**ENDANGERED SPECIES ACT: SECTION 7 CONSULTATION**
**BIOLOGICAL OPINION**

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| **Action Agency:** | National Marine Fisheries Service Permits, Conservation, and Education Division |
| **Activity:** | Incidental harassment authorization to allow for incidental takes of marine mammals during shallow hazards survey in the Chukchi Sea, Alaska, 2011 |
| **Consulting Agency:** | National Marine Fisheries Service, Alaska Region |
| **Approved By:** | [signature] |
| **Date Issued:** | 7.22.11 |

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

NMFS, Office of Protected Resources, Conservation and Education Division (Permits Division) (NMFS PR1) requested formal consultation on the authorization of "small take" permits under section 101 (a)(5) of the Marine Mammal Protection Act of 1972, as amended (MMPA), for shallow hazards site surveys and soil investigations (geotechnical boreholes) in the Chukchi Sea, Alaska. This document constitutes NMFS' biological opinion on the effects of that action on the endangered species in accordance with section 7 of the ESA. Specifically, this biological opinion analyzes the effects of an incidental harassment authorization on the endangered bowhead whales (*Balaena mysticetus*), fin whales (*Balaenoptera physalus*), and humpback whales (*Megaptera novaeangliae*).

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

- Takes of marine mammals incidentally to specific activities; taking marine mammals incidental to shallow hazards survey in the Chukchi Sea, Alaska (76FR 30110 (May 24, 2011))
- Request by Statoil for an incidental harassment authorization to allow for incidental take of marine mammals during shallow hazards survey in the Chukchi Sea, Alaska, 2011 (Statoil 2011)
- Endangered Species Act – section 7 consultation biological opinion: Oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi seas, Alaska; and authorization of small takes under the Marine Mammal Protection Act (NMFS 2008)
- Supplemental 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) (MMS 2008)
- Final recovery plan for the fin whale (*Balaenoptera physalus*) (NMFS 2010)
- Final recovery plan for the humpback whale (*Megaptera novaeangliae*) (NMFS 1991
- Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
- Published scientific studies
- Unpublished data
    - International Whaling Commission
    - North Slope Borough
    - Alaska Eskimo Whaling Commission
    - Traditional knowledge of the Alaskan Eskimo communities
    - National Marine Mammal Laboratory

**Consultation History**
The consultation was requested by NOAA Fisheries, Office of Protected Resources in a letter dated 8 June 2011.

**Terms of this Biological Opinion**
This biological opinion will be valid upon issuance and remain in force until December 31, 2011. Consultation will be re-initiated if there are 1) significant changes in the type of activities, 2) new information indicates these actions are impacting the endangered whales to a degree or in a manner not previously considered, or 3) new species or critical habitats become listed under the ESA.

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## Presentation of the Analysis in this Biological Opinion

Biological opinions are constructed around several basic sections that represent specific requirements placed on the analysis by the ESA and implementing regulations. These sections contain different portions of the overall analytical approach described here. This section is intended as a basic guide to the reader on the other sections in this biological opinion and the analyses that can be found in each section. Every step of the analytical approach described above will be presented in this biological opinion in either detail or summary form.

**Description of the Proposed Action –** This section contains a basic summary of the proposed Federal action and any interrelated and interdependent actions. This description forms the basis of the first step in the analysis where we consider the various elements of the action and determine the stressors expected to result from those elements. The nature, timing, duration, and location of those stressors define the action area and provide the basis for our exposure analyses.

**Status of the Species –** This section provides the reference condition for the species and critical habitat at the listing and designation scale. These reference conditions form the basis for the determinations of whether the proposed action is not likely to jeopardize the species or result in the destruction or adverse modification of critical habitat. Other key analyses presented in this section include critical information on the biological and ecological requirements of the species and critical habitat and the impacts to species and critical habitat from existing stressors.

**Environmental Baseline –** This section provides the reference condition for the species and critical habitat within the action area. By regulation, the baseline includes the impacts of past, present, and future actions (except the effects of the proposed action) on the species and critical habitat. This section also contains summaries of the impacts from stressors that will be ongoing in the same areas and times as the effects of the proposed action (future baseline). This information forms part of the foundation of our exposure, response, and risk analyses.

**Effects of the Proposed Action –** This section details the results of the exposure, response, and risk analyses NMFS conducted for listed species and elements, functions, and areas of critical habitat.

**Cumulative Effects –** This section summarizes the impacts of future non-Federal actions reasonably certain to occur within the action area, as required by regulation. Similar to the rest of the analysis, if cumulative effects are expected, NMFS determines the exposure, response, and risk posed to individuals of the species and features of critical habitat.

**Synthesis and Integration –** In this section of the biological opinion, NMFS presents the summary of the effects identified in the preceding sections and then details the consequences of the risks posed to individuals and features of critical habitat to the species or Distinct Population Segment at issue. Finally, this section concludes whether the proposed action may result in jeopardy to the continued existence of a species or the destruction or adverse modification of designated critical habitat.

### Legal and Policy Framework

The purposes of the ESA, "*…are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section*." To help achieve these purposes, the ESA requires that, "*Each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat…*"

### Jeopardy Standard

The "jeopardy" standard has been further interpreted in regulation (50 CFR 402.02) as a requirement that Federal agencies ensure that their actions are not likely to result in *appreciable reductions in the likelihood of both the survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution*. It is important to note that the purpose of the analysis is to determine whether or not appreciable reductions are reasonably expected, but not to precisely quantify the amount of those reductions. As a result, our assessment often focuses on whether a reduction is expected or not, but not on detailed analyses designed to quantify the absolute amount of reduction or the resulting population characteristics (abundance, for example) that could occur as a result of proposed action implementation.

For the purposes of this analysis, NMFS equates a listed species' probability or risk of extinction with the likelihood of both the survival and recovery of the species in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. A designation of a high risk of extinction indicates that the species faces significant risks from internal and external processes that can drive a species to extinction. The status assessment considers and diagnoses both the internal and external processes affecting a species' extinction risk.

The parameters of productivity, abundance, and population spatial structure are important to consider because they are predictors of extinction risk, the parameters reflect general biological and ecological processes that are critical to the survival and recovery of the listed species, and these parameters are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02).

Consultations designed to allow Federal agencies to fulfill these purposes and requirements are concluded with the issuance of a biological opinion or a concurrence letter. Section 7 of the ESA and the implementing regulations (50 CFR 402), and associated guidance documents (e.g., USFWS and NMFS 1998) require biological opinions to present: (1) a description of the proposed Federal action; (2) a summary of the status of the affected species and its critical habitat; (3) a summary of the environmental baseline within the action area; (4) a detailed analysis of the effects of the proposed action on the affected species and critical habitat; (5) a description of cumulative effects; and (6) a conclusion as to whether it is reasonable to expect the proposed action is not likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild by reducing its numbers, reproduction, or distribution or result in the destruction or adverse modification of the species' designated critical habitat.

## I. DESCRIPTION OF THE PROPOSED ACTION

Section 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce to allow, upon request the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens engaged in a specific activity (other than commercial fishing) in a specified geographical if certain findings are made. Such authorization may be accomplished through regulations and issuance of letters of authorization under those regulations, or through issuance of an incidental harassment authorization (IHA). These authorizations may be granted only if an activity would have no more than a negligible effect on the species (or stock) in question, would not have an unmitigable adverse impact on the availability of the marine mammal for subsistence uses (where relevant), and that the permissible method of taking and requirements pertaining to the monitoring and reporting of such taking are set forth to ensure the activity will have the least practicable adverse effect on the species or stock and its habitat. These authorizations are often requested for oil and gas activities which produce underwater noise capable of harassing marine mammals. Harassment is a form of taking otherwise prohibited by the MMPA and ESA.

This opinion will address the potential effects from authorization of a "small take" permit under section 101 (a)(5) of the MMPA, for certain oil and gas exploration activities in the U. S. Chukchi Sea for 2011. Its purpose is to provide an assessment of those actions on the continued existence of the bowhead, fin, and humpback whales, as well as to provide measures to conserve the species and mitigate impact. This biological opinion incorporates much of the information provided by PR1, as well as pertinent research on the whales and matters related to oil exploration. Traditional knowledge and the observations of Inupiat hunters are presented, along with information gained through scientific research. This combined knowledge contributes, along with western science, to a more complete understanding of these issues. A reasonable assessment of potential effects can only be made by considering both these systems of knowledge.

The specific activities subject to this consultation are described below.

The proposed shallow hazards and site clearance surveys would use a towed airgun cluster consisting of four, 10 $in^3$ airguns with a ~600 m towed hydrophone streamer, as well as additional lower powered and higher frequency survey equipment for collecting bathymetric and shallow sub-bottom data. The proposed survey will take place on and near Statoil's leases in the Chukchi Sea, covering a total area of ~665 $km^2$ located ~240 km (150 mi) west of Barrow and ~165 km (103 mi) northwest of Wainwright, in water depths of ~30–50 m (100–165 ft).

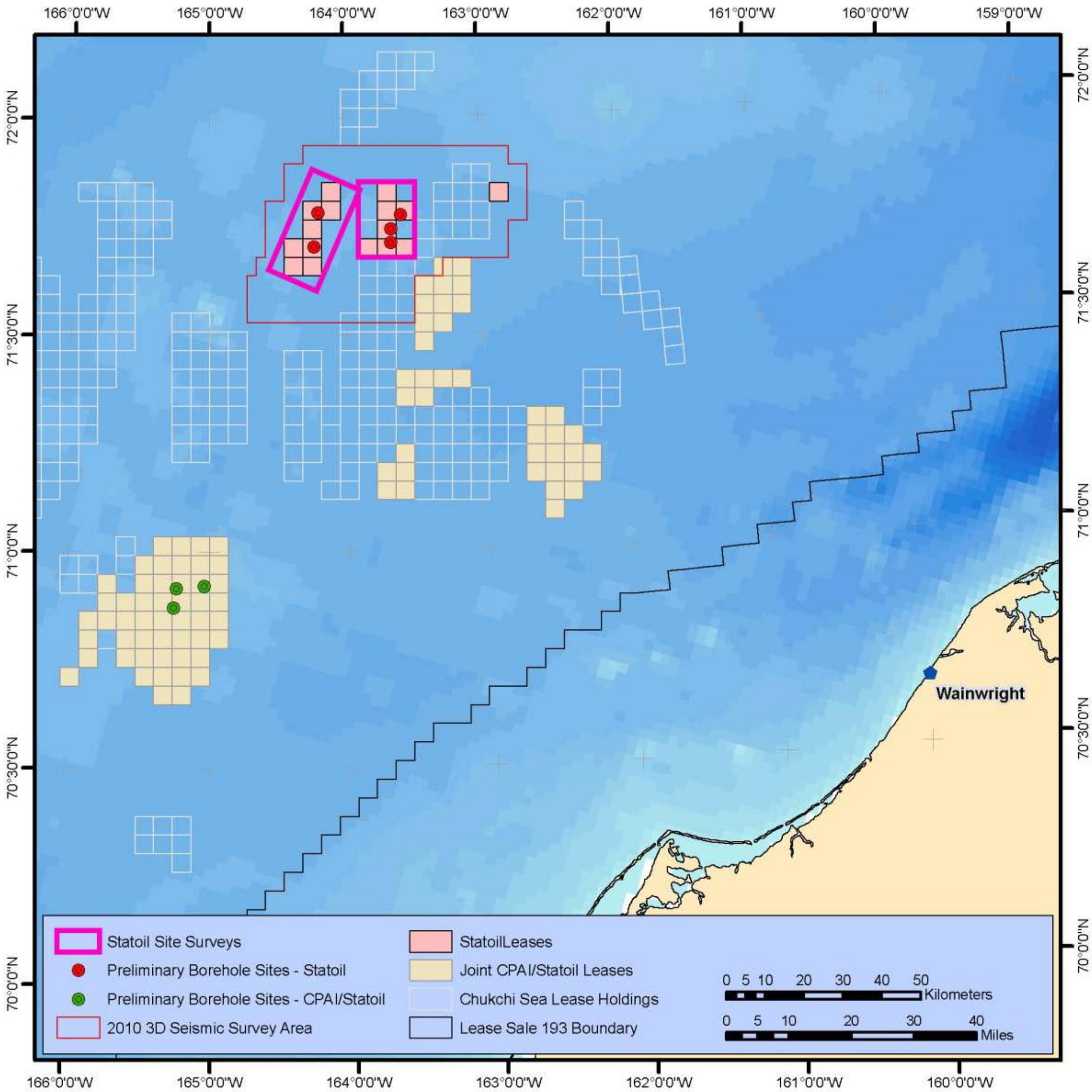
The proposed geotechnical soil investigations will take place at prospective drilling locations on Statoil's leases and leases jointly owned with ConocoPhillips Alaska Inc. (CPAI). All cores will be either 2.1 in. or 2.8 in. in diameter (depending on soil type) and those collected at prospective drilling locations will be up to 100 m in depth. The maximum samples collected as part of the drilling location and site survey program will total ~29 bore holes (Figure 1).

Statoil intends to conduct these marine surveys during the 2011 Arctic open water season (July through November). Impacts to marine mammals may occur from noise produced from active acoustic sources (including airguns) used in the surveys.

**Description of the Specified Activity**

Statoil acquired 16 leases in the Chukchi Sea during Lease Sale 193 held in February 2008. The leased areas are located ~240 km (150 mi) west of Barrow and ~160 km (~100 mi) northwest of Wainwright. During the open water season of 2010, Statoil conducted a 3D seismic survey over its lease holdings and the surrounding area. The data gathered during that survey are currently being analyzed in order to determine potential well locations on the leases. These analyses will be completed prior to commencement of the site survey program. During the open water season of 2011, Statoil proposes to conduct shallow hazards and site clearance surveys (site surveys) and soil investigations (geotechnical boreholes).

Figure 1. Location of the planned 2011 site survey and geotechnical soil investigation activities in the Chukchi Sea, Alaska.




The proposed operations will be performed from two different vessels. Shallow hazards surveys will be conducted from the M/V Duke, while geotechnical soil investigations will be conducted from the M/V Fugro Synergy. Both vessels will mobilize from Dutch Harbor in late July and arrive in the Chukchi Sea to begin work on or after 1 August. Allowing for poor weather days, operations are expected to continue into late September or early October. However, if weather permits and all planned activities have not been completed, operations may continue as late as 15 November.

To complete the site survey work on Statoil's leases will require approximately 23 days. Geotechnical soil investigations on Statoil leases and on leases jointly held with CPAI will require ~14 days of operations.

**Shallow Hazards and Site Clearance Surveys**

Shallow hazards site surveys are designed to collect bathymetric and shallow sub-seafloor data that allow the evaluation of potential shallow faults, gas zones, and archeological features at prospective exploration drilling locations, as required by the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE). Data are typically collected using multiple types of acoustic equipment. During the site surveys, Statoil proposes to use the following acoustic sources: 1) 4×10 $in^3$ airgun cluster, single 10 $in^3$ airgun; 2) Kongsberg SBP3000 sub-bottom profiler,;3) GeoAcoustics 160D side scan sonar; and 4) Kongsberg EM2040 multi-beam echosounder. The operating frequencies and estimated source levels of this equipment are provided below.

1. <u>Airguns</u>

A 4×10 $in^3$ airgun cluster will be used to obtain geological data during the shallow hazards survey. A similar airgun cluster was measured by Shell in 2009 during shallow hazards surveys on their nearby Burger prospect (Reiser et al. 2010). The measurements resulted in 90th percentile propagation loss equations of RL = 218.0 - 17.5LogR - 0.00061R for a 4×10 $in^3$ airgun cluster and RL = 204.4 - 16.0LogR - 0.00082R for a single 10 $in^3$ airgun (RL is the received level; R is the range). The estimated 190, 180, and 160 $dB_{rms}$ re 1 μPa isopleths are estimated at 39 m, 150 m, and 1,800 m from the source. More accurate isopleths at these received levels will be established prior to Statoil's shallow hazards survey (see below).

2. <u>Kongsberg SBP300 Sub-bottom Profiler</u>

This instrument will be operated from the M/V <u>Duke</u> during site survey operations. This sub-bottom profiler operates at frequencies between 2 and 7 kHz with a manufacturer specified source level of ~225 dB re 1 μPa-m. The sound energy is projected downwards from the hull in a maximum 15° cone. However, field measurements of similar instruments in previous years have resulted in much lower actual source levels (range 161-186 dB) than specified by the manufacturers (i.e. the manufacturer source level of one instrument was reported as 214 dB, and field measurements resulted in a source level estimate of 186.2 dB) (Reiser et al. 2010). Although it is not known whether these field measurements captured the narrow primary beam produced by the instruments, Statoil will measure the sounds produced by this instrument (and all other survey equipment) at the start of operations and if sounds from the instrument are found to be above mitigation threshold levels (180 dB for cetaceans, 190 dB for seals) at a distance beyond the footprint of the vessel, then the same power down and shutdown mitigation measures used during airgun operations will be employed during use of the sub-bottom profiler.

3. <u>GeoAcoustics 160D Side-scan Sonar</u>

The side scan sonar will be operated from the M/V <u>Duke</u> during site survey operations. This unit operates at 114 kHz and 410 kHz with a source level of ~233 dB re 1 μPa-m. The sound energy is emitted in a fan shaped pattern that is narrow (0.3-1.0°) in the fore/aft direction of the vessel and broad (40–50°) in the port/starboard direction.

4. <u>Kongsberg EM2040 Multi-beam Echosounder</u>

Multi-beam echosounders also emit energy in a fan shaped pattern, similar to the side scan sonar described above. This unit operates at 200 to 400 kHz with a source level of ~210 dB re 1 μPa-m. The beam width is 1.5° in the fore/aft direction. The multi-beam echosounder will be operated from the M/V Duke during site surveys operations.

**Geotechnical Soil Investigations**

Geotechnical soil investigations are performed to collect detailed data on seafloor sediments and geological structure to a maximum depth of 100 m. These data are then evaluated to help determine the suitability of the site as a drilling location. Statoil has contracted with Fugro who will use the vessel M/V Fugro Synergy to complete the planned soil investigations. Three to four bore holes will be collected at each of up to five prospective drilling locations on Statoil's leases and up to three boreholes may be completed at each of up to three potential drilling locations on leases jointly owned with CPAI. This would result in a maximum total of 29 bore holes to be completed as part of the geotechnical soil investigation program. The Fugro Synergy operates a Kongsberg EA600 Echosounder and uses a Kongsberg 500 high precision acoustic positioning (HiPAP) system for precise vessel positioning while completing the boreholes. The operating frequencies and estimated source levels of the acoustic equipment, as well as the sounds produced during soil investigation sampling, are provided in the sub-section below.

1. Kongsberg EA600 Echosounder

This echosounder will be operated from the M/V Fugro Synergy routinely as a fathometer to provide depth information to the bridge crew. This model is capable of simultaneously using 4 transducers, each with a separate frequency. However, only two transducers will be mounted and used during this project. These transducers will operate at 18 kHz and 200 kHz and have similar or slightly lower source levels than the multi-beam echosounder described above. The energy from these transducers is emitted in a conical beam from the hull of the vessel downward to the seafloor.

2. Kongsberg HiPAP 500

The Kongsberg high precision acoustic positioning system (HiPAP) 500 is used to aid the positioning of the M/V Fugro Synergy during soil investigation operations. An acoustic signal is sent and received by a transponder on the hull of the vessel and a transponder lowered to the seafloor near the borehole location. The two transponders communicated via signals with a frequency of between 21–30.5 kHz with source levels expected to be in the 200–210 dB range.

3. Geotechnical Soil Investigation Sounds

In water sounds produced during soil investigation operations by the M/V Fugro Synergy have not previously been measured and estimates of such activities vary. Measurements of another Fugro vessel that often conducts soil investigations were made in the Gulf of Mexico in 2009. However, because measurements were taken using a towed hydrophone system, recordings of soil investigation related sounds could not be made while the vessel was stationary. Therefore, sounds recorded while the vessel was in transit were compared to sounds recorded while the vessel also operated generators and mechanical equipment associated with soil investigation operations while in transit. The difference in sound levels during transit alone and during transit with soil investigation equipment operating was negligible and this was attributed to the fact that transit noise was dominant up to at least 7 kHz and likely masked the lower frequency sounds produced by the simulated soil investigation activities.

4. Dynamic Positioning Sound

During soil investigation operations, the M/V Fugro Synergy will remain stationary relative to the seafloor by means of a dynamic positioning (DP) system that automatically controls and coordinates vessel movements using bow and/or stern thrusters as well as the primary propeller(s). The sounds produced by soil investigation equipment are not likely to substantially increase overall source levels beyond those produced by the various thrusters while in DP mode. Measurements of a vessel in DP mode with an active bow thruster were made in the Chukchi Sea in 2010 (Chorney et al. 2011). The resulting source level estimate was 175.9 $dB_{rms}$ re 1 μPa-m. Using the transmission loss equation from measurements of a single 60 $in^3$ airgun on Statoil's lease in 2010 (RL = 205.6 – 13.9LogR – 0.00093R; O'Neill et al. 2011) and replacing the constant term with the 175.9 results in an estimated range of 4.97 km to the 120 dB level. To allow for uncertainties and some additional sound energy being contributed by the operating soil investigation equipment, an inflation factor of 1.5 was applied to arrive at an estimated ≥120 dB radius of 7.5 km for soil investigation activities.

**Action Area**

Federal regulations implementing the ESA (50 C.F.R. §402.02) define the action areas as follows:

> Action area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.

In order to define the actions areas for the proposed action, we must have some basic understanding of the zone over which direct and indirect effects of this action might occur. Based on literature on effects from drillships and effects from seismic surveys on migrating bowhead whales, these whales may react to noise as low as 120 dB. Based on this metric, we can define an action area as including at least 100 km from all areas of seismic operation by Statoil and less than that for Statoil's proposed geotechnical soil investigations.

Therefore, the action area for purposes of this biological opinion is defined as waters within 100 kilometers of the described activities in the Chukchi Sea. The direct and indirect effects of this action on the endangered bowhead, fin, and humpback whales are expected to be confined to the action area.

## II. STATUS OF THE SPECIES

NMFS has determined that the described actions may affect the following marine mammal species currently listed under the ESA (16 U.S.C. 1531 *et seq*.):

- Bowhead whale (*Balaena mysticetus*) Endangered
- Fin whale (*Balaenoptera physalus)* Endangered
- Humpback whale (*Megaptera novaeangliae)* Endangered

This opinion will consider the potential effects of these actions on these species. However, we believe the bowhead whale is most likely to be effected by Statoil's exploration, and that this species is likely more sensitive to noise and disturbance than humpback and fin whales. Both humback and fin whales are rare in this portion of the Chukchi Sea; neither species was encountered during 42 days of survey work in this area by Statooil in 2010. Additionally, there exists a considerable database on the Western Arctic bowhead stock (also referred to as the Bering/Chukchi/Beaufort seas stock or BCB) and the potential and measured impacts to these whales due to oil exploration in the Arctic. Much of this information will be generally applicable to other large balenopterid whales, notably fin and humpback whales. Therefore, the bowhead whale often receives the most attention under this opinion.

## Bowhead Whale

Information in this section provides updates and, in some cases, summarizes information from previous consultation documents (e.g., NMFS 2008, 2010; MMS 2006, 2008) and supplements this information with more recent information on the BCB or Western Arctic stock of the bowhead whale. Since the time of the writing of the previous section 7 documents (e.g., MMS, 2006, 2008; NMFS 2006, 2008, 2010), there has been considerable research focused on the bowhead whale in MMS's Chukchi Sea and Beaufort Sea OCS Planning areas. Key studies include:

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

Documents that summarize current information on bowhead whales:

1. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
2. Endangered and threatened species; Final determination on a petition to designate critical habitat for the Bering Sea stock of bowhead whales (67 FR 55767, August 30, 2002)
3. Biological opinion on the issuance of annual quotas authorizing the harvest of bowhead whales to the Alaska Eskimo Whaling Commission for the period 2008 through 2012 (NMFS 2008a)
4. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
5. BWASP reports
6. BOWFEST reports

7. COMIDA reports

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

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

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

Details on bowhead whales that are outside the scope of the material provided here may be provided in one or more of these aforementioned documents. NMFS has reviewed and considered information in these documents and other available information in our evaluation of potential environmental impacts.

NMFS consider traditional knowledge (also called traditional ecological knowledge or TEK) in this biological opinion. "Observations that form traditional knowledge and scientific observations are independent sources of information that when combined, can increase our depth of knowledge" (Quakenbush and Huntington 2010, citing Huntington et al. 2004). The value of the knowledge that Alaska Native bowhead hunters have about bowhead population status, behavior, habitat use, and response to anthropogenic activities is well documented. Thus, NMFS believes it is an essential component to achieve a full understanding about the bowhead whale status in this area and understanding ways in which bowhead whales may be affected by the proposed action.

**ESA Listing History and Status**

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

Shelden et al. (2001) proposed that the bowhead whale species should be listed under the ESA as five distinct population segments, based on the distinct population segment definition developed by NMFS and FWS (61 FR 4722: February 7, 1996). The five separate bowhead whale stocks are: 1) Bering Sea stock (referred to in IWC documents as the BCB bowhead whale and as the Western Arctic stock in NMFS' Alaska Marine Mammal stock assessments), 2) Spitsbergen stock, 3) Davis Strait stock, 4) Hudson Bay stock (but see Heide-Jørgensen et al. 2006; Heide-Jørgensen and Laidre 2007), and 5) Okhotsk stock. Shelden et al. (2001) evaluated each proposed distinct population segment to determine whether one or more should be reclassified. The authors presented two models to evaluate the status of bowhead whale stocks: 1) developed based on World Conservation Union criterion D1 and E (Shelden et al. 2001, citing World Conservation Union 1996); and 2) a model developed by Gerber and DeMaster (1999) for ESA classification of North Pacific humpback whales. Under each classification system, the authors determined the Bering Sea bowhead whale population should be delisted; whereas the other four bowhead whale populations should continue to be listed as endangered (see also criticism of this determination by Taylor 2003, the response by Shelden et al. 2003, discussion by the IWC SC 2003a).

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

**Population and Stock Structure**

The bowhead whale was historically found in all arctic waters of the northern hemisphere. Five populations are currently recognized by the IWC (1992) (but see Heide-Jørgensen et al. 2006; Heide-Jørgensen and Laidre 2007; and references cited therein, who argued that bowhead whales that summer in eastern Canada and winter in West Greenland, considered the Hudson Bay and Davis Strait stocks, consist of a single population). Three bowhead whale populations are found in the North Atlantic and two populations are in the North Pacific, some or all of which may be reproductively isolated (Shelden and Rugh 1995). The Spitsbergen population is found in the North Atlantic east of Greenland, in the Greenland, Kara, and Barents Seas. Once thought to have been the most numerous of bowhead whale populations, Woodby and Botkin (1993) estimate the unexploited population at 24,000 animals; it is now severely depleted, possibly in the tens of animals (Shelden and Rugh 1995).

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

The Hudson Bay population, also found in Foxe Basin, is differentiated from the Davis Strait population by their summer distribution, rather than genetic or morphological differences (Reeves et al. 1983). No reliable estimate exists for this population; however, Mitchell (1977) places a conservative estimate at 100 animals or less. More recently, estimates of 256-284 whales have been presented for the whale population within Foxe Basin (Cosens et al. 1997). There has been no appreciable recovery of this population.

The Okhotsk Sea population occurs in the North Pacific, off the west coast of Siberia near the Kamchatka Peninsula. The pre-exploitation size of this population may have been 3,000 to 6,500 animals (Shelden and Rugh 1995); and may now range 300-400 animals, although reliable population estimates are not currently available. It is possible this population has mixed with the Bering Sea population, although the available evidence indicates the two populations are essentially separate (Moore and Reeves 1993).

The BCB bowhead whale has the largest population of all surviving bowhead populations and the only stock to inhabit U.S. waters. Many other stocks are likely small (e.g., the Hudson Bay/Davis Strait population that may be more than one thousand) or very small (but see Department of Fisheries and Oceans (DFO) 2009 regarding estimates of the Eastern Arctic bowhead whale). Ivashchenko and Clapham (2010) noted that the estimated current size (in the low hundreds) of the Okhotsk stock is not based on quantitative analysis, but that population is very likely to be relatively small. Thus, available data indicate the viability of bowhead whales in the BCB stock is highly important to the long term future of the biological species as a whole.

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

**Abundance and Trends**

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

Based on both survey data and the incorporation of acoustic data, the abundance of the Western Arctic bowhead whales was estimated at 11,836 whales (95% CI; 6,795 to 20,618), and estimate that is consistent with trends in abundance estimates made from mice-based counts (Allen and Angliss 2011). George et al. (2004) reported that the Western Arctic bowhead whale stock has increased at a rate of 3.4 percent (95% CI; 1.7% to 5%) from 1978 to 2001, during which time abundance doubled from approximately 5,000 to approximately 10,000 whales. The count of 121 calves during the 2001 census was the highest yet recorded and was likely caused by a combination of variable recruitment and the large population size (George et al. 2004). The calf count provides corroborating evidence for a healthy and increasing population. The estimated increase in the estimated population size most likely is due to a combination of improved data and better census techniques, along with an actual increase in the population.

This steady recovery is likely due to low anthropogenic mortality, a relatively pristine habitat, and a well managed subsistence hunt (George et al. 2004). Based on capture-recapture statistical analysis with the “capture” of 4,894 putative individuals obtained from 10 years of photographic surveys conducted during the spring migration period past Barrow, Schweder et al. (2009) recently derived the point estimate of yearly growth rate as 3.2 percent and the bowhead whale abundance in 2001 was estimated to be 8,250 whales, similar to previous estimates.

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

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

**Reproduction, Survival, and Non-Human Sources of Mortality**

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

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

Mating may start as early as January and February, when most bowhead whales are in the Bering Sea, but was reported as late as September and early October (Koski et al. 1993). Mating probably peaks in March-April (IWC 2004b). Gestation has been estimated to range between 13 and 14 months (Nerini et al. 1984; Reese et al. 2001) and between 12 and

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

There is little information regarding causes of natural mortality for Western Arctic bowhead whales. Bowhead whales have no known predators except, perhaps, killer whales and subsistence whalers. The frequency of killer whale attacks probably is low (George et al. 1994). A relatively small number of whales likely die because they are entrapped in ice (Philo et al. 1993). Little is known about the effects of microbial or viral agents on natural mortality.

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

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

### Migration, Distribution, and Habitat Use

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

Winter

Bowhead whales from the Western Arctic stock overwinter in the central and western Bering Sea. Most mating probably occurs in the Bering Sea. The amount of feeding in the Bering Sea in the winter is unknown as is the feeding amount in the Bering Strait during the fall (Richardson and Thomson 2002). Previously, Moore and Reeves (1993) concluded that, in the Bering Sea, bowhead whales frequent the marginal ice zone, regardless of where the zone is, and polynyas. Important winter areas in the Bering Sea include polynyas along the northern Gulf of Anadyr, south of Saint Matthew Island, and near Saint Lawrence Island. Bowhead whales congregate in these polynyas before migrating north (Moore and Reeves 1993). However, recent satellite tag data (ADFG unpublished data) also show whales in ice covered habitats, in locations distant from major polynyas.

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

During their southward migration in the autumn, bowhead whales pass through the Bering Strait in late October through early November, or later (e.g. tag data indicate some may linger into January; ADFG unpublished data), on their way to overwinter in the Bering Sea. Bowhead whales were taken in large numbers all through June and July during commercial whaling in the northwestern and north central Bering Sea (Dahlheim et al. 1980, citing Townsend 1935).

Spring

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

Alaska Native whaling captains from Wainwright reported that "In the past, bowhead whales first arrived at Wainwright in late April, but . . . now they appear in the area in early April and at times even in March. Most whales have passed by early June" (Quakenbush and Huntington 2010). In spring 2010, the first bowhead of the season was seen near Barrow on 24 March 2010 and a few continued to be seen the first week of April[1]. Hunters reported that ice conditions determined local distribution and when leads near Wainwright are closed, whales travel farther offshore. They reported that whales often follow the shore fast ice edge, but they may also stay farther offshore and travel directly between Icy Cape and Point Belcher areas. Areas between Icy Cape and Point Franklin were identified by whaling captains as areas where feeding, calving and mating have been observed (Quakenbush and Huntington 2010).

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

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

The migration past Barrow takes place in pulses in some years (e.g., in 2004) but not in others (e.g., 2003) (Koski et al. 2004, citing IWC 2004b), with temporal segregation by size class (Zeh et al. 1993; Angliss et al. 1995; Koski et al. 2006; Wainwright whaling captains in Quakenbush and Huntington 2010). At Barrow, the first migratory pulse is typically dominated by subadults. This pattern gradually reverses and by the migration's end, adults constitute most bowhead whales passing Barrow. The last whales to pass Barrow tend to be females that are accompanied by calves (Angliss et al. 1995; Koski et al. 2006; Koski and Miller 2009; NSB unpublished data).

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

[1] J.C. George, personal communication 2010.

Wainwright whaling captains reported that "[w]hales in the third wave may also be found in cracks and openings far out in the pack ice" (Quakenbush and Huntington 2010).

Traditional ecological knowledge and satellite tag data both indicate that nearshore lead areas are a very important migration area and that some nearshore areas are used for feeding and calving (Quakenbush and Huntington 2010). Tag data (ADFG, unpublished data; Quakenbush et al. 2009), also show that part of the spring lead system used by bowhead whales extends into the Chukchi Sea 193 lease sale area and into other areas where there are active leases.

<u>Summer</u>

Satellite tag studies, data from small boat surveys near Barrow (George and Sheffield 2009), and other new data suggest the paradigm that underlay previous management that thought all bowhead whales round the corner at Point Barrow, swim east across the leads to Canadian waters, and stay there until "a fall migration begins" from the Canadian Beaufort (around 1 September), oversimplified a more complex and varied pattern. For example, tag data demonstrate that bowhead whales may be in the ice leads northeast of Barrow in mid June to mid July, transit to the Camden Bay area and Canadian Border from the east and west in late July, move from mid Beaufort halfway across the Chukchi in mid-August, etc. Data from the Barrow based boat surveys (George and Sheffield 2009) showed that bowhead whales were observed almost continuously in the waters near Barrow, including feeding groups in the Chukchi Sea at the beginning of July. Many whales (including a cow-calf pair), some were feeding, were observed northeast of Barrow in early August with large numbers of feeding whales east of Point Barrow later in August into September. These new data add to previous observations of bowhead whales near Barrow, in the central Beaufort Sea, or in the Chukchi Sea during the summer.

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

Some biologists conclude that almost the entire Bering Sea bowhead whale population migrates to the Beaufort Sea each spring and that few whales, if any, summer in the Chukchi Sea. Incidental sightings suggest that bowhead whales may occupy the Chukchi Sea in the summer more regularly than commonly believed. Moore (1992) summarized bowhead whale observations in the northeastern Chukchi Sea in late summer. Other scientists maintain that a few bowhead whales swim northwest along the Chukotka coast in late spring and summer in the Chukchi Sea. Natives living along the coast of Russia and other observers have long reported bowhead whale observations during the summer along the Chukotka Peninsula (Bogoslovskaya 2003; Zelensky et al. 1995). Current data are not available to estimate abundance, typify spatial and temporal patterns of use, or determine if individual bowhead whales show strong site fidelity to this area.

While sample sizes from the tagging study are insufficient to draw broad conclusions about relative distribution, it is clear from all data sources that bowhead whales may be in the

U.S. Beaufort and the Chukchi Sea during spring, summer, and fall. They may also occupy the northeastern Chukchi Sea in late summer more regularly than commonly believed (Moore 1992).

Fall

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

There is some indication that the fall migration, just as the spring migration, takes place in pulses or aggregations of whales (Moore and Reeves 1993). Eskimo whalers report that smaller whales precede large adults and cow-calf pairs on the fall migration (Braham et al. 1984, citing Moore and Reeves 1993).

Inupiat whalers estimate that bowhead whales take about two days to travel from Kaktovik to Cross Island, reaching the Prudhoe Bay area in the central Beaufort Sea by late September; and five days to travel from Cross Island to Point Barrow (NMFS 1999, citing T. Napageak 1996).

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

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

Aerial surveys near the proposed Liberty development project in 1997 (BPXA 1998) showed that the primary fall migration route was offshore of the barrier islands, outside the proposed development area. Some bowhead whales may swim inside the barrier islands during the fall migration. For example, there was a report that whales are seen inside the barrier islands near Cross Island nearly every year, and are sometimes observed between Seal Island and West Dock (Corps 1999).

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

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

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

Sightings north of 72° N. latitude suggest that at least some whales migrate across the Chukchi Sea farther to the north. Mel'nikov et al. (1997) argued that data suggest that after rounding Point Barrow, some bowhead whales head for the northwestern coast of the Chukotka Peninsula while others proceed primarily in the direction of the Bering Strait and into the Bering Sea. It was reported that abundance increased along northern Chukotka in September, as whales come from the north (NSB 2005, citing Mel'nikov 1997). More whales are seen along the Chukotka coast in October. The timing, duration, and location of the fall migration along the Chukotka Peninsula are highly variable and are linked to freeze up (Mel'nikov et al. 1997). Whales migrate in "one short pulse over a month" in years with early freeze up, but when ice formation is late, whales migrate during a 1.5-2 month period in two pulses (Mel'nikov et al. 1997).

**Feeding**

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

The significance of the Alaskan Chukchi Sea is an important issue in evaluating the potential effects from industrial activities on these whales. It has been, and remains, an area for research. Given the current combination of tagged whales, widespread aerial surveys, focused aerial surveys, photographic studies, oceanographic studies, and traditional ecological knowledge, more information is now available on the Chukchi Sea.

Available data indicate that bowhead whales feed in both the Chukchi and Beaufort Sea Planning Areas and that this use varies in degree among years, among individuals, and among areas. It is likely that bowhead whales continue to feed opportunistically where food is available as they move through or about the Alaskan Beaufort Sea, similar to what they are thought to do during the spring migration. Feeding is more prevalent or at least better documented in the summer in the Canadian Beaufort, and in the autumn (e.g., Lowry et al. 2004), than in the spring.

Observations from the 1980s documented that some feeding occurs in the spring in the northeastern Chukchi Sea, but this feeding was not consistently seen (Ljungblad et al. 1987; Carroll et al. 1987). Wainwright whaling captains have identified feeding areas in the Chukchi Sea (Quakenbush and Huntington 2010). Stomach contents from bowhead whales harvested between Saint Lawrence Island and Point Barrow during April into June indicated it is likely that some whales feed during the spring migration (Carroll et al. 1987; Shelden and Rugh 1995, 2002). Carroll et al. (1987) reported that the region west of Point Barrow seems to be of particular importance for feeding, at least in some years, but that whales may feed opportunistically at other locations in the lead system where oceanographic conditions produce locally abundant food. Lowry (1993) reported that the stomachs of 13 out of 36 spring migrating bowhead whales harvested near Point Barrow between 1979 through 1988 contained food. Lowry estimated total volumes of contents in stomachs ranged from less than 1 to 60 liters (L), with an average of 12.2 L in eight specimens. Shelden and Rugh (1995) concluded that "[i]n years when oceanographic conditions are favorable, the lead system near Barrow may serve as an important feeding ground in the spring (Carroll et al. 1997)." Richardson and Thomson (2002) concluded that some, probably limited, feeding occurs in the spring.

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

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

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

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

**Vocalizations and Hearing**

Bowhead whales are believed to be most sensitive to lower frequency sound. It may be reasonable that whales are most sensitive to noise at the frequencies at which they vocalize.

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

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

## Fin Whale

Information provided herein expands, updates, and in some cases, summarizes information provided in previous recent biological opinions (NMFS 2008, 2010). All available information is considered in NMFS update of our analyses on the potential effects from the proposed action on fin whales. Information sources that underlie NMFS evaluation on potential effects from the proposed action on fin whales include key studies such as:

1. Chukchi Offshore Monitoring In Drilling Area (COMIDA), multi-year broad scale aerial survey for marine mammals in Chukchi Sea planning area
2. Industry funded studies

Documents that summarize information on fin whales:

1. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
2. Final recovery plan for the fin whale (*Balaenoptera physalus*) (NMFS 2010)
3. COMIDA reports
4. Marine mammal monitoring in the Chukchi Sea
5. Acoustic monitoring in the Chukchi Sea

### ESA Listing History and Status

The fin whale was listed as an endangered species under the Endangered Species Conservation Act (35 FR 8495, June 2, 1970). The species was then listed as endangered under the ESA in 1973. On 2 July 2006, NMFS announced the availability of a draft recovery plan and requested public comment (71 FR 38385). On 22 January 2007, NMFS initiated a 5-year status review on the fin whale (72 FR 2649). NMFS announced adoption of an ESA recovery plan for the fin whale (75FR 19475). No critical habitat has been designated or proposed for fin whales in the North Pacific.

Under the 1994 amendments to the MMPA, fin whales are categorized as a strategic stock. They are listed in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Reeves et al. 1998). Hunting fin whales in the North Pacific was regulated under the 1946 International Convention for the Regulation of Whaling. The IWC began managing the commercial take of fin whales in the North Pacific in 1969 (Allen 1980; Reeves et al. 1999) and prohibited their harvest in the North Pacific in 1976.

**Population and Stock Structure**

NMFS currently considers stock structure for the fin whale to be equivocal (Allen and Angliss 2010). Three fin whale population stocks are currently recognized by NMFS for management purposes in U.S. waters: 1) Alaska (northeast Pacific) stock, 2) California/ Washington/Oregon stock, and 3) Hawaii (Allen and Angliss 2010). They identified that this structure should be reviewed and updated, if appropriate, to reflect new information provided by Mizroch et al. (2009), who recently completed a comprehensive summary on the historic whaling catch data, Discovery Mark recoveries, and opportunistic sightings data.

The estimated population abundance for the North Pacific population prior to commercial exploitation range was 42,000-45,000 fin whales (Ohsumi and Wada 1974). Allen and Angliss (2010) cited a revised, unpublished February 2003 version of IWC Bureau of International Whaling Statistics data, stating that “Between 1925 and 1975, 47,645 fin whales were reported killed throughout the North Pacific.” Annual catches in the North Pacific and Bering Sea ranged between 1,000 and 1,500 fin whales during the 1950's and 1960's. However, not all Soviet catches were reported. No reliable current population estimate exists for the North Pacific stock, but Allen and Angliss (2010) report a minimum estimate of 5,700 fin whales west of the Kenai Peninsula, based on incomplete surveys over a portion of their range.

**Reproduction, Survival and Non-Human Sources of Mortality**

Fin whale mating and calving are believed to occur on wintering grounds (Perry et al. 1999a). A single calf is born after a gestation of about 12 months; and then weaned between six and 11 months of age (Best 1966; Gambell 1985). Calving intervals range between two and three years (Agler et al. 1993).

Little is known about the natural causes of mortality in fin whales. Ice entrapment is known to have injured or killed some fin whales in the North Atlantic, particularly in the Gulf of Saint Lawrence (NMFS 2006); and killer whales may attack fin whales, as has been reported for gray whales. Disease presumably plays a major role in natural mortality as well, while shark attacks on weak and young individuals are probably common, but have not been documented. Lambertsen (in NMFS 2006) contended that crassicaudiosis in the urinary tract, was the primary cause of natural mortality in North Atlantic fin whales. Natural mortality rates in fin whales generally are thought to range between 0.04 and 0.06, based on studies of northeast Atlantic fin whales (Aguilar and Lockyer 1987).

## Distribution and Habitat Use

Fin whales are widespread throughout temperate oceans of the world (Leatherwood et al. 1982; Perry et al. 1999a; Reeves et al. 1998). Most fin whales are believed to migrate seasonally from relatively low latitude winter habitats, where breeding and calving take place, to relatively high latitude summer feeding habitats (Perry et al. 1999a). The degree of local population mobility, and perhaps individuals, differs; presumably in response to distribution patterns and prey abundance (Reeves et al. 1991; Mizroch et al. 2009). Some populations migrate seasonally up to thousands of kilometers; whereas, other populations reside in areas with adequate prey (Reeves et al. 1999). Data from marked fin whales indicate that at least some individuals travel long distances between wintering areas, off Mexico and California, to summer feeding areas in the Gulf of Alaska (Mizroch et al. 2009).

During the “summer” months, defined as April to October (Mizroch et al. 2009), fin whales inhabit temperate and subarctic waters throughout the North Pacific, including the Gulf of Alaska, Bering Sea, and , southern Chukchi Sea (Mizroch et al. 1984). Mizroch et al. (2009) summary indicates that fin whales range across the entire North Pacific from April to October, but in July and August they concentrate in the Bering Sea-eastern Aleutian area. Fin whale concentrations in the northern North Pacific and Bering Sea generally form along frontal boundaries, or mixing zones, between coastal and oceanic waters; which themselves correspond roughly to the 200 m isobath (shelf edge) (NMFS 2006). In September and October, sightings indicate that fin whales are in the Bering Sea, Gulf of Alaska, and along the U.S. coast, with one sighting as far as Baja California (in October) (Mizroch et al. 2009).

NMFS (2006) reports that fin whales have been observed: 1) year round off central and southern California, with peak numbers in summer and fall: 2) summers off Oregon; and 3) summer and fall in the Gulf of Alaska (including Shelikof Strait) and southeastern Bering Sea. Their regular occurrence has also been noted in recent years around the Pribilof Islands, in the northern Bering Sea. Data suggest the migratory behavior of fin whales in the eastern North Pacific is complex; whales occur in any one season, at many different latitudes, perhaps depending on their age or reproductive state, as well as their stock affinity. Movements can be either inshore/offshore or north/south.

Fin whales may occur seasonally in southwestern Chukchi Sea, which is 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. The species currently uses only part of their historic range, probably modified due to serious population reduction during commercial hunting. However, fin whales are rarely observed in the eastern half of the Chukchi Sea. Three fin whales (including a cow-calf) were observed together in the southern Chukchi Sea, directly north of the Bering Strait, in July 1981 (Ljungblad et al. 1982). In 1979-1987, no other fin whale sightings were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) in the Northern Bering Sea (north of Saint Lawrence Island), Chukchi Sea (north of 66º N. latitude), and east of the International Date Line and the Alaskan Beaufort Sea

(157º 01' W. east to 140º W. longitude) and offshore to 72º N. latitude (Ljungblad 1988). Mizroch et al. (2009) summarized that no other fin whale sightings were reported from the Arctic Alaska coast. Fin whales were not observed during annual aerial surveys of the Beaufort Sea, conducted in September and October from 1982-2004 (e.g., Treacy 2002; Moore et al. 2000). Fin whales were also not observed during a 2003 summer research cruise in the Chukchi and Beaufort seas (Bengston and Cameron 2003).

With the resurgence of oil and gas activities in the Chukchi Sea and related monitoring and research, there have been a few fin whale sightings in the eastern half of the Chukchi Sea. MMS (2008) and NMFS (2008) summarized that three adult fin whales were observed by marine mammal observers on a vessel in southeast Chukchi Sea on 23 September 2006 (Patterson et al. 2007). Clarke and Ferguson (2010) reported that one fin whale was seen swimming alone on 2 July 2008 at 69.228°N, 165.675°W (COMIDA survey, Block 20). No fin whales were observed during COMIDA surveys in 2009. Haley et al. (2010) reported no fin whale sightings during boat based monitoring in 2006 or 2007, but reported two fin whale sightings in the Chukchi Sea, for a total of four individuals in 2008. Thomas et al. (2010) did not report any fin whale sightings during their sawtooth, nearshore aerial surveys in the Chukchi Sea from 2006-2008. None were observed during 42 days of seismic acquisition by Statoil in 2010 and that survey occurred in the same action area as the proposed 2011 program (Blees et al. 2010).

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

- Fin whales have been observed, but are not expected to routinely occur, in the northeastern Chukchi Sea nor the action area.
- Fin whales do occur south and west of the Chukchi Sea Planning Areas, but may expand northward in the future.

Continued arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of fin whale prey species; and extend their distribution into waters of the Chukchi Sea, and possibly Beaufort Sea.

**Foraging Ecology and Feeding Areas**

Fin whales feed primarily on euphausiids, or "krill", but also consume substantial quantities of fish. Perry et al. (1999a, citing IWC 1992) reported that there is great variation in the predominant prey for fin whales in different geographical areas, depending on which prey are locally abundant. Nemoto and Kasuya (1965) and Kawamura (1982) indicated that in the North Pacific overall, fin whales preferred euphausiids (mainly *Euphausia pacifica*, *Thysanoessa longipes*, *T. spinifera*, and *T. inermis*) and large copepods (mainly *Calanus cristus*), followed by schooling fish such as herring, walleye pollock (*Theragra chalcogramma*), and capelin. Mizroch et al. (2009) summarized that fish, especially capelin, walleye pollock, and herring, were the main prey documented in the stomachs from harvested whales taken north of 58° N. latitude in the Bering Sea. They also reported that fin whales appear to make long distance movements quickly to track prey aggregations and can switch their diet from krill to fish as they migrate northward.

Fin whales aggregate to feed where prey densities are high (Piatt and Methven 1992; Piatt et al. 1989; Moore et al. 1998, 2002). Foraging areas tend to occur along continental shelves, with productive upwellings or thermal fronts. Fin whales tend to avoid tropical and pack ice waters (NMFS 2006), with the northern limit set by ice and the southern limit by warm water of approximately 15°C (60°F).

**Vocalizations and Hearing**

Underwater sounds from the fin whale are one of the most studied in *Balaenopteras*. Fin whales produce a variety of low frequency sounds in the 10 to 200 Hz band (NMFS 2005). The most typical signals are long, patterned sequences, of short duration (0.5 to 2 seconds) infrasonic pulses in the 18 to 35 Hz range (Patterson and Hamilton 1964). Estimated source levels are as high as 190 dB re 1 μPa (McDonald et al. 1995a, 1995b; Patterson and Hamilton 1964; Thompson and others 1992; Watkins and others 1987), but Charif et al. (2002) estimated source levels at 159 to 184 dB re 1 μPa after correcting for the Lloyd Mirror effect. In temperate waters intense bouts of long patterned sounds are very common from fall through spring; but also occur, to a lesser extent, during the summer in high latitude feeding areas (Clark and Charif 1998). Short sequences of rapid pulses in the 20 to 70 Hz band are associated with animals in social groups (McDonald et al. 1995a). Each pulse lasts on the order of one second and contains 20 cycles (Tyack 1999).

Particularly in the breeding season, fin whales produce series of pulses in a regularly repeating pattern. These bouts of pulsing may last for longer than one day (Tyack 1999). The seasonality and stereotype of these bouts with patterned sounds suggest the sounds are male reproductive displays (Watkins et al. 1987), while the individual counter calling data by McDonald et al. (1995a) suggests the more variable calls are contact calls. As with other mysticete sounds, the function of vocalizations produced by fin whales is unknown. As with blue whales, the low frequency sounds produced by fin whales have the potential to travel over long distances, and it is possible that long distance communication occurs (Edds-Walton 1997; Payne and Webb 1971).

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

## Humpback Whale

Information provided herein expands, updates, and in some cases, summarizes information provided in previous recent biological opinions (NMFS 2008, 2010). Information provided herein expands, updates, and in some cases, summarizes information provided in previous biological opinions. All available information is considered in NMFS update of our analyses on the potential effects from the proposed action on humpback whales.

Information sources that underlie NMFS evaluation on potential effects from the proposed action on humpback whales include key studies such as:

1. Structure of Populations, Levels of Abundance, and Status of Humpbacks (SPLASH) project

Documents that summarize information on humpback whales:

1. Alaska marine mammal stock assessments, 2010 (Allen and Angliss 2011)
2. Final recovery plan for the humpback whale (*Megaptera novaeangliae*) (NMFS 1991
3. SPLASH reports
4. Chukchi Offshore Monitoring In Drilling Area (COMIDA), multi-year broad scale aerial survey for marine mammals in Chukchi Sea planning area
5. Marine mammal monitoring in the Chukchi Sea

## ESA Listing History and Status

The humpback whale was listed as an endangered species under the Endangered Species Conservation Act (35 FR 8495, June 2, 1970). The species was then listed as endangered under the ESA in 1973. NMFS published a Final Recovery Plan for the Humpback Whale in 1991 (NMFS 1991b). No critical habitat has been designated for humpback whales

The IWC banned commercial hunting of humpbacks in the Pacific Ocean in 1965 (Perry et al. 1999b), although some illegal whaling continued (see discussion below). All stocks of humpbacks are classified as “Protected Stocks” by the IWC.

Since listing and the prohibition on commercial harvest, the Central and Western North Pacific humpback whale populations have increased substantially. The overall increasing trend for these populations is probably at least partially the result of protective legislation enacted in both the U.S. and Canada during the early 1970s, which resulted in reduced mortality at a time when the population was below carrying capacity. The need for a status review under the ESA was recognized during discussions at the SPLASH symposium in October 2009 (Calambokidis et al. 2009).

NMFS published a final rule that established regulations applicable in waters within 200 nmi of Alaska that made it unlawful for a person, subject to the jurisdiction of the U.S., to approach, by any means, within 100 yd (91.4 m) of a humpback whale (66 FR 29502, May 3, 2001). To prevent disturbance that could adversely affect humpback whales and to reduce threats from whale watching activities, NMFS also implemented a “slow, safe speed” requirement for vessels transiting near humpback whales. Exemptions to the rule were for1) commercial fishing vessels during the course of fishing operations; 2) vessels with limited maneuverability; and 3) State, local, and Federal vessels operating in the course of official duty.

## Population and Stock Structure

North Pacific humpback whales have been designated into three stocks based on aerial, vessel, and photo-identification surveys, as well as genetics (Allen and Angliss 2010):

1. California/Oregon/Washington and Mexico stock: population occurs winter/spring in coastal Central America and coastal Mexico, and summer/fall migrates along the coasts of California to southern British Columbia
2. Central North Pacific stock: population that occurs winter/spring in the Hawaiian Islands, and summer/fall migrates seasonally, primarily to northern British Columbia, Southeast Alaska, Prince William Sound, and the Bering Sea/Aleutian Islands
3. Western North Pacific stock: population that occurs in winter/spring off Asia and summer/fall migrates seasonally, primarily to Russia and the Bering Sea/Aleutian Islands

Allen and Angliss (2010) recently summarized that, in the North Pacific, humpback whales are currently found throughout their historic summer feeding range, including coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west through the Aleutian Islands to the Kamchatka Peninsula and the Sea of Okhotsk, and north of the Bering Strait.

Humpback whales are known to aggregate in three principal wintering locations in the North Pacific during the winter, including the Hawaiian Islands, Central America (waters from southern Mexico south along the Central America coast), and Asia (off the Ogasawara Islands, Ryukyu (Okinawa) Islands, Taiwan, the Philippines, and the Mariana Islands). In the Mexican Pacific, there are three main winter aggregations: 1) central portions of the Pacific coast by mainland Mexico; 2) southern end of Baja California Peninsula; and 3) Revillagigedo Archipelago (Urban and Aguayo 1987; Calambokidis et al. 2008).

Preliminary analyses of the genetic data from SPLASH shows a high degree of maternally directed fidelity to both breeding and feeding grounds. However, the relationship between seasonal habitats is complex. Calambokidis et al. (2008) reported the rate of interchange among these three principal wintering regions was relatively low. A few individuals were seen in different major regions in different years (Calambokidis et al. 2008). Within these three larger regions, the interchange was more complex and varied by regions.

NMFS believes the California/Oregon/Washington stock would not be affected by the proposed action. It is unlikely that whales from the Central North Pacific stock would be present in the northernmost Bering Sea near Bering Strait, or seasonally present within the southwestern Chukchi Sea.

In the Northern Hemisphere, peak densities on feeding grounds occur between June and August; and peak densities on wintering or breeding grounds occur in February and March (Rosenbaum and Collins 2004).

**Abundance and Trends**

The reliability of pre- and post-commercial exploitation and of current abundance estimates is uncertain. Based on whaling records (Perry et al. 1999b) Rice (1978b) estimated there were more than 15,000 humpback whales in the North Pacific prior to commercial exploitation. Johnson and Wolman (1984) and Rice (1978a) reported rough estimates at 1,200 and 1,000 whales , respectively, as the humpback whale population that survived in the North Pacific, after the humpback whale commercial whaling ceased in 1966. Recent abundance estimates are now available from the SPLASH project. The best estimate (Calambokidis et al. 2008) for humpback whales abundance (excluding calves) for all feeding and wintering areas in the North Pacific is 18,302 animals. This estimate, averaged the abundance estimate of 17,558 whales for wintering areas and 19,056 whales for feeding areas, represents "…a dramatic increase in abundance from other post whaling estimates for the overall North Pacific" (Calambokidis et al. 2009). This increase is consistent with an annual increase rate at 4.9 percent, since the last North Pacific estimates during 1991 to 1993.

**Migration, Distribution, and Habitat Use**
Humpback whales are found primarily in coastal and continental shelf waters, but are known to migrate through deep waters between tropical/sub-tropical breeding and calving habitats during the winter; and temperate/polar feeding habitats during the summer. Known breeding areas in the Pacific Ocean include Japan, Hawaiian Islands, Central America, Mexico, and Revillagigedo Archipelago. Humpback whales summer throughout the central and western Gulf of Alaska, including Prince William Sound, around Kodiak Island (including Shelikof Strait and the Barren Islands), and along the southern coastline of the Alaska Peninsula, as well as the California coast. It is believed that minimal feeding occurs in wintering grounds (Salden 1987).

<u>Beaufort Sea and Chukchi Sea</u>
Data collected during barge, boat, and aerial surveys since 2006 have documented humpback whales in both the Chukchi Sea and western Beaufort Sea Planning areas; although humpback whales were not observed during the COMIDA or BWASP surveys during 2006-2008 (Clarke et al. 2010).

In 2006, marine mammal observers reported one humpback whale in southern Chukchi Sea, outside the Chukchi Sea Planning Area (Patterson et al. 2007). During marine mammal observations conducted during barging operations, Hashagen et al. (2009) observed an adult humpback and calf on 1 August 2007, about 87 km east of Barrow in the Beaufort Sea. This pair approached the vessel to within 75 m (Hashagen et al. 2009) and was last observed swimming east. In 2007, gray whales were also observed farther east in the Beaufort Sea than usual and the sea surface temperatures in the Beaufort and Chukchi seas were about approximately $5^{o}$ C above normal (Steele et al. 2008). Hashagen et al. (2009) suggested that humpback and gray whales may have followed warm currents into the Beaufort Sea.

The MMS Biological Evaluation (2008) summarized that during the summer and early autumn in 2007 (until 16 October 2007), there were six humpback whale sightings in the eastern and southeastern Chukchi Sea (MMS unpublished data). Another sighting was made in the southern Chukchi Sea in 2007 (MMS unpublished data).

In their summary of Chukchi Sea vessel based monitoring during 2006-2008 seismic surveys, Haley et al. (2010) reported that: 1) no humpback whales were reported in 2006; 2) five whales were observed in 2007; and 3) one whale was observed in 2008. Clarke and Ferguson (2010) reported that one humpback whale was seen feeding “very near shore” on 25 July 2009 during COMIDA surveys in the Chukchi Sea. Thomas et al. (2010) did not report any humpback whale sightings during 2006-2008 sawtooth aerial surveys in the nearshore zone along the Alaskan Chukchi Sea coast.

There are references that indicate that both the historical and current summer feeding habitat for humpback whales included, and at least in some years currently include the southern portion, especially southwestern Chukchi Sea. Mizroch et al. (2009) cited Zenkovich, a Russian biologist who wrote that in the 1930s: “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.

NMFS (1991a; citing Nikulin 1946), summarized that the northern Bering Sea, Bering Strait, and southern Chukchi Sea along the Chukchi Peninsula, are the extreme northern range for humpback whales. The most recent stock assessment for the Western North Pacific stock (Allen and Angliss 2010) depicts the southwestern Chukchi Sea as part of the “approximate distribution” for humpback whales in the North Pacific.

Available information indicates that humpback whales present in the northern Chukchi and western Beaufort seas are recent. No humpback whale sightings were reported during aerial surveys of endangered whales in summer (July) and autumn (August, September, and October) during 1979-1987 in the northern Bering Sea (north of Saint Lawrence Island): Chukchi Sea, north of 66º N.; and east of the International Date Line, east of the Alaskan Beaufort Sea (157º 01’ W. east to 140º W.); and offshore to 72º N. (Ljungblad et al. 1988). They were observed during Beaufort Sea annual aerial surveys conducted in September and October, 1982-2008 (e.g., Clarke et al. 2010; Monnett and Treacy 2005; Moore et al. 2000; Treacy 2002). In addition, during a research cruise in which all marine mammals observed were recorded from 5 July to18 August 2003, in the Chukchi and Beaufort seas, no humpback whales were observed (Bengston and Cameron 2003). None were observed during 42 days of seismic acquisition by Statoil in 2010 and that survey occurred in the same action area as the proposed 2011 program (Blees et al. 2010).

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

- Humpback whales have been observed in recent years in the MMS Chukchi Sea Planning area and in the western Beaufort Sea, but remain uncommon.
- Humpback whales encountered in recent years in the Chukchi and Beaufort seas

most likely belong to Western North Pacific stock, but individual photo-identification and genetic data are needed to confirm stock origin.

- Continued arctic warming could result in changes in oceanographic conditions favorable to the distribution and abundance of humpback whale prey species, and the extended seasonal distribution and movements of humpback whales.

**Reproduction, Survival, and Non-Human Related Sources of Mortality**
Humpbacks give birth and presumably mate at their wintering ground. Calving in the Northern Hemisphere takes place during January and March (Johnson and Wolman 1984). Information about age at sexual maturity is uncertain (Perry et al. 1999b). While calving intervals vary substantially, most female humpback whales 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 et al. 1999b).

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

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

**Feeding**
Humpbacks tend to feed on summer grounds and not feed on winter grounds. However, some low latitude winter feeding has been observed and is considered opportunistic (Perry et al. 1999b). These whales engulf large volumes of water and then filter small crustaceans and fish through baleen plates. Humpbacks are relatively generalized in their feeding. In the Northern Hemisphere, known prey include: 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 et al. 1999b).

**Vocalizations and Hearing**
Humpbacks produce a wide variety of sounds and are a particularly vocal species. During the breeding season males sing long, complex songs, with frequencies in the 25 to 5000 Hz range and intensities as high as 181 dB (Payne 1970; Thompson et al 1986). Source levels average 155 dB, and range from 144 to 174 dB (Thompson et al. 1979). The songs appear to have an effective range of approximately 10 to 20 km (six to 12 mi). Animals in mating groups produce a variety of sounds (Silber 1986; Tyack 1981; Tyack and Whitehead 1983). Sounds are produced less frequently on the summer feeding grounds. Feeding groups produce distinctive sounds ranging from 20 Hz to 2 kHz, with median durations of 0.2 to 0.8 sec and source levels of 175 to 192 dB (Thompson et al. 1986). Social sounds (Payne 1978a, b) include non-song vocal signals and surface generated signals such as tail slapping

and breaching (Dunlop et al. 2009). Dunlop et al. (2009) summarized that humpback vocalizations probably transmit information such as the identity of the signaler (species and gender) social and behavioral context, signaler location and size, and selection criteria and social integration.

As is the case for all large baleen whales, direct information about the hearing abilities of humpback whales is not available. In a study on the mysticete auditory apparatus morphology, Ketten (1997) hypothesized that large mysticetes have acute infrasonic hearing. Southall et al. (2007) assigned humpback whales to the low frequency cetacean functional hearing group. This group has an estimated auditory bandwidth of 7 Hz to 22 kHz. However, Southall et al. (2007) also note the harmonics from some humpback signals extend above 24 kHz. As is the case for all mysticetes, they pointed out that direct data on humpback whale hearing sensitivity is not available; and  has been estimated based on behavioral responses to sounds at various frequencies, favored vocalization frequencies, body size, ambient noise levels at favored frequencies, and cochlear morphometry.

## III. ENVIRONMENTAL BASELINE

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

The following factors, other than the proposed action, have had or are having potential effects on all or some of these endangered species of whales:

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

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

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

**Historical Commercial Whaling**

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

**Subsistence Hunting**

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

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

Currently, Alaska Native hunters from 10 villages harvest bowhead whales for subsistence and cultural purposes under a quota authorized by the IWC. Chukotka Native whalers, from Russia, also are authorized to harvest bowhead whales under the same authorized quota. The population status is closely monitored and these activities are closely regulated. Strike limits are established by the IWC and set at a 5-year quota at 280 landings (NMFS 2008a). The sustained growth of the Western Arctic bowhead whale population indicates the subsistence harvest level has been sustainable. Because the quota for the hunt is tied to the population size and population parameters, it is unlikely this mortality method will contribute to a significant adverse effect on the population's recovery and long term viability.

There are adverse impacts from bowhead whale hunting, in addition to the death of animals that are successfully hunted and the serious injury to animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes: 1) disturbance to other whales, 2) changes whale behavior, and 3) sometimes temporarily effects habitat use, including migration paths. Modern subsistence hunting represents a noise source and disturbance to the whales. Whales near a struck whale could be disturbed by: 1) sound of the explosive used in the hunt; 2) boat motors; and 3) any sounds made by the injured whale. NMFS (2003a) pointed out that whales that are not struck or killed may be disturbed by noise associated with the approaching hunters, their vessels, and the sound of bombs detonating: "…the sound of one or more bombs detonations during a strike is audible for some distance. Acousticians, listening to bowhead whale calls as part of the census, report that calling rates drop after such a strike …" (NMFS 2003). We are not aware of data indicating how far hunting related sounds (ex., noise from vessels and/or bombs) can propagate in areas where hunting typically occurs; but it is likely to vary with environmental conditions. It is not known if whales issue an "alarm call" or a "distress call" after they or another whale, are struck.

NMFS (2003) reported that:

> . . . whales may act skittish" and wary after a bomb detonates, or may be displaced further offshore.[2] However, disturbances to migration as a result of a strike are temporary (George 1996), as evidenced when several whales may be landed at Barrow in a single day. There is some potential that migrating whales, particularly calves, could be forced into thicker offshore ice as they avoid these noise sources. The experience of Native hunters suggests that the whales would be more likely to temporarily halt their migrations, turn 180 degrees away…(i.e., move back through the lead systems), or become highly sensitized as they continue moving.[3]

Because evidence indicates that bowhead whales are long lived, some bowhead whales may have been in the area when hunting occurred on multiple, perhaps dozens or more,

[2] E. Brower. Personal communication.
[3] E. Brower. Personal communication.

occasions. Thus, some whales may have cumulative exposure to hunting activities. This form of noise and disturbance adds to noise and disturbance from other sources, such as shipping and oil and gas activities. To the extent such activities occur in habitats during whale migration, even if the activities (e.g., hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. However, we are not aware of information to indicate long term habitat avoidance with present activity levels. Additionally, if whales become more "skittish" and more highly sensitized following a hunt, it may be that their subsequent reactions, during the short term, to other forms of noise and disturbance are heightened by such activity. Data are not available that permit evaluation of this possible, speculative interaction.

**Commercial Fishing, Marine Vessel Traffic, and Research Activities**

Based on available data, previous incidental take of bowhead whales apparently has occurred only rarely. The bowhead whale associates with sea ice, and thus limits the fisheries activity that occurs in bowhead habitat. However, the frequency of such interactions would be expected to increase if commercial fishing activities expand northward. There is some uncertainty about whether such expansion will occur. Increases in spatial overlap alone could result in increased interactions between bowhead whales and derelict fishing gear. In a discussion on population climate warming impacts on bowhead whales at the meeting of the Subcommittee on Bowheads, Right Whales, and Gray Whales at the IWC's annual meeting, P. Wade (citing IWC 2005b) reported the commercial crab fishery extended further north (winter 2004-2005) than in previous years.

From 1989 to 1994, logbook data on bowhead whale incidental takes are available, but after that time, the requirement is for fishers to self report. Angliss and Lodge (2002) reported that ". . . the records are considered incomplete and estimates of mortality based on them represent minimums." There are no observer programs where bowhead whale mortality was reported incidental to commercial fisheries in Alaska (Angliss and Lodge 2002). New information on bowhead whale entanglements indicates that bowhead whales do have some interactions with crab pot gear. NMFS Alaska Region stranding reports documented three bowhead whale entanglements in 2001-2005. Angliss and Lodge (2008) reported on a preliminary result that reexamination of bowhead harvest records suggest there may be more than 20 cases (whales) that indicated entanglements or scarring attributable to ropes, in the harvest records. The average annual entanglement rate in U.S. commercial fisheries is currently unknown (Angliss and Lodge 2008).

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

Marine vessel traffic, in general, can pose a threat to bowhead whales because of the ship strike risk. Shipping and vessel traffic is expected to increase in the Arctic if warming temperatures continue. Additionally, noise associated with ships or other boats potentially could cause bowhead whales to alter their movement patterns or make other changes in habitat use. Pollution from marine vessel traffic, especially from large vessels such as large cruise ships, also could cause degradation of the marine environment and increase the risk of the whales' exposure to contaminants and disease vectors. The frequency of observations of vessel inflicted injuries suggests that the incidence of ship collisions with bowhead whales is low but may be increasing. Between 1976 and 1992, only three ship strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al. 1994). The low number of ship strike injuries observed suggests the bowhead whale: 1) does not often encounter vessels, or 2) avoid interactions with vessels, or 3) interactions usually result in the animals' death.

Increased vessel use for ice management associated with oil and gas exploration may present concerns for bowhead whales. During icebreaking, extremely variable increases in broadband (10-10,000 Hz) noise levels of 5-10 dB are caused by propeller cavitations. Richardson et al. (1995a) reported estimated source levels for icebreakers to range from 177-191 dB re 1 μPa-m. Based on previous bowhead whale studies in response to noise, such sound could result in temporary avoidance by animals from the areas where the icebreakers were operating; and potentially cause temporary deflection of the migration corridor, depending on the location of the icebreakers. Richardson et al. (1995) concluded that: "Ships and larger boats routinely use fathometers, and powerful side-looking sonar 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 sonar were used in commercial whaling after World War II and whaling boats sometimes tracked whales underwater using active sonar. Active sonar often caused strong avoidance by baleen whales (Richardson et al. 1995a, citing Ash 1962). 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 1) moved away from 3.3 kHz sonar pulses, 2) increased their swimming speed, and 3) swim-track linearity, in response to 3.1 to 3.6 kHz sonar sweeps. We have no information that active sonar is currently an issue within the action area.

Large research ships that are active in the bowhead whale range, when whales are present, have the potential to cause noise disturbance to the whales, potentially altering their movement patterns or other behavior. However, available evidence does not indicate such disturbance will have a significant effect on this population during the next year, which is the approximate life of the project; even when added to the effects of other effectors. The Western Arctic bowhead whale has been the focus of research activities that could, in some instances, cause minor temporary disturbance to the whales. During research on the whales themselves, the whales' reactions are generally closely monitored to minimize potential adverse effects. Additionally, research conducted primarily for reasons other than the bowhead whale studies have also occurred within the bowhead whale range. 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.

**Pollution and Contaminants**

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

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

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

Based on the autometallography (AMG) to localize inorganic mercury in kidney and liver tissues for five bowhead whales, Woshner et al. (2002) reported that "AMG granules were not evident in bowhead tissues, confirming nominal mercury (Hg) concentrations." Detected concentrations ranged from 0.011-0.038 micrograms per gram (µg/g) wet weight for total mercury. Mössner and Ballschmiter (1997) reported that total levels of 310 nanograms per gram (ng/g) polychlorinated biphenyls and chlorinated pesticides in bowhead blubber from the North Pacific and Arctic Ocean, an overall level many times lower than that of other species from the North Pacific or Arctic Ocean (i.e., beluga whales [2,226 ng/g]; northern fur seals [4,730 ng/g]); and North Atlantic pilot whales [6,997 ng/g];

North Atlantic common dolphin [39,131 ng/g]; and North Atlantic harbor seal [70,380 ng/g]). However, while total levels were low, the combined level from three isomers of the hexachlorocyclohexanes was higher in the bowhead blubber (160 ng/g) tested than in either the pilot whale (47 ng/g), common dolphin (130 ng/g), and harbor seal (140 ng/g). These results confirmed expected results, due to the lower trophic level of the bowhead whale relative to the other marine mammals tested.

In the Beaufort Sea EIS, MMS (2003) concluded that the metal levels and other contaminants measured in bowhead whales appear to be relatively low, with the exception of cadmium. Since the final multiple sale EIS (MMS 2003), additional information (included in the review presented above) on contaminants in Western Arctic bowhead whale is now available. This information supports this same general conclusion.

**Offshore Oil and Gas Related Activities and other Industrial Activities**
Offshore petroleum exploration, development, and production activities have been conducted in Alaska State waters or on the Alaska OCS in the Beaufort and Chukchi seas as a result of previous lease sales since 1979. Extensive 2D seismic surveying has occurred in both program areas. The MMS permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960's and early 1970's. Much more seismic activity has occurred in the Beaufort Sea OCS than in the Chukchi Sea OCS. The 2D marine seismic surveys in the Beaufort Sea began with two exploration geophysical permits issued in 1968 and four permits in 1969. Both over-ice (29 permits) and marine 2D (43 permits) seismic surveys were conducted in the 1970's. With one exception, all 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980's were 2D. In the Beaufort Sea, 23 MMS G&G permits were issued in 1982 (11 marine and 12 over-ice 2D surveys) and 24 MMS geological and geophysical permits were issued in 1983 (one 3D over-ice survey; 14 2D over-ice surveys; nine 2D marine surveys). The first 3D on-ice survey occurred in the Beaufort Sea OCS in 1983. In the 1990's, both 2D (two on-ice and 21 marine) and 3D (11 over-ice and seven marine ocean bottom cable) seismic surveys were conducted in the Beaufort Sea. The first marine 3D seismic survey in the Beaufort Sea OCS occurred in 1996.

Compared to the Beaufort Sea, there has been little oil and gas related activity in the Chukchi Sea. There is no existing OCS offshore development or production in the Chukchi Sea. OCS Lease Sale 193 (Chukchi Sea OCS planning area) was held on 6 February 2008. Sale 193 offered approximately 12 million acres for leasing, and bids were received for more than 1,100,000 acres. Five exploratory wells have been drilled in the Chukchi Sea from past lease sales, all using drillships. These wells were drilled between 1989 and 1991, inclusive. The last Chukchi Sea well was drilled in 1991 at the Diamond Prospect.

Many offshore activities also require ice management (icebreaking), helicopter traffic, fixed wing monitoring, other support vessels, and, in some cases standby barges.

Available information does not indicate that oil and gas related activities (or any recent activity) have had detectable long term adverse population level effects on the overall health, current status, or recovery of the Western Arctic population. Data indicate the

Western Arctic population has continued to increase during the timeframe that oil and gas activities occurred. There is no evidence of long term displacement from habitat. However, there are no long term oil and gas developments in the offshore within bowhead whale high use areas. Northstar Island (an oil production facility) is at the southern end of the migratory corridor and Endicott (a near shore oil facility) is within the barrier islands. 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 other activities, at least temporarily, displace whales farther offshore, especially if the operations are conducted in the main migration corridor. As noted in the section on effects, monitoring studies of seismic work indicated that fall migrating whales avoid an area with a radius about 20-30 km around a seismic vessel operating in nearshore waters, and that bowhead whale calling rates are negatively associated with proximity to active seismic vessels. We are not aware of data that indicate this avoidance lasts after the activity has ceased.

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

Data on past drilling in both federal and state waters is relatively complete, especially since 1990. Data on other activities, such as hunting activity, barge traffic, and shipping noise are incomplete. Thus, while it is clear there have been multiple noise and disturbance sources in the Beaufort Sea over the past 30 years, because of the incompleteness of data, even for the 1990s, for many types of activities, we cannot evaluate the totality of past effects on fin, humpback, or bowhead whales resulting from multiple noise and disturbance sources (e.g., 2D seismic in state and federal waters, drilling, ice management, high resolution acoustic surveys, vessel traffic, construction, geotechnical borehole drilling, aircraft surveys, and hunting).

**Climate Change**

There is now widespread consensus within the scientific community that atmospheric temperatures on earth are increasing (warming) and this will continue for at least the next several decades. There is also consensus within the scientific community that this warming trend will alter current weather patterns. The strongest warming is expected in the north, exceeding the estimate for mean global warming by a factor of three, due in part to the "ice-albedo feedback", whereby as the reflective areas of arctic ice and snow retreat, the earth absorbs more heat, accentuating the warming (NRC 2003). The proximate effects of climate change in the Arctic are being expressed as increased average winter and spring temperatures and changes in precipitation amount, timing, and type (Serreze et al. 2000). These changes in turn result in physical changes, such as reduced sea ice, increased coastal erosion, changes in hydrology, depth to permafrost, and carbon availability (ACIA 2005).

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

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

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

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

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

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

> 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 (McBeath and Shepro 2007).

The extent of winter sea ice, generally measured at the maximum in March, began changing in the late 1990s and has declined through 2009 (Comiso 2006; Stroeve et al. 2007; Francis and Hunter 2007; National Snow and Ice Data Center 2009). 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 in 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 six lowest maximum arctic sea ice extents since 1979 occurred 2004 to 2009 (National Snow and Ice Data Center 2009). The 2009 maximum extent was the fifth lowest maximum extent in the satellite record (National Snow and Ice Data Center 2009).

While changes in the reduction of summer sea ice extent are apparent, the cause(s) of such change are not fully established. The evidence suggests 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.

These changes are resulting, or are expected to result, in changes to the biological environment, causing shifts, expansion, or retraction of home range, changes in behavior, and changes in population parameters for plant and animal species. Much research in recent years has focused on the effects from naturally occurring or man induced global climate regime shifts; and the potential for these shifts to cause changes in habitat structure over large areas. Although many forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (ACIA 2005). Temperatures in the Arctic have risen faster than in other areas of the world as evidenced by glacial retreat and melting sea ice. Threats posed by the direct and indirect effects from global climatic change are or will be common to northern species. These threats will be most pronounced for ice obligate species such as the polar bear, walrus, and ringed seal.

However, not all arctic species are likely to be adversely influenced by global climate change. Conceptual models by Moore and Laidre (2006) suggested that, overall, reductions in sea ice cover should increase the Bering-Chukchi-Beaufort Sea bowhead whale prey availability. This theory may be substantiated by the steady increase in the Bering-Chukchi-Beaufort-Sea population during the nearly 20 years the sea ice reduced (Walsh 2008). Moore and Huntington (2008) anticipate that bowhead whales will alter migration routes and occupy new feeding areas in response to climate related environmental change. Sheldon et al. (2003) reported a high probability that bowhead whale abundance will increase under a warming global climate. NMFS National Marine Mammal Laboratory stated that data is insufficient to make reliably predict the effects of Arctic climate change on bowhead whales (Angliss and Outlaw 2008).

The recent observations of humpback whales in the Beaufort and Chukchi seas may indicate seasonal habitat expansion in response to receding sea ice or increases in prey availability, which these whales now exploit. Range expansions in response to habitat change are not uncommon among cetaceans. Gray whales in Alaska have shown pronounced change during the last several decades; overwintering at higher latitudes and occupying previously lesser used feeding areas in the Beaufort Sea. Concentrations of the rare North Pacific right whale were first observed in southeast Bering Sea in 1996 and have continued until recently, possible reflecting changes in zooplankton distribution due to large scale oceanographic change within the Bering Sea. Since humpback whales are not ice obligate or ice associated species, it is unknown how long this habitat will remain viable for the species. However, it is logical to assume these whales will continue to utilize these waters as long as the availability of prey remains.

## IV. EFFECTS OF THE ACTION

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

There is still uncertainty about the potential impacts from sound on marine mammals, on the factors that determine response and effects, and especially, on the long term cumulative consequences of increasing noise in the world's oceans from multiple sources (e.g., NRC 2003, 2005). The NRC (2005) Committee on Characterizing Biologically Significant Marine Mammal Behavior concluded that it is unknown how or in what cases marine mammal responses to anthropogenic sound rise to the levels of biologically significant effects. All this specificity greatly complicates the ability, in a given situation, to predict the impacts from sound on a species or on classes of individuals within a species. While there is some general information available, evaluation of the noise impacts on marine mammal species, particularly on cetaceans, is greatly hampered by a considerable uncertainty about their hearing capabilities and the range of sounds used by whales for different functions (Richardson et al. 1995a; Gordon et al. 1998; NRC 2003, 2005). This is particularly true for baleen whales. Very little is known about the actual hearing capabilities of large whales or the impacts from sound on them, especially physical effects. While research in this area is increasing, it is likely there will continue to be great uncertainty about physiological effects on baleen whales because of the difficulties in studying them. Baleen whale hearing has not been studied directly. There are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson et al. 1995a). Thus, predictions about probable impact on baleen whales generally are based on assumptions about their hearing rather than actual studies on their hearing (Richardson et al. 1995a; Gordon et al. 1998; Ketten 1998). Ketten (1998) summarized that vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz, but the frequency range in bowhead songs can approach 4,000 Hz (Richardson et al. 1995a). Most calls emitted by bowhead whales are in the frequency range of 50-400 Hz, with a few extending to 1,200 Hz. Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson et al. 1995a). Some or all baleen whales may hear infrasound, sounds at frequencies well below those detectable by humans. Functional models indicate that functional hearing of baleen whales extends to 20 Hz, with an upper range at 30 Hz. Even if the sensitive hearing range does not extend below 20-50 Hz, whales may hear strong infrasound at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasound at 5 Hz might be detected (Richardson et al. 1995a). Bowhead whales, as well as blue and fin whales, are predicted to hear at frequencies as low as 10-15 Hertz. McDonald et al. (1995) summarized that many baleen whales produce loud low frequency sounds underwater a significant part of the time. Thus, species that are likely to be impacted by low frequency sound include baleen whales such as bowhead, fin, and humpback whales.

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

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

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

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

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

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

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

Available evidence also indicates that behavioral reaction to sound, even within a species, may depend on the listener's gender and reproductive status, possibly age, and/or accumulated hearing damage, type of activity engaged in at the time, or, in some cases, group size. For example, reaction to sound may vary depending on whether females have calves accompanying them, and whether individuals are feeding or migrating. Response may be influenced by whether, how often, and in what context, the individual animal has heard the sound before. All of this specificity greatly complicates our ability, in a given situation, to predict the behavioral response of a species, or on classes of individuals within a species, to a given sound. Because of this, and following recommendations in McCauley et al. (2000) (discussed above), we attempt to take a conservative approach in our analyses and base conclusions about potential impacts on potential effects on the most sensitive members of a population. In addition, we evaluate the potential for effects on bowhead, fin, and humpback whales by making the implicit assumptions that sound may travel the maximums observed, rather than minimum distances; and that whales engaged in a particular activity may respond at the maximum, not the minimum, distances observed in studies to date. These assumptions overestimate potential effect in many cases. However, since at least some airgun arrays being used in the Chukchi Sea have greater total output than many of those in previous studies, we may also underestimate impact in some cases.

**Potential Exposure of Whales to Seismic Survey Activities**

Bowhead whales have documented use in portions of the Chukchi Sea evaluation areas for: spring and fall migration; feeding; calving; resting; and limited breeding. Most calving for this population probably occurs between the Bering Strait and Point Barrow. Bowhead whales have a demonstrated sensitivity to some noise and disturbance, including noise and disturbance from seismic surveys. Fin whales distribution in the action area appears very limited in the Chukchi Sea during summer months. Humpback whales are also likely to occur only seasonally, within the Chukchi Sea. Thus, both fin and humpback whales may occur in waters subject to seismic surveys and drilling activities.

Sound from these seismic sources is a potential source of disturbance to bowhead whales in and near areas where the surveys may occur. Seismic airguns are meant to produce low frequency noise, generally below 200 Hz. However, the impulsive nature of the collapse of the air bubbles inevitably results in broadband sound characteristics. Airgun arrays are designed to focus the sound energy downward. Despite this, sound pulses also are projected horizontally, with the distance traveled depending on many factors, such as those discussed by Richardson et al. (1995a) and McCauley et al. (2000). Airgun arrays produce short duration (transient) noise pulses with very high peak levels. The high peak level and impulsive nature of airguns have caused concern in the scientific and environmental communities. Bowhead whales emit tonal frequency modulated sounds at 50-400 Hz. A few calls have energy extending to 1,200 Hz. Bowhead whales also emit impulsive sounds in the frequency range of 25-3,500 Hz, as well as songs of about 20-500 Hz (Richardson et al. 1995a).

<u>Potential Effects of Airgun Sounds on Marine Mammals</u>

The effects of sounds from airgun pulses might include one or more of the following: 1) tolerance, 2) behavioral disturbance, 3) masking of natural sounds, 4) hearing impairment, 5) non-auditory physical effects, and 6) stranding and mortality. The effects of noise on marine mammals are highly variable, and can be categorized as follows:

1) Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. Numerous studies have also shown that marine mammals at distances more than a few kilometers from operating survey vessels often show no apparent response. That is often true even in cases when the pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to react behaviorally to airgun pulses under some conditions, at other times, mammals of all three types have shown no overt reactions. In general, pinnipeds and small odontocetes seem to be more tolerant of exposure to airgun pulses than baleen whales.

2) Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. These behavioral reactions are often shown as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (ex., socializing, feeding); visible startle response or aggressive behavior (ex., tail/fluke slapping, jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (ex., pinnipeds flushing into water from haul outs or rookeries).

The biological significance for many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, and/or reproduction. Significant behavioral modifications include:

- Drastic change in diving/surfacing patterns (ex., those thought to cause beaked whale strandings due to exposure to military mid-frequency tactical sonar)
- Habitat abandonment due to loss of desirable acoustic environment
- Cease feeding or social interaction

For example, at the Guerreo Negro Lagoon in Baja California, Mexico, which is one of the important breeding grounds for Pacific gray whales, shipping and dredging associated with a salt works may have induced gray whales to abandon the area through most of the 1960s (Bryant et al. 1984). After these activities stopped, the lagoon was reoccupied, first by single whales and later by cow-calf pairs.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Southall et al. 2007).

Currently NMFS uses 160 dB re 1 μPa at received level for impulse noises (such as airgun pulses) as the onset of marine mammal behavioral harassment.

3) Masking

Chronic exposure to excessive, though not high intensity, noise could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Since marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that experience severe acoustic masking will have reduced fitness in survival and reproduction.

Masking occurs when noise and signals (that the animal utilizes) overlap at both spectral and temporal scales. For the airgun noise generated from the proposed site clearance and shallow hazards surveys, noise will consist of low frequency (under 1 kHz) pulses with extremely short durations (in the scale of milliseconds). Lower frequency manmade noises are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. There is little concern regarding masking near the noise source due to the brief duration of these pulses and relatively longer silence between airgun shots (9-12 seconds). However, at long distances (more than tens of kilometers away), due to multipath propagation and reverberation, the durations of airgun pulses can be “stretched” to seconds with long decays (Madsen et al. 2006). Therefore it could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (Clark et al. 2009) and cause increased stress levels

(Foote et al. 2004; Holt et al. 2009). Nevertheless, the intensity of the noise is also greatly reduced at such long distances (ex., the modeled received level drops below 120 dB re 1 μPa rms at 14,900 m from the source).

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies, increasing call volume and vocalization rates. For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio and Clark 2010). The North Atlantic right whales (*Eubalaena glacialis*) exposed to high shipping noise increase call frequency (Parks et al. 2007), while some humpback whales respond to low frequency active sonar playbacks by increasing song length (Miller el al. 2000).

4) Hearing Impairment

Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002; 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is unrecoverable, or temporary (TTS), in which case the animal's hearing threshold will recover over time (Southall et al. 2007). Just like masking, marine mammals that suffer from PTS or TTS will have reduced fitness in survival and reproduction, either permanently or temporarily. Repeated noise exposure that leads to TTS could cause PTS. For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound.

Experiments on a bottlenose dolphin (*Tursiops truncates*) and beluga whale showed that exposure to a single water gun impulse at a received level of 207 kPa (or 30 psi) peak-to-peak (p-p), which is equivalent to 228 dB re 1 μPa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran et al. 2002). No TTS was observed in the bottlenose dolphin. Although the source level of pile driving from one hammer strike is expected to be much lower than the single water gun impulse cited here, animals being exposed for a prolonged period to repeated hammer strikes could receive more noise exposure in terms of SEL than from the single water gun impulse (estimated at 188 dB re 1 $\mu Pa^2$-s) in the aforementioned experiment (Finneran et al. 2002).

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are lower than those to which odontocetes are most sensitive, and natural ambient noise levels at those low frequencies tend to be higher (Urick 1983). As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales. However, no cases of TTS are expected given the small size of the airguns proposed to be used and the strong likelihood that baleen whales (especially migrating bowhead whales) would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS.

In pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak et al. 1999, 2005; Ketten et al. 2001). However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal, which is closely related to the ringed seal) may occur at a similar SEL as in odontocetes (Kastak et al. 2004).

NMFS (1995, 2000) concluded that cetaceans and pinnipeds should not be exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 µPa rms. The established 180- and 190-dB re 1 µPa rms criteria are not considered to be the levels above which TTS might occur. Rather, they are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As summarized above, data that are now available imply that TTS is unlikely to occur unless bow riding odontocetes are exposed to airgun pulses much stronger than 180 dB re 1 µPa rms (Southall et al. 2007).

No cases of TTS are expected as a result of Statoil's proposed activities given the small size of the source, the strong likelihood that baleen whales (especially migrating bowhead whales) would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS, and the mitigation measures proposed to be implemented during the survey described later in this document.

There is no empirical evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns (see Southall et al. 2007). However, given the possibility that mammals close to an airgun array might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage in terrestrial mammals. Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals. That is, PTS might occur at a received sound level magnitudes higher than the level of onset TTS, or by repeated exposure to the levels that cause TTS. Therefore, by means of preventing the onset of TTS, it is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during the proposed marine surveys in the Chukchi Sea.

5) Non-auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include stress, neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns, and beaked whales do not occur in the proposed project area. In addition, marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur non-auditory impairment or other physical effects. The small airgun array proposed to be used by Statoil would only have 190 and 180 dB distances of 35 and 125 m (115 and 410 ft.), respectively.

Therefore, it is unlikely that such effects would occur during Statoil's proposed surveys given the brief duration of exposure and the planned monitoring and mitigation measures described later in this document.

6) Stranding and Mortality

Marine mammals close to underwater detonations of high explosive can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten et al. 1993; Ketten 1995). Airgun pulses are less energetic and their peak amplitudes have slower rise times. To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays.

It should be noted that strandings related to sound exposure have not been recorded for marine mammal species in the Beaufort and Chukchi seas. NMFS notes that in the Beaufort Sea, aerial surveys have been conducted by BOEMRE (formerly the Minerals Management Service or MMS) and industry during periods of industrial activity (and by MMS during times with no activity). No strandings or marine mammals in distress have been observed during these surveys and none have been reported by North Slope Borough inhabitants. As a result, NMFS does not expect any marine mammals will incur serious injury or mortality in the Arctic Ocean or strand as a result of the proposed shallow hazards survey.

Potential Effects from Active Sonar Equipment on Marine Mammals

Several active acoustic sources other than the four 10 $in^3$ airgun have been proposed for Statoil's 2011 open water shallow hazards survey in the Chukchi Sea. The specifications of this sonar equipment (source levels and frequency ranges) are provided above. In general, the potential effects of this equipment on marine mammals are similar to those from the airgun, except the magnitude of the impacts is expected to be much less due to the lower intensity and higher frequencies. Estimated source levels from sonar equipment are discussed above. In some cases, due to the fact that the operating frequencies of some of this equipment (e.g., Multi-beam echo sounder: frequency at 200-400 kHz) are above the hearing ranges of marine mammals, they are not expected to have any impacts to marine mammals.

Vessel Sounds

In addition to the noise generated from seismic airguns and active sonar systems, various types of vessels will be used in the operations, including source vessel and vessel used for geotechnical soil investigations. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002; 2005; 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90 day and comprehensive reports since 2007 (e.g., Aerts et al. 2008; Hauser et al. 2008; Brueggeman 2009; Ireland et al. 2009; O'Neill and McCrodan 2011; Chorney et al. 2011). For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB at distances ranging from approximately 1.5 to 2.3 mi (2.4 to 3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater SPLs from the seismic vessel Gilavar of 120 dB at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB at 85 ft. (26 m) from the vessel. Compared to airgun pulses, underwater sound from vessels is generally at relatively low frequencies. However, noise from the vessel during geophysical soil investigation while operating the DP system using thrusters as well as the primary propeller(s) could produce noise levels higher than during normal operation of the vessel. Measurements of a vessel in DP mode with an active bow thruster were made in the Chukchi Sea in 2010 (Chorney et al. 2011). The resulting source level estimate was 175.9 $dB_{rms}$ re 1 μPa-m. Noise at this high level is not expected to be emitted continuously. It is emitted intermittently as the pitch is engaged to position the vessel.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Source levels from various vessels would be empirically measured before the start of marine surveys, and during geotechnical soil investigation while operating the DP system.

Anticipated Effects on Habitat

The primary potential impacts to marine mammals and other marine species are associated with elevated sound levels produced by airguns and other active acoustic sources. However, other potential impacts to the surrounding habitat from physical disturbance are also possible.

Potential Impacts on Prey Species

With regard to fish as a prey source for cetaceans and pinnipeds, fish are known to hear and react to sounds and to use sound to communicate (Tavolga et al. 1981) and possibly avoid predators (Wilson and Dill 2002). Experiments have shown that fish can sense both the strength and direction of sound (Hawkins 1981). Primary factors determining whether a fish can sense a sound signal, and potentially react to it, are the frequency of the signal and the strength of the signal in relation to the natural background noise level.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas et al. 1993). In general, fish react more strongly to pulses of sound rather than a continuous signal (Blaxter et al. 1981), and a quicker alarm response is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level.

Investigations of fish behavior in relation to vessel noise (Olsen et al. 1983; Ona 1988; Ona and Godo 1990) have shown that fish react when the sound from the engines and propeller exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels are 110 dB to 130 dB (Nakken 1992; Olsen 1979; Ona and Godo 1990; Ona and Toresen 1988). However, other researchers have found that fish such as polar cod, herring, and capelin are often attracted to vessels (apparently by the noise) and swim toward the vessel (Rostad et al. 2006). Typical sound source levels of vessel noise in the audible range for fish are 150 dB to 170 dB (Richardson et al. 1995).

Some mysticetes, including bowhead whales, feed on concentrations of zooplankton. Some feeding bowhead whales may occur in the Alaskan Beaufort Sea in July and August, and others feed intermittently during their westward migration in September and October (Richardson and Thomson 2002; Lowry et al. 2004). However, by the time most bowhead whales reach the Chukchi Sea (October), they will likely no longer be feeding, or if it occurs it will be very limited. A reaction by zooplankton to a seismic impulse would only be relevant to whales if it caused concentrations of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the source. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding mysticetes. Thus, the proposed activity is not expected to have any habitat related effects that could cause significant or long term consequences for individual marine mammals or their populations.

**Summary of Potential Effects of Noise and Disturbance Sources**

Available information indicates that baleen whales, and bowhead whales in particular, are responsive (in some cases highly responsive) to anthropogenic noise in their environment. At present, the primary response that has been documented is avoidance, sometimes at considerable distance. Response is variable, even to a particular noise source and the reasons for this variability are not fully understood.

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

The proposed seismic exploration could result in considerable increase in noise and disturbance in the summer and autumn range of the Western Arctic bowhead whales, and to summering fin and humpback whales. Exposure to seismic noise from Statoil in the Chukchi Sea could expose large numbers of bowhead whales, although the majority of this work may be completed prior to the main fall migration if they encounter few delays. It is unclear whether noise from the Statoil project would propagate to important feeding areas north and northeast of Barrow, or what the reaction of any whales in this area might be. However, as these areas are generally more than 125 miles from the Statoil work, the received sound levels at these distances should be low, and feeding whales have shown some tendency to show less displacement than migrating whales on exposure to seismic noise, we do not believe there is high probability for whales to abandon such habitat.

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

Overall, bowhead, fin, and humpback whales exposed to these surveys most likely would experience temporary, nonlethal effects. Data are sufficient to conclude that response to seismic noise is likely to vary with time of year; sex and reproductive status of individuals exposed; site (because of differences in noise propagation and use by bowhead whales); activity and the exact characteristics of that activity (e.g., seismic source, airgun array and configuration, etc.); the animal's motivation to be in an area; and options for alternative routes, places to feed, etc. While habituation is seen in some species, and behavioral studies have suggested that bowhead whales habituate to noise from distant, ongoing drilling or seismic operations, localized avoidance still occurred. Bowhead whales may be less likely to habituate to at least certain types of noise than fin or humpback whales because they are hunted annually, and thus, many individuals may have a strong negative association with human noise.

Available information does not indicate any long term adverse effects on the Western Arctic stock from the high level of seismic surveys and exploration drilling during the 1980's in the Beaufort and Chukchi seas. While any sub lethal impacts on health (such as reduced hearing or increased stress) could not be detected in this population through existing research, the rate of this population's increase in abundance does not indicate any sub lethal effects (if they occurred) resulted in an effect on this population's recovery. There has been no documented evidence that noise from previous OCS operations has served as a barrier to migration. Because whales respond behaviorally to loud noise, they are less likely to suffer hearing loss from increased noise. However, whales appear to be more tolerant of noise when feeding, and future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise, including the potential for increased noise to cause physiological stress responses.

Concentrations of loud noise and disturbance activities during the open water period have the potential to cause large numbers of bowhead whales to avoid using areas for resting and feeding for long periods of time (days to months) while the noise producing activities continue. Because recent data are not sufficient to evaluate current habitat use by season or area in the Chukchi Sea by bowhead, humpback, or fin whales, we cannot fully estimate the consequence of industrial noise on these species.

**Project Specific Considerations**

Proposed Mitigation

In order to issue an incidental take authorization under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses.

For the proposed Statoil open water shallow hazards survey in the Chukchi Sea, Statoil worked with NMFS and proposed the following mitigation measures to minimize the potential impacts to marine mammals in the project vicinity as a result of the shallow hazards survey activities.

As part of the application, Statoil submitted to NMFS a Marine Mammal Monitoring and Mitigation Program (4MP) for its open water shallow hazards survey in the Chukchi Sea during the 2011 open water season. The objectives of the 4MP are:

- to ensure that disturbance to marine mammals and subsistence hunts is minimized and all permit stipulations are followed
- to document the effects of the proposed survey activities on marine mammals
- to collect baseline data on the occurrence and distribution of marine mammals in the study area.

The 4MP may be modified or supplemented based on comments or new information received from the public during the public comment period or from the peer review panel (refer to “Monitoring Plan Peer Review” section later in this document).

Mitigation Measures Proposed in Statoil’s IHA Application

For the proposed mitigation measures, Statoil listed the following protocols to be implemented during its shallow hazards survey in the Chukchi Sea.

1) Sound Source Measurements

As described above, previous measurements of similar airgun arrays in the Chukchi Sea were used to model the distances at which received levels are likely to fall below 120, 160, 180, and 190 dB re 1 μPa (rms) from the planned airgun sources. These modeled distances will be used as temporary safety radii until measurements of the airgun sound source are conducted. The measurements will be made at the beginning of the field season and the measured radii used for the remainder of the survey period.

The objectives of the sound source verification measurements planned for 2011 in the Chukchi Sea will be to measure the distances at which broadband received levels reach 190, 180, 170, 160, and 120 $dB_{rms}$ re 1 μPa for the airgun configurations that may be used during the survey activities. The configurations will include at least the full array (4×10 $in^3$) and the operation of a single 10 $in^3$ airgun that will be used during power downs or very shallow penetration surveys. The measurements of airgun sounds will be made by an acoustics contractor at the beginning of the survey. The distances to the various radii will be reported as soon as possible after recovery of the equipment. The primary radii of concern will be the 190 and 180 dB safety radii for pinnipeds and cetaceans, respectively, and the 160 dB disturbance radii. In addition to reporting the radii of specific regulatory concern, nominal distances to other sound isopleths down to 120 $dB_{rms}$ will be reported in increments of 10 dB. Sound levels during soil investigation operations will also be measured. However, source levels are not expected to be strong enough to require mitigation actions at the 190 dB or 180 dB levels.

Data will be previewed in the field immediately after download from the hydrophone instruments. An initial sound source analysis will be supplied to NMFS and the vessel within 120 hours of completion of the measurements, if possible. The report will indicate the distances to sound levels based on fits of empirical transmission loss formulae to data in the end fire and broadside directions. A more detailed report will be issued to NMFS as part of the 90 day report following completion of the acoustic program.

2) Safety and Disturbance Zones

Under current NMFS guidelines, "safety radii" for marine mammal exposure to impulse sources are customarily defined as the distances within which received sound levels are ≥180 $dB_{rms}$ re 1 μPa for cetaceans and ≥190 $dB_{rms}$ re 1 μPa for pinnipeds. These safety criteria are based on an assumption that SPL received at levels lower than these will not injure these animals or impair their hearing abilities, but that at higher levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the safety radii (Richardson et al. 1995).

Initial safety and disturbance radii for the sound levels produced by the planned airgun configurations have been estimated (Table 1). These radii will be used for mitigation purposes until results of direct measurements are available early during the exploration activities. The proposed surveys will use an airgun source composed of four 10 $in^3$ airguns (total discharge volume of 40 $in^3$) and a single 10 $in^3$ airgun. Underwater sound propagation from a similar 4×10 $in^3$ airgun cluster and single 10 $in^3$ was measured in

2009 (Reiser et al. 2010). Those measurements resulted in 90th percentile propagation loss equations of RL = 218.0 - 17.5LogR - 0.00061R for the 4×10 $in^3$ airgun cluster and RL = 204.4 - 16.0LogR - 0.00082R for the single 10 $in^3$ airgun (where RL = received level and R = range). The estimated distances for the proposed 2011 activities are based on a 25% increase over 2009 results (Table 1).

In addition to the site surveys, Statoil plans to use a dedicated vessel to conduct geotechnical soil investigations. Sounds produced by the vessel and soil investigation equipment are not expected to be above 180 dB (rms). Therefore, mitigation related to acoustic impacts from these activities is not expected to be necessary.

An acoustics contractor will perform direct measurements of the received levels of underwater sound versus distance and direction from the airguns and soil investigation vessel using calibrated hydrophones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify and adjust the safety distances. The field report will be made available to NMFS and the MMOs within 120 hrs. of completing the measurements. The mitigation measures to be implemented at the 190 and 180 dB sound levels will include power downs and shut downs as described below.

Table 1. Distances to specified received levels measured from a 4×10 $in^3$ airgun cluster and a single 10 $in^3$ airgun on the Burger prospect in 2009 as reported by Reiser et al. (2010). The 2011 "Pre-SSV" distances are a precautionary 25 percent increase above the reported 2009 results and will be used by MMOs for mitigation purposes until an SSV is completed in 2011.

| **Received Levels (dB re 1 μPa rms)** | **Distance (m)** | | | |
|---|---|---|---|---|
| | **Airgun Cluster (4 x 10 $in^3$)** | | **Single Airgun (1 x 10 $in^3$)** | |
| | **2009 Results** | **2011 pre-SSV** | **2009 Results** | **2011 pre-SSV** |
| 190 | 39 | 50 | 8 | 10 |
| 180 | 150 | 190 | 34 | 45 |
| 160 | 1,800 | 2,250 | 570 | 715 |
| 120 | 31,000 | 39,000 | 19,000 | 24,000 |

3) Speed and Course Alterations

If a marine mammal is detected outside the applicable safety radius and, based on its position and the relative motion, is likely to enter the safety radius, changes of the vessel's speed and/or direct course will be considered if this does not compromise operational safety. For marine seismic surveys using large streamer arrays, course alterations are not typically possible. However, for the smaller airgun array and streamer planned during the proposed site surveys, such changes may be possible. After any such speed and/or course alteration is begun, the marine mammal activities and movements relative to the survey vessel will be closely monitored to ensure that the marine mammal does not approach within the safety radius. If the mammal appears likely to enter the safety radius, further mitigative actions will be taken, including a power down or shut down of the airgun(s).

4) Power Downs

A power down for immediate mitigation purposes is the immediate reduction in the number of operating airguns such that the radii of the 190 $dB_{rms}$ and 180 $dB_{rms}$ zones are decreased to the extent that an observed marine mammal(s) are not in the applicable safety zone of the full array. Power downs are also used while the vessel turns from the end of one survey line to the start of the next. During a power down, one airgun (or some other number of airguns less than the full airgun array) continues firing. The continued operation of one airgun is intended to (a) alert marine mammals to the presence of the survey vessel in the area, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.

The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full array, but is outside the applicable safety zone of the single mitigation airgun. Likewise, if a mammal is already within the safety zone when first detected, the airguns will be powered down immediately. If a marine mammal is sighted within or about to enter the applicable safety zone of the single mitigation airgun, it too will be shut down (see following section).

Following a power down, operation of the full airgun array will not resume until the marine mammal has cleared the safety zone. The animal will be considered to have cleared the safety zone if it

- is visually observed to have left the safety zone of the full array, or
- has not been seen within the zone for 15 min in the case of pinnipeds or small odontocetes, or
- has not been seen within the zone for 30 min in the case of mysticetes or large odontocetes.

5) Shut Downs

The operating airgun(s) will be shut down completely if a marine mammal approaches or enters the then applicable safety radius and a power down is not practical or adequate to reduce exposure to less than 190 or 180 $dB_{rms}$, as appropriate. In most cases, this means the mitigation airgun will be shut down completely if a marine mammal approaches or enters the estimated safety radius around the single 10 $in^3$ airgun while it is operating during a power down. Airgun activity will not resume until the marine mammal has cleared the safety radius. The animal will be considered to have cleared the safety radius as described above under power down procedures.

A shut down of the borehole drilling equipment may be requested by MMOs if an animal is sighted approaching the vessel close enough to potentially interact with and be harmed by the soil investigation operation.

6) Ramp Ups

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step wise increase in the number and total volume of airguns firing until the full volume is achieved. The purpose of a ramp up (or “soft start”) is to “warn” cetaceans and pinnipeds in the vicinity of the airguns and to provide the time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed site survey program, the seismic operator will ramp up the airgun cluster slowly. Full ramp ups (i.e., from a cold start after a shutdown, when no airguns have been firing) will begin by firing a single airgun in the array. The minimum duration of a shutdown period, i.e., without air guns firing, which must be followed by a ramp up is typically the amount of time it would take the source vessel to cover the 180dB safety radius. Given the small size of the planned airgun array, it is estimated that period to be about 1-2 minutes based on the modeling results described above and a survey speed of 4 kts.

A full ramp up, after a shutdown, will not begin until there has been a minimum of 30 minutes of observation of the safety zone by MMOs to assure that no marine mammals are present. The entire safety zone must be visible during the 30 minute lead to a full ramp up. If the entire safety zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30 minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the safety zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes and pinnipeds, or 30 minutes for baleen whales and large odontocetes.

During turns or brief transits between survey transects, one airgun will continue operating. The ramp up procedure will still be followed when increasing the source levels from one airgun to the full four airgun cluster. However, keeping one airgun firing will avoid the prohibition of a cold start during darkness or other periods of poor visibility. Through use of this approach, survey operations can resume upon entry to a new transect without the 30minute watch period of the full safety radius required for a cold start. MMOs will be on duty whenever the airguns are firing during daylight, and during the 30 min periods prior to ramp ups as well as during ramp ups. Daylight will occur for 24 h/day until mid-August, so until that date MMOs will automatically be observing during the 30 minute period preceding a ramp up. Later in the season, MMOs will be called to duty at night to observe prior to and during any ramp ups. The survey operator and MMOs will maintain records of the times when ramp ups start, and when the airgun arrays reach full power.

Additional Mitigation Measures Proposed by NMFS

Besides Statoil's proposed mitigation measures discussed above, NMFS proposes the following additional protective measures to address some uncertainties regarding the impacts of bowhead cow-calf pairs and aggregations of whales from shallow hazards surveys. Specifically, NMFS proposes that

1) A 160 dB vessel monitoring zone for large whales will be established and monitored in the Chukchi Sea during all shallow hazards surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a non-migratory, significant biological behavior (e.g., feeding, socializing)) are observed during a vessel monitoring program within

the 160 dB safety zone around the survey operations, the survey activity will not commence or will shut down, until they are no longer present within the 160 dB safety zone of shallow hazards surveying operations.

2) Furthermore, NMFS proposes the following measures be included in the IHA, if issued, in order to ensure the least practicable impact on the affected species or stocks:
    a. All vessels should reduce speed when within 300 yards (274 m) of whales, and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group
    b. Avoid multiple changes in direction and speed when within 300 yards (274 m) of whales
    c. When weather conditions require, such as when visibility drops, support vessels must adjust speed (increase or decrease) and direction accordingly to avoid the likelihood of injury to whales.

Mitigation Conclusions

NMFS has carefully evaluated the applicant's proposed mitigation measures and considered a range of other measures in the context of ensuring that NMFS prescribes the means of affecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another:

1) the manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals
2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned
3) the practicability of the measure for applicant implementation.

## V. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 (Interagency Cooperation on the ESA of 1973, as amended): "…those effects of future State or private activities not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation." Reasonable foreseeable future federal actions and potential future Federal actions that are unrelated to the proposed action are not considered in the analysis of cumulative effects because they would require separate consultation pursuant to section 7 of the ESA. Cumulative effects are usually viewed as those effects that impact the existing environment and remain to become part of the environment. These effects differ from those that may be attributed to past and ongoing actions within the area since they are considered part of the environmental baseline. Additionally, most structures and major activities within the Chukchi Sea OCS require Federal authorizations from one or more agencies, such as the BOEMRE, Army Corps of Engineers, and the Environmental Protection Agency. Such projects must consult under the ESA on their effects to the bowhead whale, and are therefore not addressed here as cumulative impacts.

The State of Alaska is currently leasing State owned portions of the Beaufort Sea for oil and gas exploration and production. No sales have occurred nor are planned for the Chukchi Sea by the State

State oil and gas activities in the Beaufort Sea would require some equipment and supplies to be transported to the site by barge or sealift should development and production plans proceed. The process modules and permanent living quarters and other equipment and supplies likely would be transported to these sites on seagoing barges during the open water season. Barge traffic through the Chukchi Sea and around Point Barrow is likely to be limited to a short period from mid-August through mid-to-late September and should be completed before the bowhead whales migrate into the Chukchi Sea.

Oil spill probabilities associated with exploration are extremely low. As this activity does not include drilling, any spill probabilities are those associated with operaion of the vessels. In the event an oil spill occurred on State leases during the fall bowhead migration, the effects of an oil spill on bowhead whales would be as have been described earlier in this document. These effects include inhalation of hydrocarbon vapors, a loss of prey organisms, ingestion of spilled oil or oil contaminated prey, baleen fouling with a reduction in feeding efficiency, and skin and/or sensory organ damage. These effects would be most pronounced whenever whales were confined to an area of freshly spilled oil. Of course, if the spill occurred over a prolonged period of time, more individuals could be contacted. Some individuals could be killed as a result of prolonged contact with freshly spilled oil, particularly if spills were to occur within ice lead systems. While oil spills are not considered a direct or indirect effect of the proposed action, they are accounted for here as potential cumulative impacts. A comprehensive discussion of the effects of oil spills on these listed whales may be found in NMFS's 2008 Biological Opinion for Federal oil and gas leasing and exploration by the Minerals Management Service (MMS) within the Alaskan Beaufort and Chukchi Seas (NMFS 2008).

Activities that are not oil and gas related also affect bowhead whales. Between 1976 and 1992, only three ship strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al. 1994). The low number of observed ship strike injuries suggests that bowhead whales either do not often encounter vessels or they avoid interactions with vessels, or that interactions usually result in the death of the animals. However, there is recent evidence that interaction of bowhead whales with ships and fishing gear may be increasing.

Subsistence harvest by Alaska Natives is another non-OCS activity that affects the bowhead whale. Bowhead whales are taken in the northern Bering Sea and in the Chukchi Sea on their spring migration and in the Beaufort Sea on their fall migration. Barrow whalers harvest whales during both the spring and the fall migrations. Requests to harvest bowhead whales also have been made by Canadian and Russian Natives. The Canadian Government granted permission in 1991 to kill one bowhead whale, and a bowhead was harvested in Mackenzie Bay in the fall of 1991. Additional permits were granted in 1993 and 1994, but no bowhead whales were harvested in either year. There has been a renewed interest by villages along the Russian Chukchi Sea coast to hunt bowhead whales. At the

1997 IWC, the Commission approved a combined quota allowing an average of 56 bowhead whales to be landed each year to meet the needs of Eskimos in Alaska and Chukotka Natives of the Russian Far East. The annual number of bowhead whales landed by Alaskan Natives has ranged from 8 in 1982 to 55 in 2005 (USDOC 2008). Struck-but-lost figures have been between five in 1999 to 82 in 1977.

There currently is a 5-year block quota of 280 bowhead whales landed, authorized by the IWC for 2008-2012. The number of bowhead whales struck in each year may not exceed 67, except that any unused portion of a strike quota from any year may be carried forward. No more than 15 strikes may be added to the strike quota for any one year. This level of harvest was approved by the IWC under the supposition that it still would allow for continued growth in the bowhead population. It is likely the bowhead whale population will continue to be monitored and that harvest quota will be set accordingly to maintain a healthy bowhead population level.

The cumulative effects of noise on bowhead whales from offshore oil and gas activities would be similar to that described and summarized for OCS leasing and exploration. The effects from an encounter with aircraft generally are brief, and the whales should resume their normal activities within minutes. Bowhead whales may exhibit temporary avoidance behavior to vessels at a distance of 1-4 kilometers. Fleeing from a vessel generally stopped within minutes after the vessel passed, but scattering may persist for a longer period. Bowhead whales also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Bowhead whales appear to recover from these behavioral changes within 30-60 minutes following the end of seismic activity. However, recent monitoring studies indicate that bowhead whales during the fall migration avoid an area around a seismic vessel operating in nearshore waters by a radius of about 20 kilometers. Avoidance did not persist beyond 12 hours after the end of seismic operations. This work also stated that bowhead whales may begin to deflect around a seismic source at distances up to 35 kilometers.

Overall, bowhead whales exposed to noise producing activities most likely would experience temporary, nonlethal effects. Some avoidance behavior could persist up to 12 hours.

## VI. SYNTHESIS and CONCLUSIONS

This biological opinion has considered the effects of authorizing small takes of endangered marine mammals under the MMPA for certain oil and gas exploration activities in the U.S. Chukchi Sea for the year 2011 on bowhead, fin, and humpback whales. These actions are likely to adversely affect these whales due to vessel operations, noise from marine geophysical (seismic) exploration, and aircraft traffic.

The applicants for the activities considered in this biological opinion estimate the average number of individual bowhead whales exposed to received sound levels ≥ 160 dB is 11 whales and the average estimate of the number of individual bowhead whales exposed to received sound levels ≥ 120 dB is 15 whales; with much fewer numbers of fin and humpback whales. The majority of these takes are likely to be by harassment due to acoustic exposure to seismic, vessel, and drilling noise. A number of whales may be exposed to seismic noise exceeding 180 dB. These levels are believed to be capable of damaging hearing in whales by creating permanent threshold shifts. The numbers of whales expected to be so exposed is very small, and should be mitigated to some extent by the likelihood the period of exposure would be brief, owing to the movement of both the whale and the seismic vessel. No lethal takes are expected. These estimates were derived through density estimates from various sources that may not reflect the actual numbers of whales in these particular areas, sound propagation figures which are derived from models that may differ from actual conditions, and an assumed "take" received sound level of 160 dB, which may be higher or lower than the actual levels that elicit biologically significant response from the whales. However, the estimates appear reasonable in view of industry reported data for Artic seismic, and are consistent with monitoring results from Statoil's 2010 2D and 3D seismic program, which occurred within this action area. In acquiring over 6,600 miles of trackline between August 20 and October 1, no cetaceans were observed within the 180 dB isolpeth, and 18 cetaceans were estimated to have been potentially exposed to sounds at or above 160 dB, based on cetaceans that would have been exposed had they not shown localized avoidance of the source vessel (Blees et al. 2010). Of these, nine would have been bowhead whales based on the percentage of occurrence for that species.

As discussed earlier, there is concern that received levels below 160dB are detectable by whales and may cause some behavioral reaction. The numbers of animals so effected cannot be determined or estimated, depending on many factors including the specific sound propagation characteristics of the area and the age and sex of the receiving whales. The degree to which whales exposed to these lower received sound levels may react is not known, and will vary with age, sex, and behavior. While there is concern for whales abandoning feeding areas when exposed to seismic noise, it appears that most reaction by whales to seismic disturbance persists only for 12-24 hours, after which time whales would resume their pre-exposure behavior. We note, however, this is an area requiring further study.

Elevated noise levels in the marine environment could alter the hearing ability of whales, causing temporary or permanent threshold shifts. However, information suggests most continuous and impulsive underwater noise levels would be at levels or durations below those expected to injure hearing mechanisms. Nonetheless, marine seismic activities present concerns with respect to hearing, and should be closely conditioned and monitored to avoid these effects. Noise has also been shown to cause avoidance in migrating gray and bowhead whales. Available data do not indicate that noise and disturbance from oil and gas exploration and development activities since the mid-1970s had lasting population level adverse effects on bowhead whales. Data indicate that bowhead whales are robust, increasing in abundance, and have been approaching (or have reached) the lower limit of their historic population size at the same time that oil and gas exploration activities have been occurring in the Beaufort Sea and, to a lesser extent, the Chukchi Sea.

Research on the effects of offshore seismic exploration in the Beaufort Sea, supported by the testimony of Inupiat hunters based on their own experience, has shown bowhead whales avoid these operations when within 20 km of the source and may begin to deflect at distances up to 35 km (Richardson 1999a). Similarly, current data do not fully identify the importance of the Chukchi Sea to bowhead, fin, and humpback whales (it is known to be important as a migrational corridor for bowhead whales). Concern is warranted over the distribution in time and space of several noise producing activities. While the activities considered in this opinion will produce in water noise that will be detectable by endangered whales, there is little physical or acoustic overlap between them owing to the physical location of the activity, the timing of the activity, the relative operational frequency and energy of the devices, or all three. Also, most of the BCB bowhead whales will be east of the action area for much of the operational time of these activities, although the activities would occupy the time frames of at least part of the fall migration.

Similar seismic operations have occurred in the Beaufort and Chukchi seas throughout the last several decades. NMFS has issued MMPA small take authorizations for many of these programs and has required monitoring, which in some cases has employed acoustic arrays to detect whale vocalizations/ locations in addition to the observations of ship based observers and aerial monitors. Thus, our consideration of these seismic operations is somewhat unique in that we have data and observations from past actions that are very similar to the proposed work. The monitoring from these efforts indicates varied responses among whales (the large majority of observations have been on bowhead whales), with migrating whales being more responsive to noise and feeding whales less so. Whale calling rates decline in the presence of seismic sounds, and all but a very few whales show localized avoidance of the area near the source vessel. To our knowledge, no whales or other marine mammals have been killed or injured by these past seismic operations, and the BCB population of bowhead whales continues to increase at an annual rate estimated more than 3 percent.

Because the Western Arctic bowhead whale population is approaching its pre-exploitation population size and has been documented to be increasing at a roughly constant rate for over 20 years, the impacts of oil and gas industry on individual survival and reproduction in the past have likely been minor (Angliss and Outlaw 2010). These activities are unlikely to have any effect on the other four stocks of bowhead whales. Similarly, only the western North Pacific stock of humpback whales and the Northeast Pacific stock of fin whales would be potentially affected by oil and gas leasing and exploration activities in the Chukchi Sea. The described work would have no effect on the remaining worldwide stocks of humpback or fin whales. No injury or lethal takes are anticipated from these activities, nor are population level consequences to the stocks expected. Most impacts would be due to harassment of whales, which may lead to behavioral reactions from which recovery is fairly rapid. Mitigative measures will be recommended to reduce harassment and the possibility of harm or lethal takes.

Our ability to study and to predict potential effects of these actions on this species is, and will remain, hampered due to the fact that bowhead whales are very large baleen whales (e.g., they cannot be measured and weighed when alive, cannot be brought into aquariums and studied, etc.). Data indicate that at least some bowhead whales are extremely long lived (100 years or more), and this longevity can affect the potential for a given individual to be exposed to a high number of acoustic disturbance and pollution events in its lifetime. There is, and will remain, considerable uncertainty about the long term effects of oil and gas related activities and cumulative effects on a species whose potential lifespan so exceeds our own. This species could be exposed to multiple anthropogenic stressors at many locations throughout its range and over very many years. This species also inhabits remote areas of the ocean, far (in many cases) from any human settlement, making logistics for many types of study challenging.

After reviewing the current status of the bowhead, fin, and humpback whale, the environmental baseline for the action area, the biological and physical impacts of these actions, and cumulative effects, and in consideration that the described actions are expected to impact only a single stock of each of these endangered whales, and not the species as a whole, it is NMFS's biological opinion that authorization of the described small takes of marine mammals under the MMPA for oil and gas exploration activities in the U.S. Chukchi Sea by Statoil for the year 2011 is not likely to jeopardize the continued existence of the endangered bowhead, fin, and humpback whale. No critical habitat has been designated for these species, therefore none will be affected.

## VII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The National Marine Fisheries Service should implement the following measures for these purposes:

1) Vessel operations in the Chukchi Sea, including seismic geophysical exploration, should be scheduled to minimize operations in order to reduce potential harassment of bowhead whales. These activities should, to the extent practicable, avoid migratory periods in the spring and fall.
2) NMFS should conduct research to describe the impact of exploration activities on the migrational movements and feeding behavior of the bowhead whale. Specific plans should be developed and implemented to monitor the cumulative effects of exploration, development, and production on the bowhead whale. These research designs and results should be reviewed annually to ensure that the information collected is addressing the concerns of NMFS and the affected Native communities.
3) To minimize potential harassment of bowhead, fin, and humpback whales, operators should be advised that aircraft (other than monitoring flights) should observe a minimum altitude of 1,000 feet, weather and safety factors permitting.
4) Upon learning of any unauthorized take of bowhead whales which occurs as a result of OCS exploratory activity, NMFS should immediately notify the assistant

Regional Administrator for Protected Resources at (907) 586-7235 of this taking to determine the appropriate and necessary course of action.

5) NMFS should recommend IHA holders take the following measures during operating to reduce potential interference with listed whales:
    a. Reduce vessel speed when within 300 yards of whales, and those vessels capable of steering around groups of whales should do so
    b. Avoid multiple changes in direction and speed when within 300 yards of whales
    c. Require, when weather conditions require, such as when visibility drops, support vessels to adjust speed to avoid injury to whales.
6) NMFS should prohibit authorization of takes of endangered marine mammals due to vessel operation to access work sites through the spring lead system or requiring ice breaking, and require vessels to await open water conditions to avoid impacting bowhead whales during their spring migration (March through June).
7) NMFS will require that Statoil notify NMFS' Office of Protected Resources and NMFS' Stranding Network within 48 hours of sighting an injured or dead marine mammal in the vicinity of marine survey operations. Statoil shall provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). In the event that an injured or dead marine mammal is found by Statoil that is not in the vicinity of the proposed open water marine survey program, Statoil will report the same information as listed above as soon as operationally feasible to NMFS.

## VIII. REINITIATION OF CONSULTATION

This concludes formal consultation on this action. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Biological Opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Biological Opinion; or (4) a new species is listed or critical habitat designated that may be affected by this action. In circumstances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

## IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

This opinion does not include an incidental take statement at this time. Upon issuance of regulations or authorizations under Section 101(a)(5) of the MMPAand/or its 1994 Amendments, NMFS will amend this opinion to include a incidental take statement(s) for the described work.

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