths. Data are not available to determine how intensively humpbacks feed during the open-water season or autumn migration in the Chukchi Sea, or whether aggregations occur in certain places where prey resources may concentrate.

We note that the potential for individuals to be excluded by avoidance from a habitat-use area, or potentially affected by higher levels of noise if feeding, could be avoided or substantially reduced by mitigations requiring site-specific monitoring in an area prior to initiation of seismic surveys, with specific restrictions on seismic surveys if certain abundance and age/sex classes of humpback thresholds were exceeded. Large zones of potential avoidance could be reduced through mitigation measures that manage the number, timing, and spatial arrangement of active seismic-survey vessels operating in an area of important habitat use or life function at any given time in relation to each other and other oil- and gas-related activities.

**IV.A.8. Effects of Noise from On-Ice 2D/3D Seismic Surveys.** Humpback and fin whales are not expected to occur in the Chukchi Sea or Beaufort Sea when on-ice 2D/3D seismic survey operations would occur. Therefore no effects are anticipated.

**IV.A.9. Summary of Noise Effects Associated with Seismic Surveys.** Humpback and fin whale response to aircraft is uncertain; however bowhead whale responses may offer an indication of expected humpback and fin whale response. Bowheads typically do not respond to aircraft overflights at altitudes above 984 ft (300 m). Below this altitude, some changes in whale behavior may occur, depending on the type of aircraft 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. Pods of humpbacks with females consistently avoided a single (not an array) operating airgun at an average range of 1.3 km. The generalized response of migrating humpback whales to a 3D seismic-survey vessel was to take some avoidance maneuver at greater than (>)4 km, then to allow the seismic-survey vessel to pass no closer than 3 km. Humpback pods containing cows that 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 km from a large seismic-survey-sound source. Within the key habitat areas where resting females and females and calves occurred, the humpbacks showed high levels of sensitivity to the airgun. The mean airgun level at which avoidance was observed was 140 dB re 1  $\mu$ Pa (rms), the mean standoff range was 143 dB re 1  $\mu$ Pa (rms), and a startle response was observed at 112 dB re 1  $\mu$ Pa (rms). Standoff ranges were 1.22-4.4 km. The levels of noise at which a response was observed are considerably less than those published for gray and bowhead whales. They also were less than those observed by McCauley et al. (2000) in observations made from the seismic-survey vessel operating outside of the sensitive area where whales were migrating and not engaged in a sensitive activity.

For comparison, bowhead whales may exhibit 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. Repeated or frequent encounters with aircraft and/or vessels that caused panicked or "fleeing" behavior that result in limited temporary physiological stress reactions from isolated encounters, collectively could have adverse effects on health over time. Scattering may persist for a longer period. In some instances, some bowheads returned to their original locations. Occasional brief interruption of feeding by a passing vessel or aircraft probably is not of biological significance but could become so, if whales were repeatedly interrupted or essentially were excluded from a feeding area. The importance of a given high-use feeding area (current data are insufficient to identify high-use areas for humpback whales) 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 potential winter areas near the Japan and western Beaufort seas. These disturbances or avoidance factors were unlikely to be significant, because the anticipated level of industrial activity was not sufficiently intense to cause repeated displacement of specific individuals; the level of activity in 2006 and 2007 was greater than in 2003, but less than the activities in the late 1970s and 1980s. A disturbance that causes whales to avoid or leave an important feeding area for weeks or longer is one that would remove the whales' access to that resource for a high percentage of the total time available to them. A disturbance that caused whales, particularly females and females and calves, to avoid or leave an area

typically used for resting (e.g., between hunting areas, or resting during the normal course of migration) for long periods of time (e.g., days in key periods to weeks) could have adverse effects on humpback and bowhead whale health. Reactions are less obvious in the case of industrial activities that continue for hours or days, such as distant exploration seismic surveys and drilling. Behavioral studies have suggested that bowheads habituate to noise from distant, ongoing drilling or seismic-survey operations (Richardson et al., 1985a), but there still is some apparent localized avoidance (Davies, 1997). Indication of similar habituation by humpbacks is uncertain.

**IV.A.10. Effects of Noise from Small Oil Spills Associated with Seismic Surveys.** There potentially could be displacement of humpback whales from a local feeding area following a fuel spill, and this displacement could last as long as there is a sizeable amount of oil and related cleanup-vessel activity and noise. We expect seismic-survey spill-related noise effects to be minor. Please refer to Section IV.C.b for a more detailed account of the effects of small oil/fuel spills.

**IV.A.11. Potential Mitigation Actions to Eliminate and Reduce Effects of Seismic-Survey Noise on Endangered Whales.** There are existing and potential mitigation actions and strategies available to eliminate and/or substantially reduce effects of noise generated by seismic surveys on endangered whales. The following list of mitigation tools is not meant to be a comprehensive list, but only provides basic approaches. This generalized list is meant to provide a general state of the art and is meant to use proven practices and strategies and to encourage innovative and creative approaches to the issue.

**Existing Practices Available to Mitigate Effects to Endangered Whales (may or may not be active in Alaska OCS):**

- Minimum elevations for aircraft overflights of marine mammals; example: 1,500-ft minimum AGL while conducting monitoring flights and personnel transport to offshore facilities-all aircraft.
- Seasonal operation windows; examples: No seismic survey activity until after July 1 in the spring lead system, to protect concentrated migrating, calving bowhead whales.
- Spatial and temporal closures for subsistence hunts of bowhead whales.
- Sound-verification tests to determine individual sound-proliferation profiles for specific sound sources.
- Situational shutdown protocols when marine mammals occur within established sound-exposure level safety zones of injury and behavior.
- Established sound-level criteria for injury, and onset of significant behavior responses.
- Laws-regulations; example: 100-yd approach distance and slow, safe speed regulation for humpback-vessel interactions; ESA and MMPA compliance and respective Letters of Authorization and IHA procedures.
- Spill-response preparedness, protocols, and standard practices; example: booming for refueling operations.
- Conflict Avoidance Agreements.
- Establish minimum distances between and arrangements of other OCS sound sources (active drill ships) that allow for corridors with adequate noise levels to allow free passage of migrating marine mammals.
- Protect opportunity for timely marine mammal access and occupancy duration to traditional subsistence-hunting areas.
- Communication-network systems.
- Monitoring and research programs designed to evaluate effectiveness of mitigation and to provide information to craft more effective mitigation and make better decisions to protect endangered species while meeting the goals of the OCS Program. Passive-acoustic monitoring and active-acoustic monitoring are examples as well as aerial- and vessel-monitoring safety zone around sound-source vessels. To discover new occurrences of and identify trends in distribution, abundance, and habitat selection of endangered whales and their responses, short and long term, to activities.
- Monitoring to have real-time data from which to make timely proactive in-season decisions to eliminate and minimize potential conflicts and adverse effects.

- Research to resolve specific issues and adverse effects to endangered whales where data are lacking, or specific information needs to better implement operations and mitigation actions. Satellite-transmitter equipped whale tracking during migrations and habitat selection determination studies; photo-identification to strengthen stock of origin for humpback whales.

**Existing Strategies or Approaches Available** (may or may not be active in Alaska OCS)

- Adapt the Unified Incident Command System (ICS) model for in-season, onsite day-to-day open-water season administration and management. Such a command system provides a team for day-to-day onsite centralized planning; decisionmaking; conflict resolution; coordination; mitigation implementation; dispatch; operational tracking; personnel and equipment resources coordination; real-time intelligence (coordinated data input for location, type, monitoring data for all activities, vessels); communications; record keeping; and data management. This is similar to large disaster and wildfire command systems that integrate regulatory, industry, local government, stakeholder and other entities on a short-term basis (open-water period) and are delegated decisionmaking command authority. If activities become more or less complex over time, the command team can change to an appropriate level and composition of skills. Another analogy might be the function of a flight control tower at an airport. This is a proven and flexible system or organizational approach to complex and controversial incidents and operations as experienced in the Arctic OCS.
- Utilized or pre-season comprehensive or collective planning for all seismic survey activities for each open-water period.

**IV.A.12. Summary: Effects of Noise from Seismic Survey Activities on Fin and Humpback Whales.**

Our summary of information about the current and historic distributions of fin whales and humpback whales indicate that:

- fin whales are not likely to be exposed to potential noise and disturbance associated with seismic-survey actions that could occur within the Chukchi Sea or the Beaufort Sea Planning Area; and
- if recent observations are indicative of a trend of increasing abundance and distribution of humpback whales in the U.S. Arctic Ocean, then humpback whales would 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 Area.

Bowhead, fin, and humpback whales are known to inhabit the southwestern portions of the Chukchi Sea in waters adjacent to the coast of Chukchi Peninsula. They also inhabit the Bering Strait and northerly portions of the Bering Sea. They could be disturbed by noise resulting from increased OCS oil- and gas-related shipping and transit through the Bering Strait attributed to 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 would be adverse effects on fin whales from noise-causing activities in the Beaufort Sea or Chukchi Sea Planning Areas.

We acknowledge that new information gathered in 2006 and 2007 regarding humpback whales indicates that these whales do occur in the Chukchi and Beaufort seas, and that information indicates but does not confirm these whales are from Western North Pacific Stock. There are not sufficient current data available for these program areas on which to determine current humpback whale use, abundance, distribution, habitat selection, key use areas, or verified stock of origin. Thus, we conclude that if recent observations are indicative of a trend of increasing abundance and distribution of humpback whales in the U.S. Arctic Ocean, then there likely would be adverse effects to humpback whales from noise and disturbance from seismic-survey activities in the Chukchi Sea and Beaufort Planning Areas. Active monitoring would provide an opportunity to define stock of origin, spatial and temporal distribution patterns, habitat selection and use areas, and trends in abundance from which to make informed in-season and longer term decisions and mitigation to guide oil and gas activities. Such monitoring is valuable to provide timely knowledge of whales and their habitat use dynamics in concert with the planning areas' changing uses and ecology.

#### **IV.B. Effects from Discharges on Fin and Humpback Whales.**

Discharges of various types associated with oil and gas drilling and production are not expected from seismic-survey activities and, therefore, potential effects on humpback and fin whales, their prey, and habitat are not expected to occur. Vessel discharges of various types (grey water, black water, coolant, bilge water, ballast, etc.) are regulated by the Environmental Protection Agency, U.S. Coast Guard, and the State of Alaska, and not considered here.

Any discharges that may be associated with seismic-survey activities would be small, localized, and negligible to humpback and bowhead whales in the Chukchi Sea and Beaufort Sea Planning Areas as these whales typically would avoid the area of activity, and discharges would rapidly dissipate or be diluted so as not to affect the whales or their prey.

#### **IV.C. Effects of Oil Spills from Seismic Survey Activities on Fin and Humpback Whales.**

A detailed discussion of potential effects of oil spills on endangered whales in the Arctic can be found in the 2006 ARBE (USDOJ, MMS, 2006b:Section IV.F, pp. 87-87-104).

**IV.C.1. Potential Effects of Large and Very Large Oil Spills on Fin and Humpback Whales.** Large oil or fuel spills are not expected from seismic-survey activities. The greatest potential for an adverse effect to bowhead whales would be if a large fuel spill (e.g., due to vessel damage or sinking) occurred in the Chukchi Sea or Beaufort Sea and affected the spring lead system. Seismic surveys and any spill associated with seismic activity would not occur until after July 1 after the spring lead system has deteriorated, and bowhead whales are no longer concentrated and vulnerable in the lead system, engaged in calving, or with new born calves. The probability of such an accident resulting from seismic activities and affecting the spring lead system is unlikely. It is unlikely that humpback or fin whales would be present in the spring open-lead system, as they likely would be present only during the open-water season.

The potential for there to be adverse effects from a fuel-oil spill likely would 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 whales in the open-water period. Unless females and calves were contacted by a spill, available evidence indicates that it is unlikely there would be a significant effect on humpback or fin whales. No large aggregations of fin or humpback females with calves or other groups have been documented in the Chukchi Sea or Beaufort Sea, and recent data documenting fin and humpback whale use of these areas are limited to nine total observation events during the open-water seasons of 2006 and 2007.

No data are available to MMS that definitely link even a large oil spill with a significant population-level effect on a species of large cetacean. Large spills resulting from seismic surveys are not expected to occur and we consider potential effects upon baleen whales to be negligible.

**IV.C.2. Effects from Small Oil Spills Associated with Seismic Surveys.** We acknowledge that small fuel spills associated with the vessels used for seismic surveys could occur, especially during fuel transfer. There could be localized, short-term alterations in bowhead, fin, and humpback habitat and habitat use as a result of such a spill. Whales exposed to a small fuel spill likely would experience temporary, nonlethal effects. Data available from other mammals indicate that prolonged exposure, or particularly exposure of nursing young to spilled oil, potentially could 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 effect would be detectable. Whale exposure to small fuel spills is further decreased as whales generally avoid seismic-survey activities and, therefore, likely would not be in the immediate area of a spill and would avoid the vessel activity, human activity, and noise associated with cleanup of such a spill. These conclusions are supported by the best available information.

Copepods may passively accumulate aqueous polyaromatic compounds (PACs) from water and could serve as a conduit for the transfer of PACs to higher trophic-level consumers. Bioaccumulation factors were

~2,000 for *M. okhotensis* and about ~8,000 for *C. marshallae*. *Calanus* and *Neocalanus* copepods have relatively higher bioaccumulation factors (Duesterloh, Short, and Barron, 2002). A small fuel spill would not permanently affect zooplankton populations and higher trophic-level consumers that also are humpback prey. The amount of zooplankton and other prey lost in such a spill likely would be small compared to what is available on the whales' summer-feeding grounds, however, little no information is available regarding humpback diets or available prey base in the Chukchi or Beaufort seas.

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

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

We conclude that individual fin or humpback whales potentially could be exposed to small fuel oil spills, and this exposure could have short-term, nonlethal effects on health. We expect seismic survey-related small-spill effects to be negligible.

#### **IV.D. Environmental Baseline and Cumulative Effects.**

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

**IV.D.2. Cumulative Effects.** Cumulative effects are defined in 50 CFR 402.02 (Interagency Cooperation on the ESA of 1973, as amended): "...those effects of future State or private activities not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation."

To enhance NMFS' evaluation of the material, we have attempted to clarify those actions that have operated only in the past and are unlikely to happen again (e.g., commercial whaling); those actions that have operated in the past, are continuing to exert effects, and are likely to continue to have some effect in the future (e.g., subsistence hunting and oil and gas exploration) and those activities that have not occurred in the past and are not occurring, but may occur in the future (e.g., development in the Chukchi Sea Planning Area). Thus, some effects that are discussed as cumulative effects in the Beaufort Sea multiple-sale EIS (USDOJ, MMS, 2003a) and in the EA for proposed Lease Sale 202 (USDOJ, MMS, 2006c) are discussed in the environmental baseline section in this BE. All actions that require Section 7 consultation under the ESA are included under baseline effects in this evaluation (e.g., subsistence hunting, Federal offshore oil and gas lease sales).

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

In the baseline and cumulative effects analyses, we have considered all factors that we believe potentially have contributed, are contributing, or could contribute to the baseline status and to cumulative effects on bowhead whales, fin whales, and humpback whales anywhere in the range of the appropriate stocks. For this reason, the geographic area considered in our cumulative analyses includes the range of the BCB Seas bowhead whale, with emphasis on the Beaufort Sea and the eastern Chukchi Sea, as well as portions of the western Chukchi Sea (Angliss and Outlaw, 2005b:Figure 2) and the Western North Pacific stock of humpback whales (Angliss and Outlaw, 2007:Figure 38).

Our baseline date for analysis was the initiation of commercial whaling of these whale populations beginning with bowheads in 1848 and humpback expanding significantly from 19<sup>th</sup> century aboriginal to commercial harvest in the 20<sup>th</sup> century. Our endpoint is the likely period of effect of reasonably foreseeable potential effectors that could be expected to occur over the expected life of the proposed actions, approximately 30 years.

**IV.D.2.b. Activities Considered.** We have identified the following events and human actions, other than the subject seismic surveys, that either have had, are having, or are likely to have potential effects on humpback and fin whales occurring in the Chukchi Sea and Beaufort Sea Planning Areas.

- historic commercial whaling;
- past, present, and future subsistence hunting;
- previous, present, and future oil- and gas-related activity;
- previous, present and future non-oil and gas industrial development
- past, current and future research activities;
- recent, current, and future marine vessel traffic and commercial fishing;
- pollution and contaminants baseline; and
- climate change-arctic warming that already has 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 effect(s) of specific effectors.

Detailed discussion of baseline and cumulative effects can be found in the 2006 ARBE (USDOJ, MMS, 2007b:Section IV.G, pp. 104-130) for bowhead, fin, and humpback whales. The following presents new information and a comprehensive discussion of arctic warming.

#### **IV.D.3. Humpback Whale.**

**IV.D.3.a. Historical Commercial Whaling.** The humpback whale in much of the range of the Western North Pacific Stock (WNPS) was considerably reduced by commercial whaling in the 20<sup>th</sup> century. Commercial whaling severely depleted humpback whales. Rice (1978) estimated that the number of humpbacks in the North Pacific may have been approximately 15,000 individuals prior to exploitation; however, this was based on incomplete data and, given the level of known catches (legal and illegal) since World War II, may be an underestimate. Intensive commercial whaling removed 28,000 animals from the North Pacific during the 20th century (Rice, 1978). From 1961-1971, an additional 6,793 humpbacks were killed illegally by the USSR. Many animals taken during this period were taken from the Gulf of Alaska and Bering Sea (Doroshenko, 2000); however, additional illegal catches were made across the North Pacific, from the Kuril Islands to the Queen Charlottes, and other takes in earlier years may have gone unrecorded. Humpback whales theoretically were protected in 1965, but illegal catches continued until 1972 (Ivashchenko, Clapham, and Brownell, In prep., as cited in Angliss and Outlaw, 2007a).

**IV.D.3.b. Past, Present, and Future Subsistence Hunting.** Indigenous peoples of the Arctic and subarctic of what is now the Chukchi Peninsula have hunted bowhead whales, and some villages have taken humpback whales for at least 2,000 years (Bogoslovskaya, Votrogov, and Krupniok, 1982). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. No reported harvest of humpback whales has been reported by subsistence hunters in Alaska and Russia from the WNPS in recent decades. 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, there has been no subsistence take from WNPS since 1977.

#### **IV.D.3.c. Offshore Oil- and Gas-Related Activities and other Industrial Activities.**

**IV.D.3.c(1) Past and Current Activities.** We provide a description of past and current oil and gas industrial activities in the 2006 ARBE (USDOJ, MMS, 2006a:Appendix V), and additional information is provided in

Wainwright (2002; see below). While we focus our description and consideration of potential effects of offshore activities, we also provide relevant information about onshore activities, because onshore activities can lead to increases in related offshore support (e.g., barge traffic).

Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Beaufort and Chukchi seas as a result of previous lease sales since 1979. Extensive 2D seismic surveying has occurred in both planning areas. Refer to the 2006 ARBE (USDOI, MMS, 2006a: Figures V-A, V-B, and V-C) and figures in Wainwright, 2002 to view the extent of historical seismic surveys. The MMS-permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960s and early 1970s. Historically, more seismic-survey activity has occurred on the Beaufort Sea OCS than in the Chukchi Sea OCS. The 2D marine seismic surveys in the Beaufort Sea began with two exploration geophysical permits issued in 1968 and four in 1969. Both over-ice (29 permits) and marine 2D (43 permits) seismic surveys were conducted in the 1970s. With one exception, all 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980s were 2D. In the Beaufort Sea, 23 MMS geological and geophysical (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). The first 3D on-ice survey in the Beaufort Sea OCS occurred in 1983. In the 1990s, both 2D (2 on-ice and 21 marine) and 3D (11 over-ice and 7 marine ocean-bottom cable (OBC) seismic surveys were conducted in the Beaufort Sea. The first marine 3D seismic survey in the Beaufort Sea OCS occurred in 1996. Until 2006, all 3D marine seismic surveys in the Beaufort Sea OCS have been OBC operations. In 2006, one 3D streamer survey and two surveys in 2007 occurred in the Beaufort Sea. One on-iced survey was conducted in 2007. There is one ongoing on-ice and a minimum of 6 open-water season 3D seismic surveys currently proposed for the open-water season of 2008. The most exploration geophysical permits issued in any one year in the Chukchi Sea was seven (6 marine and 1 over ice) in 1986.

Thirty exploratory wells have been drilled in the Federal Beaufort Sea. Refer to the 2006 ARBE (USDOI, MMS, 2006a: App. V, Table V-11) over a >20 year period between 1981 and 2002. This drilling occurred from a variety of drilling platforms (e.g., gravel islands, SSDC, drillships, etc.) during different seasons of the year, including the open-water period. The last exploration well drilled in the Beaufort Sea OCS was drilled in winter 2002 at the McCovey prospect.

Compared to the North Slope/Beaufort Sea, there has been little oil- and gas-related activity in the Chukchi Sea. There were no existing OCS offshore leases in the Chukchi Sea until the current pending leases resulting from Lease Sale 193 held in February 2008, which are in the process of and may be finalized in the second quarter of 2008. Except for the Barrow gas fields (local use only), there is no existing OCS development in the Chukchi Sea Planning Area. Five exploratory wells have been drilled using drillships, in the Chukchi Sea OCS. These wells were drilled between 1989 and 1991, inclusive. The last Chukchi Sea well was drilled in 1991 at the Diamond Prospect. No seismic-survey activity occurred in the Chukchi Sea from 1991-2005. There has been 3D seismic-survey activity in the Chukchi Sea Planning Area during the open-water seasons of 2006 and 2007. There are seismic surveys currently proposed for the open-water season of 2008. It is noted that the recent 2006 and 2007 humpback whale observation occurred under the current levels and trends of activities in the Beaufort Sea and Chukchi Sea Planning Areas. Data are insufficient to determine whether humpback whales are expanding into these areas as result of arctic warming and enhanced habitat and prey sources or an anomaly.

Many offshore activities also required icebreaking and ice management (including moving icebergs), helicopter traffic, fixed-wing aircraft 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, fin, or humpback populations. Fin and humpback whale information is insufficient regarding habitat use and population trend in the evaluation area to determine effects, but similar effects as bowheads experience could potentially occur. Data indicate that the BCB Seas bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred. There is no evidence of long-term displacement from habitat. There are no long-term oil and gas developments in the offshore within bowhead high-use areas. Northstar is at the southern periphery of the migratory corridor, and Endicott

is within the barrier islands. Past behavioral (primarily, but not exclusively, avoidance) effects on bowhead whales from oil and gas activity have been documented in many studies. Inupiat whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor. As noted in the section on effects, recent monitoring studies indicated that most fall migrating whales avoid an area with a radius about 20-30 km around a seismic-survey vessel operating in nearshore waters. We are not aware of data that indicate such avoidance is long lasting after cessation of the activity. Information on humpback and fin whales in the planning area is insufficient to determine effects as noted for bowheads above, and bowhead responses may be an indicator of potential responses by these two species. It is noted that the new observation (2006 and 2007) information regarding humpback whales in the Chukchi and Beaufort seas occurred during a period when the current levels of seismic activity was occurring in both planning areas. No mortalities or injury to the North Pacific stock of humpback whales have been documented to be the result of collisions or entanglement related to OCS oil and gas activities in the Bering Sea or the Arctic Region.

The MMS study *GIS Geospatial Data Base of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea* (Wainwright, 2002) provides 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 survey activity, drilling, and oil and gas support vessel activities may have on the behavior of...especially the bowhead whale." Wainwright, (2002) found that there are significant gaps in the data for the period 1979-1989 and very limited information on ice management. Wainwright found that the data were "not suited for statistical analysis." 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.

Data on past drilling in both Federal and State waters is relatively complete. Data on non-oil- and gas-related activities, such as hunting, barge traffic, and aircraft 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 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 surveys in State and Federal waters, drilling, ice management, high-resolution 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. Existing data indicate that the BCB Seas bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred. There is no evidence of long-term displacement from habitat. The initial 2006 and 2007 appearance of humpbacks in the planning areas has occurred concurrent with recent activity levels in those areas.

*IV.D.3.c(2) Future Activities.* Potential cumulative effects to humpback whales from oil and gas activities could include behavioral responses to seismic surveys; aircraft and vessel traffic; exploratory drilling; construction activities, including dredging/trenching and pipelaying; development drilling; production operations; and oil-spill-cleanup operations that take place at varying distances from the whales. It also could include effects from small and large oil spills (no large spills have occurred to date). In general, humpbacks 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. Humpbacks try to avoid close approaches by motorized vessels. 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 survey activity). In some species, responsiveness is linked to both context and to the sex and/or reproductive status of the animal. In studies in Australia, humpback females with calves show greater avoidance of operating seismic-survey boats than do males (McCauley, 2000). Detailed discussions of how these various activities may affect humpback, fin and bowhead whales can be found in the effects section above and the 2006 ARBE (USDOI, MMS, 2006a).

Federal Lease Sale 193 in the Chukchi Sea was held in February 2008. Issuance of leases from Sale 193 likely will result in industry proposals to conduct OCS activities, including 2D/3D seismic surveys, ancillary activities, and exploration drilling. These activities would be expected to have associated noise and

disturbance effects. High-resolution and 3D seismic surveys associated with existing leases, as well as exploratory drilling in the Beaufort, are expected to continue into the foreseeable future.

Other activities within the marine environment may include those associated with Bureau of Land Management (BLM) lease sales in the National Petroleum Reserve-Alaska (NPR-A) and the planned October 2008 and other State Beaufort Sea lease sales for all unleased State blocks from Barrow to the Canadian border. The BLM's scenario for NEPA analysis included hypothetical docking facilities potentially could be located in Peard Bay, Barrow, or Dease Inlet, although the scenario acknowledged that initial development projects could be staged out of Prudhoe Bay and materials transported by vehicle in winter or barge in summer (USDOI, BLM and MMS, 2003). Establishment of such facilities could increase vessel traffic through the Dease Inlet/Smith Bay areas. Humpback use in the northwestern portion of Smith Bay was observed on one occasion in 2007. Vessel traffic coming from either the west or the east into this area has the potential to disturb whales. The response of female and calf groups to such vessel traffic is unknown. The BLM noted that the vessel trip frequency would depend on the number of concurrent projects and the stage of development (USDOI, BLM and MMS, 2003). Because numbers of vessel round trips from equipment-source area to NPR-A staging area (13/summer) are forecast for a project during the construction period, and supply vessels are likely to follow established routes, the actual area disturbed potentially could be limited. The area and numbers of individuals affected could increase if concurrent projects at different locations were to be developed, and humpback numbers in the area increase.

Vessel traffic occurs during the open-water season. The numbers of humpbacks that could be exposed to such traffic likely would remain low; and the geographic scale of the effect, even off Smith Bay and Dease Inlet, is likely to be small and concentrated in the nearshore shipping corridor. However, if such activity is coincident with seismic surveys occurring in State and Federal waters of the Smith Bay/Dease Inlet area, with exploration drilling and/or with any construction, the cumulative effects of these activities could cause humpback use of the area north of Smith Bay/Dease Inlet to decline.

It is not clear how whales feeding in the area would respond to noise and disturbance in the area, or if humpbacks would stop to feed if there were a high level of activity within either the inlet or the bay. If whales, particularly females with calves that would have used the area for feeding or resting, avoid the area because of the noise, and if comparable feeding areas are not accessible to them without a significant expenditure of energy, then a potentially biologically significant effect could occur. As pointed out at the NOAA International Symposium on Shipping Noise and Marine Mammals, and summarized by Southall (2005:15), changes in behavior such as altering motor behavior and vocalizations, have "...both direct energetic costs and potential effects on foraging, navigation, and reproductive activities." This is clearly true if large numbers of individuals, especially females and calves, avoid or are dispersed from seasonally available feeding areas or important rest areas. One observation of humpback whales (one cow and one calf) in 2007 is the only observation of record for this area.

Overall, humpback whales exposed to seismic-survey related noise associated with offshore oil and gas exploration, development, and production activities would be most likely to experience temporary, nonlethal behavioral effects, such as avoidance behavior. The MMS will reconsult for development, production, and abandonment actions incrementally, as these activities become more definitive. Effects potentially could be longer term, if sufficient oil and gas activity were to occur in a localized area. For example, there is some indication that long-term displacement has occurred in some cetaceans, albeit rarely, due to noise and/or disturbance associated with increased vessel traffic effects and noise associated with other (non-oil- and gas-associated) sources. For example, shipping and dredging associated with an evaporative saltworks project in Guerrero Negro Lagoon in Baja California (NRC, 2003) caused gray whales to abandon the lagoon through most of the 1960s. When boat traffic declined, the lagoon was reoccupied first by single whales and later by cow-calf pairs (Bryant, Lafferty, and Lafferty, 1984). Morton and Symonds (2002) reported that killer whale use of Broughton Archipelago in British Columbia declined significantly when high-amplitude acoustic-harassment devices were installed at salmon farms in an attempt to deter seal predation. Almost no whales were observed in the archipelago between 1993 and 1999, when the acoustic-harassment devices were in use. Killer whales reoccupied the archipelago within 6 months of the removal of the devices in 1999 (Morton and Symonds, 2002; NRC, 2003).

There is no indication that human activities (other than historic commercial whaling) have caused long-term displacement in humpbacks. However, available information indicates that over the timeframe of the proposed actions (about 30 years) there is some potential for a level of noise and/or related disturbance to be reached that potentially would 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 effects from noise and other disturbance.

Available information suggests that the potential for oil-industry and other activities outside of the Beaufort Sea and Chukchi Sea to contribute to cumulative effects on this stock of humpback whales or fin whales is largely lacking. The Norton Bay and Hope Basin Planning Areas of the Bering Sea, which occur within the current range of the WNP humpback stock, are not in the 2007-2012 OCS leasing program. The 2007-2012 5-Year Oil and Gas Leasing Program (USDOJ, MMS, 2006b) does include leasing the North Aleutian Basin, which lies within the range of the NWP and Central Pacific stocks of humpback whale. The Bering Sea, including portions of the North Aleutian Basin Planning Area, is an area of high use by humpback whales for feeding during several months of the year (See Sections II.C.3. and 4.). Oil and gas exploration and development activity may occur in the waters of foreign nations including China, Korea, Japan, Philippines, and Russia in other portions of the year-long range of the WNPS humpback whales. If oil and gas leasing and related activities occur, then humpback whales could be exposed to the potential impacting factors referred to in the effects section of the bowhead whale in the 2006 ARBE (USDOJ, MMS, 2006a). Studies have documented that humpback whales, especially females with calves, respond to seismic survey noise (See Section IV.A.5.c.). Todd et al. (1996) concluded that exposure of the humpbacks to deleterious levels of sound may have influenced entrapment rates.

In conclusion, recent data about humpback whale response to oil and gas activities are not available for the Arctic Region; however, in other Alaska OCS waters, available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s had a lasting population-level adverse effect on humpback whales. Oil and gas exploration activities, especially during the 1990s and early 2000s have been shaped by various mitigation measures and related requirements for monitoring. Such mitigation measures, with monitoring requirements, were designed to and probably did reduce the effect on the whales. We assume future activities in Federal OCS waters would have similar levels of protective measures. However, we cannot be certain of what mitigation measures will be imposed in State waters or what the effects of land-related support activities will be. We also note that the effectiveness of mitigation is not always entirely clear. It also is not clear when, or if, the level of activity might become large enough to cause effects that are biologically significant. 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 to a substantial increase in noise and disturbance that will occur in combination with noise from oil and gas activities in State waters and on land, as well as an increased spill risk to the WNPS population of humpback whales. It is not clear what the potential range of outcomes might be if multiple disturbance activities occur within focused areas of high importance to the whales. As we consult with NMFS over the next few months and incrementally as potential development and production are proposed, we will continue to explore ways to determine the potential for cumulative effects on these whales and craft and implement appropriate mitigation.

#### ***IV. D.3.d. Previous, Present and Future Non-Oil and Gas Industrial Development.***

*IV. D.3.d.(1) Past, Current, and Future Activities.* The NMFS (1991b) lists noise and disturbance from whale-watching boats; industrial activities; and ships, boats, and aircraft as causes of concern for humpback whales. The NMFS (1991b) reported that at least five photographed humpbacks in southeastern Alaska had gashes and dents probably caused by vessel strikes. The effect of pollution on humpbacks is not known. Habitat degradation also could occur due to coastal development. 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, coastal erosion, and agriculture associated runoff are potential causes of humpback whale-habitat degradation. These activities at this time have not been identified as factors affecting habitat quality in the Arctic, and information on humpback and fin whales is insufficient to determine habitat use or quality of habitats in the arctic seas.

There has been speculation recently that commercial shipping through the Northwest Passage will increase in the coming decades (PAME, 2007; Alaska Climate Impact Assessment Commission, 2008). Many shipping experts believe that “in-and-out” shipping (e.g., shipping from the Pacific Ocean or Bering Sea through the Chukchi Sea into the Beaufort Sea and then back again) is likely to increase well in advance of regular shipping through the Northwest Passage.

Based on the general category of factors specified as requiring consideration under the ESA, Perry, DeMaster, and Silber (1999) listed the following factors as possibly affecting the recovery of humpbacks in the North Pacific:

- vessel traffic and oil and gas exploration as types of “Present or threatened destruction or modification of habitat”(Central Stock);
- whale-watching, scientific research, photography, and associated vessel traffic as types of “Overutilization...” (Central Stock); and
- entanglement in fishing gear as “Other natural or manmade 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 of humpbacks 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 CNPS were reported in Hawaiian waters. Table 27b of Angliss and Lodge (2003:157) gives a total of 34 humpbacks from the CNPS 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, 1999). Perry, DeMaster, and Silber (1999) reported that continued development of coasts and oil exploration 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 sub-bottom blasting (Ketten, Lien, and Todd, 1993; Lien et al., 1993; Ketten, 1995). Perry, DeMaster, and Silber (1999) summarized that humpbacks respond most to moving sound sources (e.g., 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, 1999; also see further discussion in Section IV.B.1.f). Helicopters are guidelines indicate maintaining a range of 1,500 ft (486 m) from humpbacks (NOAA, 2006). Noise on their wintering grounds from the Thermometry of Ocean Climate Program and the Navy’s Low-Frequency Active Sonar program also are sources of concern for the CNPS (Angliss and Lodge, 2002). No subsistence take of humpbacks is reported from Alaska or Russia (Angliss and Lodge, 2002).

Perry, DeMaster and Silber (1999:35) concluded that based on available information, “commercial fishing activities may pose a significant threat to the status...” of the stock of humpbacks inhabiting the western North Atlantic. Todd et al. (1996) have suggested that exposure to deleterious levels of sound may be related to rates of entrapment in fishing gear. Rates of entrapment between 1980 and 1992 were shown to vary between a low of 26 per year to a high of 200 (see Todd et al., 1996:Table 1 and references cited therein).

The PBR for the WNPS of humpback whale is estimated as 1.3 animals ( $367 \times 0.035 \times 0.1$ ) and for the CNPS as 12.9 ( $3,698 \times 0.035 \times 0.1$ ) (Angliss and Outlaw, 2005a:rev. 1/12/06). For the WNPS, NMFS (Angliss and Outlaw, 2007a) noted that the “estimated human-related mortality rate is based solely on mortalities that occurred incidental to commercial fisheries and is higher than the PBR level for this stock; therefore, the estimated fishery mortality and serious injury rate exceeds 10% of the PBR (0.1). The rate cannot be considered insignificant and approaching zero.” The NMFS (Angliss and Outlaw, 2005:rev. 1/12/06) also noted that: “Noise pollution from the U. S. Navy’s Low Frequency Active Sonar program and other anthropogenic sources (i.e., shipping) is a potential concern....”

Potential cumulative effects on the WNPS warrant concern and monitoring.

**IV.D.3.e. Past, Current and Future Research Activities.** Research vessels and projects may employ a number of noise-producing actions. Icebreaker noise would not be a factor for humpbacks in the planning areas, as they are not likely to be in areas and during periods where ice management was required. Richardson et al. (1995a:301) concluded that: "Ships and larger boats routinely use fathometers, and powerful side-looking sonars are common on many military, fishing, and bottom-survey vessels.... Sounds from these sources must often be audible to marine mammals and apparently cause disturbances in some situations."

Active sonars were used in commercial whaling after World War II, and whaling boats sometimes tracked whales underwater using active sonar. Ash (1962, cited in Richardson et al., 1995a) reported that this often caused strong avoidance by baleen whales. Reeves (1992) reported that ultrasonic pulses were used to scare baleen whales to the surface. Maybaum (1990, 1993) reported that humpback whales on the wintering grounds moved away from 3.3-kHz sonar pulses and increased their swimming speed and swim-track linearity in response to 3.1- to 3.6-kHz sonar sweeps. Clapman and Brownell (1999) summarized that "...effects of ship noise on whale behavior and ultimately reproductive success are largely unknown."

The NRC summarized that:

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

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

Some of the research ships that have made trips into the range of the humpback whale are likely to do so again, especially in view of new information regarding distribution and occurrence of this species in the Arctic Region. All large research ships that are active in the range of the humpbacks during periods when they are present have the potential to cause noise and disturbance to the whales, potentially altering their movement patterns or other behavior. The Western Arctic bowhead has been the focus of research activities that, in some instances, could 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 also has occurred within the portions of areas where humpbacks have been newly observed. 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. However, available evidence does not indicate such disturbance will have a significant effect on this population over the approximate life of the project, even when added to the effects of other affectors.

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

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). In 1994, for example, the R/V *Maurice Ewing* conducted a 2D seismic-survey investigation of the continental crust in the Bering and Chukchi seas in Alaska between August 6 and September 1. Details of this cruise are available (Galloway and Shipboard Scientific Party, EW94-10, 1994).

The source level for this operation was greater than those summarized in Table 6.6 of Richardson et al. (1995a), and it is far greater than those recently employed in operating oil- and gas-related seismic surveys in the Beaufort Sea or in most or all experiments to which the reactions of bowheads have been studied. In a more recent permit application for an IHA, Lamont-Doherty (2003), the entity that controls the R/V *Maurice Ewing*, summarized that airgun noise could cause "...tolerance, masking of natural sounds, behavioral disturbance, and perhaps permanent or temporary hearing impairment." In September 2002, two beaked whales were discovered beached on the Gulf of California (Mexico) coast by NMFS biologists vacationing in the region when the Maurice Ewing was conducting a seismic survey in the general area (Lamont-Doherty, 2003). However there is no specific evidence of cause and effect. If similar projects would be conducted in the future, humpback whales could be exposed to similar sound-source noise levels, as bowhead whales could have been exposed in 1994.

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

More generally, Brigham (2004) point out that from 1977-2004 there have been 52 icebreaker trips to the North Pole (presumably not all in the range of these stocks of bowhead, fin, and humpback whales) for science and tourism. The NMFS has record of IHAs that have been applied for and issued associated with research, shipping, and other types of cruise activities. However, application for IHAs for the various vessel activities in the Arctic is inconsistent, and an unknown amount of activity occurs unrecorded.

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

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

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

Other ships have made numerous research trips into the range of the bowhead. The MMS is continuing to evaluate information about cumulative effects from research activities as it becomes available.

We conclude that some past and present research-related noise and disturbance potentially could 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. Recent available data are insufficient to form any conclusions about potential effects of noise having behavioral or physiological adverse effects on the humpback whales of the WNPS during the period they are present in OCS waters.

**IV.D.3.f. Recent, Current and Future Marine Vessel-Traffic and Commercial Fishing.** The NMFS (1991b) reports that entrapment and entanglement in active fishing gear (O'Hara, Atkins, and 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 (e.g., von Zeigesar, 1984 cited in von Zeigesar, Miller, and Dahlheim, 1994). From 1984-1989, 21 humpbacks are known to have become entangled in gear in Alaska. Gear types included gillnets, seine nets, longlines or buoy lines, and unidentified gear.

Based on available data, previous incidental take of WNPS humpback whales has occurred rarely (0.2 mortalities per year from 2001-2005) incidental to U.S. commercial fisheries; however, this should be considered a minimum. Brownell et al. (2000) compiled records of bycatch in Japanese and Korean commercial fisheries between 1993 and 2000. From 1995-1999, six humpback whales were indicated as "bycatch" plus two strandings. Analysis of four samples of meat found in markets indicated humpback whales were being sold, although it is not known whether any or all strandings or meat identified in market samples were killed as result of interaction with commercial fisheries. These represent a mortality level of 1.1/year to 2.4/year. Because many mortalities go unreported, the actual rate in these areas likely is much higher. During 1990-2000, six commercial fisheries within the range of the both the WNPS and CNPS 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 CNPS were reported in Hawaiian waters. Table 27b of Angliss and Lodge (2003:157) gives a total of 34 humpbacks from the CNPS 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. There is some uncertainty about whether such expansion will occur. Increases in spatial overlap alone could result in increased interactions between bowheads and derelict fishing gear.

In a discussion of climate-warming effects on bowheads at the meeting of the Subcommittee on Bowheads, Right Whales and Gray Whales at the IWC's annual meeting, P. Wade (referred to in IWC, 2005:4) reported that that the commercial crab fishery extended farther north the previous winter (winter 2004-2005) than in previous years. Angliss and Outlaw (2007a,b) indicate the PBR for the WNPS of humpback whales is 1.3. However, as noted in the section on climate change, the frequency of such interactions in the future would be expected to increase in arctic waters if commercial-fishing activities expand northward, with resultant increases in temporal and, especially, spatial, overlap between commercial-fishing operations and humpback habitat use.

Marine vessel traffic, in general, can pose a threat to bowheads and humpbacks because of the risk of ship strikes. Since 2001, two humpback whale mortalities due to large cruise ship strikes in Glacier Bay have occurred. All vessels are required to comply with law that forbids a person subject to the jurisdiction of the U.S. to approach, by any means, within 100 yd (91.4 m) of a humpback whale in any waters within 200 nmi of Alaska. Vessels (with some exemptions) transiting near humpbacks also are required to adhere to a "slow, safe speed" requirement to prevent disturbance that could adversely affect humpbacks. As discussed in Section IV.D.3.h, shipping and vessel traffic is expected to increase in the Arctic if warming continues. There has been speculation recently that commercial shipping through the Northwest Passage is likely to substantially increase in the coming decades. For example, an article in 2000 in the *Christian Science Monitor* (Walker, 2000) quotes the director of the Canadian Project at the Center for Strategic and International Studies in Washington, C. Sands, as saying he believes that "there's a reasonable chance" arctic commercial shipping is going to occur across the Northwest Passage. Burns (2000:4) concludes that: "...proposed reduction in sea ice area could also open up the Northwest Passage. This could expose cetaceans in the Arctic Region to increased ship traffic and mineral exploitation." Many shipping experts believe that "in-and-out" shipping (e.g., shipping from the Pacific Ocean or Bering Sea through the Chukchi Seas into the Beaufort and then back again) is likely to increase well in advance of regular shipping through the Northwest Passage. Additionally, noise associated with ships or other boats potentially could cause bowheads to alter their movement patterns or make other changes in habitat use. The data on humpback whale are insufficient to determine consistent movement patterns or patterns of habitat use at this time. 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.

No mortalities or injury to North Pacific stock of humpback whales have been documented to be the result of collisions or entanglement related to oil and gas activities in the Bering Sea of the Arctic Region. Bowhead whale-incident data of vessel inflicted injuries in the Arctic may indicate the potential for humpback whale injury or mortality. The frequency of observations of vessel-inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low but may be increasing. Between 1976 and 1992, three ship-strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al., 1994). The low number of observations of ship-strike injuries suggests that bowheads either do not often encounter vessels, or they avoid interactions with vessels, or that interactions usually result in the animals' death. The NMFS (2003, citing C. George, pers. commun.) states that since the 1994 publication by George et al. (1994), ship-strike injuries have been observed on 6 additional whales out of about 180 whales examined between 1995 and 2002. There is no documented record regarding injury from vessel-humpback interaction in the Chukchi or Beaufort seas.

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, and humpback and other large whale encounters in the Arctic may or may not reflect a similar pattern, depending on the dynamics of humpback numbers and use of the Arctic Region. We also agree with the conclusion by the NMFS (2003) that the rate in bowhead encounters may have increased slightly in recent years and humpbacks may be subject to similar trends regarding potential encounters.

**IV.D34.g. Pollution and Contaminants Baseline.** No collections or contaminant studies of humpback whale tissues from the Chukchi or Beaufort seas have been conducted. This stock of humpbacks uses seasonal habitats and prey that differ substantially from bowhead whales, and contaminant studies likely would not reflect similar contaminant levels as initial studies of bowhead tissues collected from whales landed at Barrow in 1992 (Becker et al., 1995).

**IV.D.3.h. Climate Change (also referred to as arctic warming, global warming, or climate warming).** The MMS OCS Oil and Gas Leasing Program 2007-2012 EIS (USDOI, MMS 2007b), the Sale 195 BE (USDOI, MMS, 2004:Appendix C), and the 2006 ARBE (USDOI, MMS, 2006a), prepared for consultation under Section 7 of the ESA with NMFS on endangered whales, we expanded and summarized information on the potential effects of climate change on bowhead whales, which we incorporate herein by reference. We

further discuss climate warming below. 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.

We noted in our Sale 195 BE (USDOI, MMS, 2004:Appendix C) that Working Group I of the Intergovernmental Panel on Climate Change (IPCC, 2001a) concluded that:

Since 1861, the global average surface temperature (which is the average of near surface air temperature and sea surface temperature) has increased. Over the 20th century, the increase has been 0.6±0.2 °C.

It is likely that there has been about a 40% decline in Arctic sea-ice thickness during late summer to early autumn in recent decades and a considerably slower decline in winter sea-ice thickness" (IPCC (2001a:4).

Average global sea level rose between 0.1-0.2 meters during the 20th century.

In the 20th century, it is very likely that there was a 0.5-1% increase in precipitation per decade over most mid- and high latitudes of the Northern Hemisphere continents.

It is likely that there has been an increase in cloud cover and an increase in the frequency of heavy precipitation events in the mid to high latitudes.

Since the mid 1970s, warm episodes of the El Niño-Southern Oscillation (ENSO) phenomenon) have been more intense, persistent and frequent compared to the previous 1,000 years.

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

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

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

Human activities have increased the atmospheric concentrations of greenhouse gases and aerosols since the preindustrial era.

An increasing body of observations gives a collective picture of a warming world and other changes in the climate system.

On a global basis, it is very likely that 1998 was the warmest year and the 1990's was the warmest decade in instrumented history (1861-2000) (IPCC, 2001a,b).

There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities.... The best agreement between model simulations and observations over the last 140 years has been found when all...anthropogenic and natural forcing factors are combined" (see Figure SPM-2 of IPCC, 2001b).

The IPCC (2001b:30-31) considers their statement that most of the observed warming over the past 50 years is likely due to increases in greenhouse gas concentrations due to human activities as a "robust finding." They define such findings as those that "hold under a variety of approaches, methods, models, and assumptions, and one that is expected to be relatively unaffected by uncertainties". However, they highlight that there is uncertainty that constrains relating regional trends to anthropogenic change.

Changes in sea level, snow cover, ice extent, and precipitation are consistent with a warming climate near the Earth's surface. The IPCC (2001b:6) noted "Examples include...increases in sea level and ocean-heat content, and decreases in snow cover and sea-ice extent and thickness" and consider their statement that "rise in sea level during the 21st century that will continue for further centuries" to also be a "robust finding." However, they highlight the uncertainty of understanding the probability distribution associated with both temperature and sea-level projections.

The IPCC's projections using the Special Reports on Emissions Scenarios (SRES) emissions scenarios in a range of climate models result in an increase in globally averaged surface temperature of 1.4-5.8 °C over the period 1990-2100. This is about 2-10 times larger than the central value of observed warming over the 20<sup>th</sup> century, and the projected rate of warming is very likely to be without precedent during at least the last 10,000 years, based on paleoclimate data. For the periods 1990-2025 and 1990-2050, the projected increases are 0.4-1.1 °C and 0.8-2.6 °C, respectively (IPCC, 2001b:8).

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

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

The NRC concluded:

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

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

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

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

The analysis of long-term data sets indicates 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 during summer and more recently during winter. Beginning in the 2000s, several record summer minimum extents were recorded in 2002, 2005, and 2007 and extreme minima in 2003, 2004, and 2006 (Stroeve et al., 2005; NASA, 2005; Comiso, 2006, University of Colorado, NSIDC, 2007). The September ice-extent trend for 1979-2006 declined by -8.4 % per decade (Meier, Stroeve, and Fetterer, 2007) and, from 1979-2005, declined by -9.8% per decade (Comiso, 2006). After the September 14, 2007, record minimum, the trend for perennial ice extent and area are -10.2% and 11.4%, respectively (Comiso et al., 2008). The data show an increasing negative trend for sea-ice extent and area from 2005-2007.

The sea ice was gone; there's no main ice pack anymore. All of its just floating ice. There are just small pieces of ice. When I first went out whaling, I saw big icebergs, but not now. The ice is too

far out to see it. In the 1970s and 1980s the ice was close. You didn't have to go far to see it. Now you don't see any glacier ice at all." (Footnote 8, personal interview, October 5, 2004, as cited by McBeath and Shepro, 2007).

Within the background of the general decline of arctic sea-ice extent, the Chukchi and Beaufort seas have some of the largest declines in sea-ice extent during summer (Belchansky, Douglas, and Platnov, 2007, Perovich et al., 2007) and an increase in the length of the ice-free season in the Chukchi Sea (Belchansky, Douglas, and Platnov, 2005). From 1979-2006, Meir, Strove, and Fetterer (2007) found regional trends in percent per decade of -4.9% for the Chukchi and -1.2% for the Beaufort. 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. Lukovich and Barber (2007) report a maximum sea-ice concentration anomaly during the onset of ice formation occurs near the Beaufort and Chukchi during the late summer/early fall from 1979-2004.

The extent of winter sea ice, generally measured at the maximum in March, began changing in the late 1990's and has declined through 2006 (Comiso, 2006; Stroeve et al., 2007; Francis and Hunter, 2007). Comiso (2006) attributed the changes to corresponding changes in increasing surface temperature and wind-driven ice motion. The factors causing the reduction in the winter sea-ice extent are different from those in the summer. The reduction of the winter sea-ice extent in the Bering Sea preconditions the environment during the melt season for the Chukchi Sea. The end-of-winter perennial sea-ice extent was the smallest on record in March 2007 (Nghiem et al., 2007). The arctic sea ice reached its maximum on March 10, 2008. Although the maximum in 2008 was greater than in 2007, it was below average and was thinner than normal (Martin and Comiso, 2008; University of Colorado, NSDIC, 2008).

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

Francis and Hunter (2006) suggest that downwelling longwave radiation fluxes account for approximately 40% of the variability of perennial sea-ice extent in the Beaufort and Chukchi sea area. Perovich et al. (2007) demonstrate the importance of the ice-albedo feedback in explaining the large reduction of sea ice in the western Arctic during the open-water period. The largest input was in the Chukchi Sea with as much as 4% per year.

In the Chukchi Sea, meridional wind (one with a strong north-south component) also had an influence but played a lesser role in the Beaufort. Watanabe et al. (2006) suggest the Arctic dipole anomaly contributes to sea-ice export during its positive stage. Shimada et al. (2006) present evidence that the pattern of sea-ice extent is similar to the distribution of warm Pacific summer water. Kwok (2004) and Kwok, Maslowskii, and Laxon (2005) identify and discuss the implications of multiyear-ice distribution both in terms of an unusual outflow of multiyear ice into the Barents Sea and its consequences as a freshwater source to the transformation of Atlantic Water circulating in the Arctic.

Recent measurements and modeling show that the ice cover has continued to become thinner in some regions during the 1990s (Rothrock, Yu, and Maykut, 1999; Rothrock and Zhang, 2005). 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. 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 portion of the Arctic Ocean (from 3.1 m in 1958-1976 to 1.8 m in the 1990s [Yu, Maykut, and Rothrock, 2004]). The fractional coverage of first-year ice increased from <20% to 33%, respectively, between the two periods (Yu, Maykut, and Rothrock, 2004). The decrease is greater in the central and eastern Arctic than in the Beaufort and Chukchi seas (Rothrock and Zhang, 2005).

Changes in the landfast ice have been occurring. Hunters living in Barrow report the absence or rarity of old ice, thinner ice, shorefast breakoffs, and changing patterns of pressure-ridge formation and the stability of landfast ice (Gearhead et al., 2006). 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. Polykov et al. (2003) estimated that the long-term trends for fast-ice thickness in the Chukchi Sea are small, from 1900-2000. Most of these data are from the Russian side of the Chukchi Sea. Through modeling studies, Dumas, Carmack, and Melling (2005) postulate that air temperature and snow accumulation are a large factor in determining the duration of landfast ice in the Beaufort Sea.

As air temperature rises, landfast ice duration is shorter, melting out approximately a month earlier in the Beaufort and 2 weeks earlier in the Chukchi (Mahoney et al., 2007). An earlier onset date of thawing in spring is responsible for the earlier breakup of landfast ice in the Beaufort and Chukchi seas (Eiken et al., 2006; Mahoney et al., 2007).

The analysis of melt and freeze dates to describe the melt season duration were estimated from 1979-2001. Following the Arctic Oscillation (AO) high-index phase in the late 1980s and early 1990s, the melt duration increased 2-3 weeks in the Chukchi (Belchansky, Douglas, and Platnov, 2004). Although freeze distributions have re-established to the low AO index-phase patterns, the melt distributions have not (Belchansky, Douglas, and Platnov, 2004).

The distribution of age-class of ice in the Arctic has changed with less old ice and more new or first-year ice. During the late 1980s and the early 1990s, a large portion of old ice (>10 years) was flushed out of the Arctic through Fram Strait (Rigor and Wallace, 2004). By the beginning of this decade, the loss of old pack ice continued and even increased. There was a 23% loss of Arctic perennial sea ice from March 2005 to March 2007 (Nghiem et al., 2007). Kwok (2007) found that the replacement of multiyear ice at the end of summer 2005 was near zero. He reported that from June through September 2005, the export through Fram Strait was the highest compared to a 7-year average from 2000-2006 (Kwok, 2007).

On the regional scale there is a pronounced loss of old ice in the western Arctic at a rate of -4.2% annually and an increased prevalence of young ice through 2003 due to atmospheric circulation anomalies in the early 1990s (Belchansky, Douglas, and Platnov, 2005). The largest declines in multiyear ice concentration (-3.3% yr<sup>-1</sup>) occurred in the southern Beaufort and Chukchi seas (Belchansky, Douglas, and Platnov, 2004). The two prominent hypotheses on the loss of multiyear ice are the flushing factor through the Transpolar drift out of the Arctic (Kwok, 2004; Rigor and Wallace, 2004) and loss of multiyear ice with the addition of general rise in arctic temperatures (Rothrock and Zhang, 2004; Lindsay and Zhang, 2005; Francis et al., 2005). Hunters in Barrow have reported that the ice pack appears more diffuse in midsummer (Gearhead et al., 2006).

Sandven and Johannessen (2004, as cited in Brigham and Ellis, 2004:A-13) reported that data obtained using passive microwave-satellite data have shown a decrease of total ice area in the Arctic of 3-4% per decade and a more significant reduction of 7-8% reduction per decade in multiyear ice. Significant reductions in the thickness of Arctic sea ice (Rothrock, Yu, and Maykut, 1999) and winter multiyear ice (Johannessen, Shalina, and Miles, 1999) have been reported. In 1998, record sea-ice retreat was observed for the Beaufort and Chukchi seas (Maslanik et al, 1999). Vincent, Gibson, and Jeffries (2001) reported a decrease in pack-ice thickness by 27% from 1867-1999 in the Canadian High Arctic with the collapse of the Ellesmere Ice Shelf (90% reduction). Whether ice cover and ice thickness will continue to decrease in the Arctic is uncertain. Analysis of ice thickness from six submarine cruises from 1991-1997 showed no trend towards a thinning ice cover (Winsor, 2001).

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

SEARCH SSC (2001:2) noted that:

Available data point to long-term and recently augmented reductions in sea-ice cover (Maslanik et al., 1996; Bjorgo et al., 1997; Cavalieri et al., 1997; Zakharov, 1997; Rothrock et al., 1999)....

Perhaps most alarming, there have...been significant reductions in sea ice extent (Parkinson et al., 1999) and a 43% reduction in average sea ice thickness (Rothrock et al., 1999) in recent decades.

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

*IV.D.3.h(1) Potential Effects of Climate Change on Humpback and Fin Whales.* Potential effects of climate change on humpback and fin whales include:

- increased noise and disturbance related to possible increases in shipping and development from all potential activities 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 fin whale and humpback distributions; and increased length of open-water periods;
- more frequent climatic anomalies, such as El Niños and La Niñas, with potential resultant changes in prey concentrations and distribution; and
- a northern expansion or shift of other whale species (evidenced by new observation information on humpbacks in 2006 and 2007), with the possibility of increased overlap and competition for prey, predation and increased transfer of or exposure to parasites and pathogens associated with contact with other species in the northern Bering and/or the Chukchi and Beaufort seas. This may be more of a threat to bowhead whales than either fin or humpbacks that may be the vectors of transmission.

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.

Tynan and DeMaster (1997) note an earlier IPCC report that concluded that an increase in human activity is likely to accompany the opening of the Northwest Passage and the Russian Northern Sea Route. They identify a potential for increased environmental pollution, an increased incidence of epizootics, exploration, increased ship traffic, increased fisheries, and increased industrial activities, and the synergistic effects of these factors with ecosystem changes due to climate change as potential concerns for marine mammals populations. The preliminary report of the Arctic Marine Shipping Assessment's (PAME, 2007) Arctic Climate Impact Assessment key finding #6 notes: "Reduced sea ice is very likely to increase marine transport

and access to resources.” In its final report to the legislature the AK Climate Impact Assessment Commission notes:

...it should be considered fact that the high Arctic will become increasingly more accessible in the next decade. Couple this with projections that the Arctic will continue to grow as a major energy development area and that it will offer new, long sought commercial shipping routes. Given these developments, it can be seen that new demands for financing, shore-based infrastructure, new resource extraction, a variety of regulatory regimes, environmental protection, military and homeland security, international cooperation, cultural integrity, research strategies, and more will all be at hand.

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 a Northern Sea Route along the Russian north coast and increasing shipping in parts of the range of the WNPS of humpback, fin and bowhead whales. SEARCH SSC (2001:30) concludes that:

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

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

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

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

Increased shipping could have substantial effects on development in the Arctic, making new areas economically feasible to develop (SEARCH SSC, 2001). SEARCH SSC (2001:31) states that: “A substantial change in the open water season for the Beaufort Sea – from 60 to 150 days (Maxwell, 1997) – can potentially reduce the costs associated with offshore oil and gas exploration and production.... Shipping access to the large oil and gas reserves in the Barents and Kara seas will be substantially improved if regional warming of the Russian Arctic continues....”

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

The Office of Naval Research (2001) reported that climate warming in the Arctic is likely to result in the northward migration of subarctic species of marine mammals and an increase in commercial-fishing activities into the Chukchi and Beaufort seas, where operations have been minimal in the past. If substantial increases in shipping were to occur that placed more ships in waters inhabited by humpback whales, increases in adverse effect to them also might occur due to shipping-related noise and disturbance, vessel strikes, and pollution. Quantification of such potential changes are not possible at this time due to the level of uncertainty about changes that might occur over the course of the proposed project and the shipping industry's response to greater cross-Beaufort transiting opportunities, when they occur.

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

New information regarding humpback whale occurrence in the Chukchi Sea and Beaufort Sea Planning Areas are limited to data from marine mammal monitoring in 2006 and 2007 whale. The MMS concludes that this low intensity sampling are insufficient to make reliable predictions about the effect of arctic climate change on humpback whales. We cannot rule out that recent changes in humpback distribution may be due in part to climate change phenomena.

*IV.D.3.h(2). Conclusions Regarding Climate-Change Effects.* We conclude that the potential effects of climate change on the WNPS population of humpback whales, Northern Pacific stock of fin whales, or Western Arctic bowhead stock are uncertain. There is no current evidence of adverse effects on the whales. There is no documented evidence suggesting that many of the changes that could occur, such as changes in timing of migrations, shifts in distribution, shifts in migration routes, and shifts in abundance and distribution of prey would be associated with overall adverse or positive effects on these whales. The occurrence of humpbacks in the Chukchi and Beaufort seas in 2006 and 2007 may be initial indications that habitat conditions may be changing that favor humpback whales pioneering new summer ranges; however, the short duration of observations is insufficient to conclude whether the recent observations indicate an anomaly or a trend.

However, we have identified some potential changes that could result in adverse effects on humpback whales, were they do occur. In our Sale 195 BE (USDOI, MMS, 2004:Appendix C), we greatly expanded and summarized information on the potential effects of climate change on bowhead whales that likely would apply to humpback whales. In 2005, a symposium titled "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, 2005). At this symposium, concerns we identified in the 195 BE again were 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 raised concerns about thermoregulatory issues. The IWC Scientific Committee (IWC, 2005:23) summarized that: "...the Committee...found it difficult to predict how bowhead whales might be affected by large-scale oceanographic changes in the future." It is similarly difficult to predict how humpback whales or fin whales might be affected by large scale oceanographic changes in the future.

Based on our previous and continued review of available information, we agree with these general conclusions. However, we believe evidence is accumulating that increased noise and disturbance in humpback summer and autumn habitat, from increasing shipping and industrial activity associated with arctic warming, has begun to occur and is likely to continue to occur during the time period of activities that result from the proposed actions (e.g., over approximately the next 30 years). This increase in noise and disturbance will be in addition to the levels of noise from current industrial activity, subsistence harvest activities, local/regional shipping, research, recreational, military, aircraft, and other vessel traffic.

#### **IV.E. Summary and Conclusions.**

Our summary of information about the current and historic distributions of bowhead, fin, and humpback whales indicate that new information regarding bowhead whales is not substantial and would not alter the findings of the 2006 BE, incorporated by reference herein.

Concurrent with arctic warming and subsequent change in oceanographic functions (such as prey abundance and distribution) and the potential for increasing levels of offshore activities and disturbances (both oil- and gas-related and non-oil- and gas-related), humpback whales may be extending their range into the Chukchi and Beaufort seas. Close monitoring appears important to test whether recent humpback occurrence is an anomaly or the beginning of a longer term trend in population and range expansion.

Adding enhanced passive-acoustic monitoring and classification for fin whale and humpback whale vocalizations, in addition to bowhead vocalizations, would help indicate duration, distribution, and habitats used by these species in the Beaufort and Chukchi seas.

Enhanced vessel-based MMO monitoring skills and equipment or rapid real-time communication to appropriate skilled and equipped personnel are needed to capitalize on opportunities to perform photo-identification procedures whenever humpback whales are observed would aid in defining stock of origin.

If recent observations are indicative of a trend of increasing abundance and distribution of humpback whales in the U.S. Arctic Ocean, then humpback whales would likely to be exposed to and be adversely affected by potential noise and disturbance associated with many of the seismic-survey activities that could occur within the Chukchi Sea or the Beaufort Sea Planning Area.

Fin whales are not likely to be exposed to or adversely affected by potential noise, disturbance, discharges, or oil spills associated with seismic-survey activities that could occur within the Chukchi Sea or Beaufort Sea Planning Area. Fin whales occurring along the Chukotka Peninsula and extreme southern Chukchi Sea may detect noise from OCS seismic activity; however, if such detection occurs, response would be short-term, involve minor behavior changes, and be of negligible effect.

We have no information that indicates fin whales typically 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 adversely affect this species.

Bowhead whales are likely to be exposed to and be adversely affected by potential noise and disturbance associated with many of the seismic-survey activities that could occur within the Chukchi Sea or the Beaufort Sea Planning Area.

Depending on largely unpredictable circumstances, endangered whales, primarily bowheads, potentially can be deflected or delayed along routes during seasonal migration, displaced from key feeding or other life-function habitats; "herded" into entrapment situations against shorelines; or other arrays of activities that alter behavior, direction of travel, or induce stress.

Migrating bowhead whales inadvertently may be "herded" through repeated avoidance behavior of multiple or collective sound-source arrangements sufficient distances to alter subsistence-hunt opportunity, safety, and success. This phenomenon potentially can either move whales into hunting areas and increase whale availability to hunters or decrease availability of harvestable whales by moving whales away from hunt areas.

Creative strategies may be needed to ensure free movement and reduce trap situations of endangered whales by providing corridors of adequate width and with reduced sound and disturbance levels. This way, whales would not be inhibited from using such corridors to travel between sound sources or groups of sound sources, with minimal alteration of long-term migration and habitat-use patterns.

Simultaneous, multiple seismic surveys may increase in number and complexity of temporal and spatial footprint in relation to each other and to other OCS activities such as active drill ships, support vessels, and

aircraft traffic. This increases the need for intensive in-season (open-water period), real-time adaptive management to implement timely mitigation and avoid developing adverse-effect situations.

There are existing and potential mitigation practices and strategies that can be developed, adapted, and implemented to eliminate or substantially reduce potential adverse effects of noise and disturbance to humpback and bowhead whales.

Humpback and fin whales are not expected to occur in the Chukchi Sea or Beaufort Sea when on-ice 2D/3D seismic survey operations would occur. No adverse effects to fin, humpback, or bowhead whales are likely to be related to on-ice seismic surveys.

Discharges of various types from seismic-survey activities and potential effects on humpback whales, their prey, and habitat are not expected. Any discharges that may be associated with seismic-survey activities would be small, localized, and negligible to humpback and bowhead whales in the Chukchi Sea and Beaufort Sea Planning Areas, as these whales typically would avoid the area of activity and discharges would rapidly dissipate or be diluted so as to not affect the whales or their prey.

Large and very large oil spills are not expected from seismic-survey activities, and no adverse effects are likely to occur.

Small, operational, refined oil spills associated with seismic surveys could occur, especially during fuel transfer. Small, operational fuel spills typically are very-localized (at sea in the Chukchi Sea and likely at West Dock in the Beaufort), low-frequency (up to 8 refueling actions per marine seismic survey), and low-volume (<5 gallons per refueling) events. They are unlikely to have detectable effects on humpback or bowhead whales, because it is anticipated that these whales generally would avoid seismic-survey activities and not be in the immediate vicinity at the time of a spill.

Bowhead whales would be vulnerable to spills in the spring lead system in the Chukchi and Beaufort seas when large numbers of cows with calves could be exposed to spilled oil. However current mitigation does not allow activity prior to July 1 for vessel-based seismic surveys and, in the Chukchi, the major portions of the current nearshore spring lead system remains outside the planning area.

It appears that arctic-warming trends are likely to continue; however, the rate and magnitude of change remains unclear as does the potential for adverse and/or positive effects to endangered whales. Climate change is occurring, and MMS encourages appropriate monitoring to document change, identify potential effects to endangered whales, identify substantial issues, facilitate informed management decisions, and implement appropriate actions as necessary.

The MMS encourages and supports research and monitoring efforts to provide for periodic assessment and, if warranted, development of appropriate measures to protect and conserve humpback whales and fin whales. It is suggested that measures and procedures be implemented that capture opportunities resulting from marine mammal-monitoring programs to enhance knowledge and conservation of humpback stock origin by providing for rapid-response by or on-site humpback photo-identification procedures by trained, experienced personnel with appropriate equipment. Stock identification is important to apply protection measures appropriate to the vulnerability of a particular stock such as the WNPS of humpback whales, characterized by low numbers and subject to mortality exceeding potential biological removal levels in parts of their year-long range outside OCS jurisdiction.

The MMS encourages continuation of monitoring efforts that investigate the potential and ongoing effects of climate change on human activities and endangered whales in the Arctic region ecosystem to enhance adaptive management of human activity as appropriate to protect endangered and otherwise protected marine mammals.

Recent review, analysis, and proposed marine mammal exposure criteria (Southall et al., 2007) may differ from current criteria and may be a consideration in development and recommendation of mitigation actions to protect endangered whales in the Beaufort and Chukchi seas.

The MMS suggests NMFS consider in their biological opinion seismic-survey activities associated with all phases (pre- and post-lease exploration, development, production, and abandonment) of oil and gas and not reinitiating ESA consultation for seismic-survey activities incrementally at each phase, unless new seismic-survey technology or activities and events not considered herein warrant further analysis.

The MMS encourages and supports application of new technologies and modifying seismic-survey activities to minimize anthropogenic noise in the Arctic OCS associated with seismic surveys.

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**FIGURE 1**

**CHUKCHI SEA AND BEAUFORT SEA PLANNING AREAS**

