VIA ELECTRONIC MAIL – NO HARD COPY TO FOLLOW

From: Wall, Rance
Sent: Friday, August 01, 2008 2:33 PM
To: Bill J Streever (Bill.Streever@bp.com)
Cc: 'brad.smith@noaa.gov'; Schroeder, Mark; Sloan, Pete; Banet, Susan; Newbury, Thomas; Wedemeyer, Kate; Cowles, Cleveland
Subject: Permit modification to G&G Permit 08-05

After more field reviews and discussions with the appropriate resource managers, the protocol for handling kelp as stated in MMS OCS G&G Permit 08-05 is modified as follows:

1. Rough estimates of the number of fronds that come up on each line will be recorded and submitted with weekly reports. Information will include estimated number of fronds, line number, line length, line location, date, and vessel name. To the greatest practicable extent, all kelp and kelp pieces will be returned to the ocean at a location as close as practicable to their point of origin.

2. When the OBC survey is operating full time in denser parts of the kelp community, several orders of magnitude more kelp might be retrieved. BP will notify MMS if the volume of retrieved kelp increases dramatically.

This protocol modification replaces the previous permit modification dated July 22, 2008.

Rance Wall, PE
Regional Supervisor, Resource Evaluation
Alaska Regional Office
Minerals Management Service
(907) 334-5321

Via Electronic Mail, No Hard Copy to Follow

From: Wall, Rance
Sent: Tuesday, July 22, 2008 10:53 AM
To: Bill J Streever (Bill.Streever@bp.com)
Cc: 'brad.smith@noaa.gov'; Schroeder, Mark; Sloan, Pete; Banet, Susan; Newbury, Thomas; Wedemeyer, Kate; Cowles, Cleveland
Subject: Permit modification to G&G Permit 08-05

The protocol for handling kelp as stated in MMS OCS G&G Permit 08-05 is modified as follows:

1. When kelp comes up with intact holdfasts and cobble, if possible untangle it from the cables and throw it back, preferably as close as practicable to its original location. (That is, as the cable comes up, throw the intact kelp back.) An attempt should be made to try to record how often kelp is picked up and what percentage is intact and returned to the seafloor.

2. Bag all other kelp (including kelp within the nominal outline of the boulder patch and outside). Use one bag per line and include labels on each bag that indicate which line the kelp came from and its start and end points, as well as the date. To the extent possible, put the bags on ice.

Rance Wall, PE
Regional Supervisor, Resource Evaluation
Alaska Regional Office
Minerals Management Service
(907) 334-5321

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

MAR 13 2008

Mr. Cash Fay
BP Exploration (Alaska), Inc
P O Box 196612
Anchorage, Alaska 99519-6612

Dear Mr. Fay:

Your application dated December 27, 2007, requests a Federal permit to conduct geophysical operations on certain Outer Continental Shelf (OCS) lands. The activity is in the Beaufort Sea area as shown on the map accompanying your application. Your application specified CGG Veritas will be your service providing company, and will conduct the subject operations using the vessels described in the Operation Plan. Operations are proposed to begin on or after June 1, 2008, and will be completed on or before November 1, 2008. The proposed program is a 3D ocean bottom cable (OBC) seismic acquisition using airguns as an energy source.

Your application states that BP Exploration (Alaska) Inc. has requested an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS) for whales and pinnipeds, and an Letter of Authorization (LOA) from the U.S. Fish and Wildlife Service (USFWS) for polar bears and walrus. The Minerals Management Service (MMS) will require a signed copy of the IHA and LOA authorizations prior to conducting seismic operations. The IHA from the NMFS and the LOA from the USFWS are in place to resolve subsistence-related concerns and to insure that impacts to marine mammals are not significant. The procedures outlined in these authorizations represent a good faith effort on the part of BP Exploration (Alaska) Inc. to avoid conflict with subsistence activities which may be conducted during a portion of the time proposed for this seismic operation.

OCS Permit 08-05 is hereby granted to conduct geophysical exploration operations on the OCS in the area and manner described in the application. A detailed track map of planned operations must be submitted to this office prior to the start of seismic operations. All operations are subject to the enclosed stipulations (see Enclosure 1) and approved Permit for Geophysical Exploration for Mineral Resources on the OCS. In all cases, the specific mitigating measures identified in the NMFS IHA and the USFWS LOA will apply and will take precedence over any MMS requirements, where applicable, including protocols for monitoring programs.

The information contained in the following paragraphs should be evaluated before initiating operations and appropriate action taken:

Endangered bowhead whales may occur in the Beaufort Sea during operations. Bowhead whales pass through the area on their fall migration back to the Bering Sea. They begin to leave Canadian Beaufort Sea waters in August and September and travel west through the southern Beaufort Sea into the Chukchi Sea. Other marine mammals that may appear in the project vicinity include beluga whales, spotted, bearded and ring seals, gray whales, polar bears, and walrus.

The Endangered Species Act (ESA) states there shall be no activity conducted which might jeopardize the continued existence of an endangered species or result in the destruction or adverse change of habitat of such species. In addition, the Marine Mammal Protection Act (MMPA) provides there shall be no unauthorized take of marine mammals. "Take" means to harass, hunt, capture, collect, kill, or attempt to harass, hunt, capture, collect of kill any marine mammals. Whenever whales or marine mammals are encountered in the project vicinity, BP Exploration (Alaska) Inc. and its contractors should exercise precautions to assure that activities are not in violation of the provisions of the MMPA or the ESA.

Further information on the identification and occurrence of endangered whales or marine mammals in the proposed area of operations and the provisions and penalties of the ESA and the MMPA are available. This information may be obtained from the

U.S. Fish and Wildlife Service
Alaska Region
1011E.Tudor Road
Anchorage, Alaska 99503
Telephone (907) 786-3467

And from the

National Marine Fisheries Service
Federal Building, Room C-554
Anchorage, Alaska 99513
Telephone (907) 271-5006

This permit is effective from the date of approval until November 1, 2008, or the completion of the survey, whichever occurs earlier. Please be advised that this office requires a weekly report of daily operations. Daily reports may be substituted for this requirement. We will require a completion report within 30 days following cessation of field operations.

Sincerely,

Rance R. Wall
Regional Supervisor
Resource Evaluation

2 Enclosures

Minerals Management Service (MMS), Alaska OCS Region Seismic Survey G&G Permit Stipulations for Permit 08-05

- No solid or liquid explosives shall be used without specific approval.
- Permittee operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. Any difficulty encountered with other uses of the area or any conditions that cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the MMS Regional Supervisor/Resource Evaluation (RS/RE). Serious or emergency conditions shall be reported without delay.
- Permittee operations shall maintain a minimum spacing of 15 miles between the seismic-source vessels for separate operations. The MMS RS/RE must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permittee operators shall use the lowest sound levels feasible to accomplish their data-collection needs.
- Vessels and aircraft shall avoid concentrations or groups of whales. Permittee operators shall, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level (ASL) when within 1,500 lateral feet of groups of whales. Helicopters shall not hover or circle above such areas or within 1,500 lateral feet of such areas.
- When weather conditions do not allow a 1,000-foot ASL flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot ASL altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet ASL because of weather conditions, the operator must avoid known whale-concentration areas and should take precautions to avoid flying directly over or within 1,500 yards of groups of whales.
- When the Permittee operates a vessel near a concentration of whales, every effort and precaution shall be taken to avoid harassment of these animals. Therefore, vessels shall reduce speed when within 900 feet of whales and those vessels capable of steering around such groups should do so. Vessels shall not be operated in such a way as to separate members of a group of whales from other members of the group.
- Vessel operators shall avoid multiple changes in direction and speed when within 900 feet of whales. In addition, operators shall check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

- Small boats shall not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of injury to whales.
- When any operator becomes aware of the potentially harassing effects of operations on whales, or when any operator is unsure of the best course of action to avoid harassment of whales, every measure to avoid further harassment shall be taken until the NMFS is consulted for instructions or directions. However, human safety shall take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of whales.
- The Permittee shall notify MMS RS/RE, NMFS, and FWS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals and other wildlife resources.
- The deployment of cables or batteries is prohibited within a 100-m radius (i.e. exclusion zone) around the following long-term Boulder Patch monitoring sites (datum NAD 27):

Site	**Location**
B-1	Lat. 70 17.825 N, Long. 147 38.44 W.
DS-11	Lat. 70 19.330 N. Long. 147 34.927 W. (150-m exclusion zone for site DS-11)
E-1	Lat. 70 18.879 N. Long. 147 44.075 W.
E-2	Lat. 70 19.088 N. Long. 147 43.074 W.
E-3	Lat. 70 19.452 N. Long. 147 38.978 W.
L-1	Lat. 70 17.328 N. Long. 147 36.621 W.
L-2	Lat. 70 18.063 N. Long. 147 34.65 W.

- Navigators will be supplied with the coordinates of the aforementioned Boulder Patch exclusion zones.
- The use of lightweight equipment should limit impacts to the Boulder Patch, and there will be no anchoring of any vessels in the Boulder Patch. Dates of any scientific activity at these monitoring sites will be concluded so that if any work will be occurring during the time of the proposed survey, a simultaneous operations plan can be developed. The chain that will be attached to the hydrophone to prevent movements will be entirely taped to the hydrophone pigtail and, as such, will form an integrated part of the hydrophone. This will prevent entanglement of plants.
- BPXA will report to MMS RS/RE if damage to the Boulder Patch occurs as a result of their operations. Additionally, BPXA shall notify MMS if they detect any fragile biocenoses otherwise not documented in their permit application.
- Vessels will not anchor within any documented Boulder Patch areas, unless an emergency situation involving human safety specifically exists and there are no other feasible sites to anchor at the time.
- No refueling of vessels will occur in the Boulder Patch area.
- All possible options will be investigated to avoid or minimize the use of surface buoys on the batteries that will be deployed on the Boulder Patch.
- Caution with cable deployment and retrieval is an important factor for data quality and, as such, part of the operational procedures. However, captains of the vessels involved in the retrieval of receiver cables will receive extra instructions to

operate their vessels in a manner that will minimize the chance of dragging cables when operating in the Boulder Patch. A specific speed will not be dictated, because vessel control in varying weather conditions must be left to the captain's discretion.

- An awareness video and/or presentation will be provided to all crew members. This orientation will include instructions on the implementation of the above mitigation measures. This orientation session will be documented with an attendance list.
- A toolbox meeting will be held among the crew prior to the start of the operations within the Boulder Patch area to remind them of the Boulder Patch mitigation requirements.
- The crew of the cable vessels will document if kelp plants are entangled in the receiver cable lines, hydrophones, or batteries when they are retrieved and will bag the samples. The number of plants, approximate coordinates on the Boulder Patch, water depth and a short description of the plant (e.g., length, signs of damage) will be recorded and reported to MMS RS/RE after seismic-data acquisition on the Boulder Patch is completed.
- To help avoid causing bird collisions with seismic survey and support vessels, seismic and surface support vessels will minimize the use of high-intensity work lights, especially within the 20-meter-bathymetric contour. High-intensity lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog) otherwise they shall be turned off. Deck lights, interior lights, and lights used during navigation could remain on for safety.[1]
- All bird collisions (with vessels and aircraft) shall be documented and reported within 3 days to the MMS RS/RE, or his designee. Minimum information shall include species (if possible), date/time, location, weather, identification of the vessel or aircraft involved and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Permittees/operators are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.
- Ledyard Bay Critical Habitat Unit (Unit) – Except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the Unit between July 1 and November 15. To the maximum extent practicable, aircraft supporting seismic survey operations shall avoid operating below 1,500 feet ASL over the Unit between July 1 and November 15. Vessel travel within the Unit and altitude deviations by aircraft over the Unit for emergencies or human safety shall be reported within 24 hours to MMS RS/RE.
- Seismic surveys (i.e. no active seismic data collection) shall commence no earlier than June 10 to allow pre-nesting birds using nearshore waters time to disperse to onshore nesting sites.

[1] Nothing in this mitigation measure is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

The following monitoring and mitigation measures are related to MMS complying with the requirements of the Marine Mammal Protection Act, Endangered Species Act and Migratory Bird Treaty Act. However, comparable mitigation and monitoring requirements defined in any: (1) NMFS (the Federal agency having MMPA management authority for cetaceans and pinnipeds, less Pacific walrus) and FWS (the Federal agency in having MMPA management authority for Pacific walrus, polar bear, and sea otter) ITA and/or Letters of Authorization (LOA) obtained by the seismic survey operator; and (2) FWS Fish and Wildlife Coordination Act review of the BPXA's Section 10/404 Corps Permit will have precedence over any related measures listed below:

- Exclusion Zone – A 180/190 dB isopleth exclusion zone from the seismic-survey sound source shall be free of marine mammals before the survey can begin and must remain free of marine mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from Level A harassment (injury).The 180 dB applies to cetaceans and the Pacific walrus, and the 190 dB applies to pinnipeds other than the Pacific walrus. The exclusion zones specified in ITAs and/or LOAs will take precedence over the MMS-identified exclusion zone.
- Monitoring of the Exclusion Zone – Individuals (marine mammal biologists or trained observers) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the marine mammal monitoring program and observers.
- Shut Down/Power Down – A seismic survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the exclusion zone or to power down to a sound level where the marine mammal in no longer in the exclusion zone. If the airgun array is completely powered down for any reason during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.
- Ramp Up – Ramp up is the gradual introduction of sound to deter marine mammals from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at 20-to-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated when monitoring the exclusion zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line

transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the exclusion zone before the airgun array is again ramped up to full output.

- Field Verification – Before conducting the survey, the operator shall verify the radii of the exclusion zones within real-time conditions in the field. This provides for more accurate exclusion-zone radii rather than solely relying on modeling techniques before entering the field. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the exclusion zones by applying a sound-propagation series.
- Reporting Requirements – Operators must report immediately any shut downs/power downs due to a marine mammal entering the exclusion zones and provide the regulating agencies and MMS RS/RE with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.
- Walrus - Vessels and aircraft should avoid concentrations or groups of walruses. Operators should, at all times, conduct their activities at a maximum distance from such aggregations. Seismic-survey and associated support vessels shall observe a 0.5-mile safety radius around Pacific walrus groups hauled out onto land or ice. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,500 feet ASL when within 0.5-mile of walrus groups. Helicopters may not hover or circle above such areas or within 2,500 lateral feet of such areas.
- Polar Bear - Seismic survey operators shall adhere to any mitigation measures identified by the FWS to protect polar bears from being harassed and/or injured.

U.S. Department of the Interior

Minerals Management Service

Alaska Outer Continental Shelf Region

3801 Centerpoint Drive, Suite 500

Anchorage, AK 99503-5823

Environmental Assessment

Three-Dimensional, Ocean-Bottom Cable, Transitional Zone Seismic Survey

Permit Number 08-05

BP Exploration (Alaska) Inc.

March 13, 2008

1.0 PURPOSE AND NEED

1.1 Purpose of the Proposed Action.

Under the Outer Continental Shelf Lands Act, as amended, the U.S. Department of the Interior (USDOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal Outer Continental Shelf (OCS). The Secretary of the Interior oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained.

British Petroleum Exploration (Alaska) Inc. (BPXA) proposes a three-dimensional (3D) seismic survey in support of the Liberty Development Project within the Foggy Island Bay area during the 2008 open-water season in the Beaufort Sea. This area includes portions of the Duck Island Unit, known as Endicott, which comprises the Endicott causeway, Satellite Drilling Island (SDI) and Main Production Island (MPI); and the full Liberty Unit and adjacent State land and waters and Federal waters. The purpose of this survey is to collect geophysical data required to support the ultra-Extended Reach Drilling (uERD) program for the Liberty Development Project. Planned geophysical data acquisition activities will be conducted by BPXA's contractor, CGGVeritas, and will take place shoreward of the barrier islands in shallow waters with depths less than (<)30 feet (ft), including some minimal areas on land (for purposes of this survey, land does not include any tundra, only the causeway, Howe Island, and mudflats).

The proposed seismic operation is an ocean bottom cable (OBC) transition zone survey. The OBC surveys involve deploying receiver cables from a vessel for placement on the seabed. Sensors (hydrophones or geophones) attached to the cables will be used to detect seismic energy reflected from underground rock strata. The source of this energy will be a submerged compressed air source (air gun) towed by a vessel. After sufficient data have been recorded to allow accurate mapping of the rock strata, the cables will be lifted onto the deck of the vessels, moved to a new location (ranging from several hundred feet to a few thousand feet away), and placed onto the seabed again. By repeating the process, the volume of subsurface rock can be acoustically imaged.

In accordance with the National Environmental Policy Act (NEPA), codified at 40 CFR 1508.9, and Departmental Manual (516 DM 15), this Environmental Assessment (EA) considers the potential impacts associated with the Proposal and shall conclude whether an Environmental Impact Statement (EIS) is needed.

This EA implements the tiering process outlined in 40 CFR 1502.20, which encourages agencies to tier environmental documents and eliminate repetitive discussions of the same issue. By tiering from recent NEPA documents, including the 2002 *Liberty Development and Production Plan Final Environmental Impact Statement* (USDOI, MMS, 2002)*;* and 2007 *Liberty Development and Production Plan Ultra Extended Reach Drilling from Endicott – Satellite Drilling Island (SDI) Environmental Assessment* (USDOI, MMS, 2007a), this EA concentrates on environmental issues specific to the proposal.

While this EA adopts major sections of the various documents outlined in Section 2.2 of this EA, the Minerals Management Service (MMS) also updated and expanded on the information provided, as needed. The conclusions in this EA reflect MMS analysts' conclusions based on MMS's significance thresholds and consideration of additional required mitigation measures developed subsequent to submission of the documents outlined in Section 2.2 of this EA and the permit application.

1.2 Need for the Proposed Action.

The proposed seismic survey would facilitate the imaging of subsurface rock to support the uERD program for the Liberty Development Project. The currently available seismic data focused primarily on deeper targets and, hence, does not optimally image the shallow overburden sections of the well bore. To increase the probability of successful implementation of the proposed uERD technique, the seismic survey is needed.

2.0 DESCRIPTION OF THE PROPOSED ACTION

2.1 Multi-Agency Briefing.

BPXA and CGGVeritas provided a project briefing to the following Federal and State agencies on January 28, 2008, at the MMS Alaska Regional Office:

- MMS - Leasing and Environment; Field Operations; and Resource Evaluation
- National Marine Fisheries Service (NMFS)
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- Alaska Department of Natural Resources - Division of Oil & Gas (ADNR/DOG); and State Historic Preservation Office (SHPO)

2.2 Documentation Provided to MMS.

BPXA contracted with LGL Alaska Research Associates, Inc. for the preparation of following biological reports:

- *Liberty Shallow Water Seismic Survey 2008, Biological Assessment Boulder Patch Area,* LGL Report 988-1, submitted to BPXA in December 2007 (BPXA, 2007a). Appendix 9.1 of this EA. [Boulder Patch Report]
- *Liberty Shallow Water Seismic Survey 2008, Biological Assessment for Fish and Fish Habitat*, LGL Report 988-2, submitted to BPXA in December 2007 (BPXA, 2007b). Appendix 9.2 of this EA. [Fish/EFH Report]
- *Liberty Shallow Water Seismic Survey 2008, Biological Assessment for Marine and Coastal Birds*, LGL Report 988-3, submitted to BPXA in December 2007 (BPXA, 2007c). Appendix 9.3 of this EA. [Bird Report]
- *BPXA, Liberty Shallow Water Seismic Program 2008, Project Description/Plan of Operations as submitted with the Permit Application 08-05* (BPXA, 2008). [Plan of Operations]

BPXA submitted the following requests to other agencies:

- *Request for an Incidental Harassment Authorization (IHA)* pursuant to Section 101(A)(5) of the Marine Mammal Protection Act covering incidental harassment of marine mammals during an OBC seismic survey in the Liberty Prospect, Beaufort Sea, Alaska in 2008 (BPXA, 2007d), submitted to NMFS, November 2007. Appendix 9.4 of this EA.
- *Request of Letter of Authorization (LOA)* pursuant to Section 101(A)(5) of the Marine Mammal Protection Act covering 3D OBC Liberty seismic survey and bathymetry survey (BPXA, 2007e), submitted to USDOI, Fish and Wildlife Service (FWS), December 14, 2007. Appendix 9.5 of this EA.

The following project description was derived from the six aforementioned documents provided to MMS.

2.3 Project Location.

The location within which the proposed seismic survey will be conducted is shown in Figure 1. The well path is the area of primary interest that needs to be fully covered by the seismic data. The size of this zone is 35.6 square miles (mi^2) (92.1 square kilometer [km^2]) (measurements are in statute miles). To obtain full data coverage in this area of interest, a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The [larger] project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay, Beaufort Sea, 1% of which is on mudflats/causeway, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft, 43% in water depths of 10-20 ft, and 25% in water depths of 20-30 ft (Figure 2). The approximate boundaries of the total surface area are between lat. 70°11'N and lat. 70°23'N and between long. 147°10'W and long. 148°02'W (Figure 2).

Given favorable operating conditions, the geophysical survey will cover the entire 135.8 mi^2 survey area. Most support activities, such as vessel mobilization/demobilization, refueling of the mother ship (M/V *Arctic Wolf*), and vessel resupply, will occur at West Dock. A staging area will be used at the West Dock Staging Pad. Activities at Endicott primarily will be personnel transfers. Equipment staging and vessel refueling also may occur at Endicott facilities. For protection from weather, vessels will anchor near the barrier islands. Personnel transfers also may occur at barrier island locations. Navigation positioning base stations (tripod) will be required on land and currently are planned on the Endicott causeway and Tigvariak Island.

Because a small portion of this survey covers land (i.e., Endicott causeway, MPI, SDI, Howe Island, and mudflats), limited layout of receiver cables may occur before the ice has cleared. There are no private lands within the planned survey area. However, BPXA may seek short-term use permits from private land owners in the adjacent area. Additionally, Letters of Non-Objection will be requested from affected leaseholders and from BP Transportation Alaska for activity in the Endicott causeway Pipeline Right-of Way.

A bathymetric survey to collect more detailed bathymetry information in shallow areas (<6 ft) within the seismic-survey area is planned in early 2008 following opening of winter tundra travel and sufficient ice thickness. Land use permits for bathymetric-survey activities may be requested from ADNR and the North Slope Borough under separate cover, depending on timing of decision of this request.

Deployment and retrieval of cables will be accomplished from vessels that have the cabin located at the rear and task-specific apparatus located at the bow. These vessels are called "bow pickers." In water depths less than those accessible by the bow pickers, the use of equipment such as swamp buggies, the Northstar hovercraft, and/or Jon boats may be required. Jon boats are flat-bottomed boats constructed of aluminum with 1-3 bench seats. They are useful due to their level of stability. Surveyors may be required to locate these shallow-water and land-based receivers during the summer activity.

Coordination and communications with subsistence users will be addressed in a Conflict Avoidance Agreement (CAA) and Plan of Cooperation that is being developed among the Alaska Eskimo Whaling Commission (AEWC) and village Whaling Captains' Associations, and BPXA.

2.4 Planned Vessel Inventory.

The vessels involved in the seismic-survey activities will consist of approximately 11 vessels, as listed in Table 1. In water depths less than those accessible by the bow pickers, the use of equipment such as swamp buggies, the Northstar hovercraft, and/or Jon boats may be required.

2.5 Mobilization.

Most vessels will be transported by truck to the North Slope in late May/early June, where they will be prepared at West Dock located within the Prudhoe Bay Unit. Vessel preparation will include assembly of navigation and source equipment, cable deployment and retrieval systems, and safety equipment. Once assembled, the deployment, retrieval, navigation, and source systems will be tested prior to departure to the project site. The mobilization process will require about 35 days to complete, with most activities occurring at West Dock. The *Arctic Wolf* will sail around Barrow when ice conditions allow, and the hovercraft will travel from West Dock.

Preparation of the cables ("cable dressing") will be conducted and completed at the CGG Veritas shop in Anchorage. Cable dressing includes attaching lead line and weighting systems to the cables to reduce any chance for movement on the seafloor. After completion of the final quality-control check, the cables will be transported by truck together with the vessels to West Dock, where they will be loaded onto the vessels prior to departure to the project site. Some support equipment might be staged at the Endicott facilities.

2.6 Seismic-Survey Area Details.

The well path is the primary area of interest that needs to be fully covered by the seismic survey. According to BPXA, the size of this zone has been reduced to an absolute minimum of 35.6 mi² (92.1 km²). To obtain full data coverage in this area, a larger zone needs to be surveyed to account for accurate positioning of sound-wave reflections. The total seismic-survey extent is 135.8 mi² (351.8 km²) (Figure 2).

Data will be acquired using the patch technique composed of 22 patches with 3 receiver lines per patch. Approximately 30-33 source lines will be acquired perpendicular to the receiver lines for each patch. This allows recording on one patch, laying the next patch, and holding a third patch on deck as backup.

Receiver cable lines consist of a hydrophone and a Field Digitizing Unit (FDU) placed on the cables at 110-ft intervals, and placed on the seabed according to a predefined configuration to record the reflected source signals from the air guns. The cables that may be deployed on land may have marsh-type geophones attached and would be placed in a similar configuration as those deployed at the seabed. The receiver cables will be oriented in a northeast-southwest direction. Approximately 66 northeast-southwest-oriented receiver lines will be deployed, with increasing line spacing from west to east of ~880 ft to ~2,000 ft. Total receiver line length will be ~490 mi (~788 km), ~10 miles (~16 km) of which will be laid on mudflats/land. The source vessels will travel perpendicular over these receiver cables along lines that will have a northwest to southeast orientation and a varying total length between a minimum of 2 and maximum of 3.5 mi (=3.2 and 5.6 km). The total source line length is ~2,000 mi (~3,220 km) in water depths varying from 3-30 ft (1-9.1 meter [m]). The Liberty seismic-survey design is planned so that the most critical data along the well path will be acquired as highest priority, if time becomes limited.

2.7 Cable Deployment and Retrieval.

The M/V *Peregrine*, M/V *Maxime*, and four bow pickers (F/V *Canvasback*, F/V *Cape Fear*, F/V *Rumplemimz*, and F/V *Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels have jet drives powered by diesel engines and are rigged with hydraulically driven deployment and retrieval systems ("squirters"). The M/V *Peregrine*, which functions both as source and cable vessel, will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are small and allow a pull of 800 pounds. The smaller bow picker cable vessels also will carry 120 hydrophone stations and are capable of beach landings. All cable vessels will maintain 24-hour operations.

Part of the receiver cables will be deployed and retrieved on the causeway/mudflats to pick up reflected source signals and allow for full interpretation of the data in the area of interest, i.e., well path (pink line in Figure 2). Receiver cables would be deployed across the causeway using vehicles with a land-based team. Temporary slotting of the Endicott road or speed bumps may be required for placement of cables that cross the road to prevent cables from potential damage. Limited layout of receiver cables might be possible on the causeway/mudflats as early as June. Receiver cables still requiring deployment in mudflats or water <2 ft during the summer will be conducted using equipment that can operate in shallow waters and tideland conditions (such as the hovercraft, swamp buggies, or Jon boats).

2.8 Recording.

Once the receiver cables for a patch have been deployed, they will be connected to the recorder on the M/V *Alaganik* (a pin-together boat-barge combination). While recording, the pin-together boat barge is stationary and is expected to use a four-point anchoring system.

A Sercel 428 FDU will be located at each hydrophone. This system is lightweight and robust and rated to 14 m (45 ft) of water depth, which will allow it to operate well in the water depths for this survey. The data received at each FDU will be transmitted through the cables to the recorder for further processing.

Batteries will be used to maintain necessary power to maintain data transmission to the recorder. Each battery will be placed in a sealed aluminum container. Battery packs will be deployed with the receiver cable approximately every 30 hydrophones along the receiver lines. Each battery pack will be equipped with a buoy (or acoustic release) and a pinger, so that the battery packs can be located and retrieved when needed.

2.9 Source-Vessel Operations.

To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the M/V *Peregrine* and M/V *Maxime*. After the cable patch has been positioned on the seabed, a vessel with a compressed air-gun source will sail over at right angles to the receiver cables. At each patch, an array of air guns will be discharged as a source of seismic energy. This array of air guns is designed to emit a certain power and frequency output that is focused downward toward the seabed. The sources used for seismic data acquisition will be sleeve air-gun arrays with a total discharge volume of 880 cubic inches (in^3) divided over two arrays. Each source vessel will have two 440-in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. The 880-in^3 array has an estimated source level of ~250 decibels re 1 micro Pascal (dB re 1 μPa). Compressed air used for the air guns will be generated from compressors mounted on the deck of the source vessels. Table 2 summarizes the compressed-air source configuration and acoustical outputs.

The air-gun arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at water depths varying from 1-4 m (3-13 ft). The vessel will travel along predetermined lines at ~1-5 knots (kn), mainly depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4-second-shot intervals with two operating source vessels. The seismic-data acquisition will occur over a 24-hour/day schedule.

An initial operation with air guns could precede or follow the source operation. This operation would serve as a calibration run to gain accurate data to verify distance for safety zone and cable positioning.

2.10 Navigation and Data Management.

Navigation will be accomplished with the use of a Differential Global Positioning System (DGPS). The proposed navigation system will remotely link the operating systems located on each of the vessels assigned to the survey. A minimum of two DGPS shore stations will be maintained along the coast at all times. One station will be located at Endicott; the planned location for the second station is on the southwestern tip of Tigvariak Island.

The raw data that is used to calculate the GPS corrections will be gathered on an exhibit archiving system. The instrument navigation system will be capable of many features that are critical to an efficient OBC operation. The system will include a hazard-display system that can be loaded with known obstructions (e.g., causeway, artificial islands) and areas of sensitivity (e.g., boulder patch) along with preplotted source and receiver-line positions. The hazard displays are loaded with information from several sources (hydrographic charts, infrastructure, U.S. Coast Guard [USCG] notices, etc.) prior to the project commencing, and day-to-day operational hazards, such as buoys, are added to the display during operations. These daily hazards are added and subtracted to the hazard database as the crew occupies and abandons patches.

The asset monitor will update the positions of each vessel in the survey area every few seconds. Individual ship's positions will be pulled port to port from the recorder vessel, and then displayed on the hazard screen along with the other details that are part of its database. This feature will give the crew a quick display as to each ship's position relative to the various display items. It also will allow the crew managers to properly and efficiently manage the vessels. This display will give a quick reference when a question regarding positioning or tracking arises. In the case of inclement weather, the hazard display can and has been used to vector vessels back to the recorder vessel. This system also allows safe acquisition operations to continue during periods of reduced visibility.

Receiver positioning will use a method called Ocean Bottom Receiver Location, or first-arrival picking (First Break Receiver Location). For each line of receivers, two positioning runs will be made by the source vessel on either side of the receiver line. These positioning runs will be made at an offset from the receiver line designed to maintain optimum survey geometry. In very shallow water (possibly <15 ft), "as-laid" positions will be used for receiver locations.

2.11 Housing.

There will be approximately 115 persons on the crew. Approximately 40 persons will be housed at the Endicott MPI existing camp, 25 in Deadhorse or Prudhoe Bay facilities, and 50 on vessels.

The mother ship, the M/V *Arctic Wolf*, will house up to 30 crew and store cable parts and fuel for the other vessels. The M/V *Arctic Wolf* is a propeller-driven vessel. Because of its size, the vessel cannot be transported by truck to Prudhoe Bay; it will mobilize from either Homer or Anchorage and sail around Barrow to the survey area, when ice conditions allow and in consultation with beluga whale hunters in the Chukchi Sea. Two marine mammal observers (MMO's) will conduct observations off of this vessel during the transits from and to Anchorage/Homer. Crew will be housed temporarily in other camps in Deadhorse or other operating areas, if the M/V *Arctic Wolf* arrives after seismic acquisition begins.

The recorder barge/boat (M/V *Alaganik* and M/V *Hook Point*) can accommodate 2-4 persons. The barge portion is dedicated to recording and staging of cables, hydrophones, and batteries. It cannot be used to create additional housing due USCG restrictions.

The source vessel M/V *Peregrine* is able to house 10 crew, including MMO's. The source vessel M/V *Maxime* can accommodate 6 persons, including the MMO's. Because the four cable-handling bow pickers are too small to house their crew, they will be accommodated on land or the M/V *Arctic Wolf*.

The seismic survey is a 24-hour operation to allow for efficient data acquisition during the short summer season; therefore, crew-change vessels will transfer crews from the MPI or the M/V *Arctic Wolf* approximately every 12 hours. Shifts for crews on the source vessels and cable vessels will be staggered to maximize transport efficiency. Two vessels may be used for these crew transfers, a crew boat (M/V *Qayaq Spirit*) and, if authorized, the Northstar hovercraft (*Arctic Hawk*).

2.12 Vessel Operations.

All vessel accommodations for personnel are self supporting. Crews transferring from Endicott MPI and the M/V *Arctic Wolf* will be rotated every 12 hours and will be transported to and from camp to individual operations vessels, i.e., the cable vessels or source vessels. Living quarters on each vessel include a kitchen and diner, sleeping areas, washrooms, and offices. Appropriate vessel-operating permits or authorizations, including USCG certifications, food service, and water- and wastewater-handling plan reviews will be held by CGGVeritas. Sanitary conditions in the kitchen, diner, and washrooms will be maintained in full compliance with governmental regulations.

Potable water will be hauled from approved water sources or produced from a vessel desalination unit in accordance with appropriate regulations. Vessels will have independent USCG-approved marine-sanitation devices for handling sewage. All fluids will be managed in accordance with applicable governmental regulations.

Wastes will be transported to the *Arctic Wolf* (the mother ship) from support vessels. A waste-management plan will be developed and implemented. Wastes, such as metals, used oil, and trash, will be hauled on the M/V *Arctic Wolf* back to the Prudhoe Bay West Dock for recycling, treatment, or disposal in existing approved facilities.

Approximately 30,000 gallons of diesel will be stored on the M/V *Arctic Wolf* to refuel the vessels during seismic operations. Resupplying the *Arctic Wolf* fuel-storage tanks will take place at West Dock, Endicott dock, or by delivery from an approved Crowley vessel. All fuel transfers between the vessels at sea will be conducted according to applicable USCG and regulatory requirements.

2.13 Survey Schedule.

The timing of the survey depends on sea-ice conditions. Mobilization is planned to occur in late May/early June. Vessels will be mobilized from West Dock and proceed to the survey area. The largest vessel, the *Arctic Wolf*, will transit from Homer or Anchorage to the site, when ice conditions allow and in consideration of the spring beluga hunt in the Chukchi Sea. Seismic-data acquisition is planned to start as early as July 1, depending on the presence of ice. Open-water seismic operations can only start when the project area has minimal ice (i.e., approximately <10% ice coverage), which in this area normally occurs around July 30 (+/- 14 days). Limited layout of receiver cables may occur on the causeway/mudflats as early as June.

The seismic survey will take place inside the barrier islands in nearshore shallow waters. BPXA seeks to continue survey activities for 60 days, in the period July/August 2008, prior to the bowhead whale-migration season. Given the uncertainties of ice conditions and other factors that can influence the survey, there is a contingency to obtain data in September/October after the whaling season, in accordance with the planned CAA, if necessary. The survey would be completed by end of October 2008.

3.0 ALTERNATIVES

3.1 (No Action) Non-Approval of the Proposed Action.

The applicant would not be allowed to undertake the proposed activities. This alternative could prevent the development and production of hydrocarbon resources and result in the loss of royalty income for the U.S. Under this alternative, none of the potential impacts associated with the proposed actions on the Federal portion of the Liberty prospect would occur. Under this alternative, none of the economic benefits to potential local employees, the North Slope Borough, State of Alaska, and Federal Government, as discussed in the Liberty Development and Production Plan (DPP) EA (USDOI, MMS, 2007a), would be realized. This alternative is not analyzed further in this EA.

4.0 AFFECTED ENVIRONMENT

The following resources addressed in the Liberty DPP EA (MMS 2007a:Chapter 2) that are relevant to this proposed action are Benthic and Boulder Patch Communities; Fish; Marine Mammals; Marine and Coastal Birds; Threatened and Endangered Species; Cultural Resources. The information from the Liberty DPP EA is incorporated herein by reference.

5.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

From our review of the Liberty DPP EA and recent lease sale EIS's and EA's, MMS has concluded that negligible impacts will result from the proposed action for the following resources: Air Environment; Marine Water Quality; Fresh Water Environment; Terrestrial Mammals; Vegetation and Wetlands; and Socioeconomics. These subjects are not analyzed further in this EA.

The MMS carefully considered the potentially affected resources and species as related to our permitting activities. Several "effect determinations" have been prepared as they relate to required consultations for the resources and species potentially affected by the Proposal:

- Essential Fish Habitat as defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)
- Federally listed or proposed threatened/endangered species (or those species' designated critical habitat) as defined by the Endangered Species Act (ESA)
- Historic or prehistoric resources eligible for listing in the National Register of Historic Places as defined by the National Historic Preservation Act

The various "effect determinations" are discussed in this section, and official copies can be found as appendices to this EA.

Reviewers of the documents outlined in Section 2.2 of this EA will note that "significant" findings have been modified to reflect: (1) MMS analysis of potential impact; (2) MMS significance thresholds; and (3) additional mitigation measures identified subsequent to submittal of the permit application, which have been incorporated in the proposed action or become requirements for the proposed action.

5.1 Boulder Patch.

We have reviewed the Boulder Patch Report (BPXA, 2007a) plus the MMS Liberty EIS (USDOI, MMS, 2002), which assessed the effects of pipeline trenching near the Boulder Patch, and the Beaufort Sea multiple-sale EIS (USDOI, MMS, 2003). We conclude that the Boulder Patch organisms and research sites could be affected by OBC laying and retrieval, suspended sediments, and possible fuel spills. The effects of suspended sediments are assessed carefully in the Boulder Patch Report and USDOI, MMS (2002:Sec. III.C.3.e(2)(b)2). The effects of possible fuel spills are assessed carefully in USDOI, MMS (2003:Secs. IV.C.2.a(3)(b)1) and 2). The following paragraph updates the assessments for the effects of cable laying and retrieval.

The amount of habitat that would be affected physically by the cables can be estimated. The cable might not crush kelp, but it probably would crush fragile organisms like sponges and soft coral. The area affected can be estimated with Figure 3 in the Boulder Patch Report. It indicates that the total length of cable in kelp habitat is about 40 mi, and the report explains that the cables are about 1-in wide. Those two numbers indicate that the cables would crush fragile organisms in an area aggregate of approximately ½ acre. The recolonization time or recovery time for Boulder Patch organisms would require several years (USDOI, MMS, 2002:Sec. IV.C.2.a(2)). While cable laying and retrieval would affect a relatively small percentage of Boulder Patch organisms, the effect on the few Boulder Patch research sites could be major. Overall, the level of effect due to cable laying and retrieval, suspended sediments, and possible fuel spills would be moderate. This determination is based on mitigation outlined in Section 6.3 of this EA.

5.2 Essential Fish Habitat.

After reviewing the Fish/EFH Report (BPXA, 2007b), MMS concurs that disturbance from exposure to airgun sounds during the proposed shallow-water seismic survey in the Liberty area may have the potential to impact feeding and migrating fish. The extent of the impact, however, would be sufficiently low that it falls within natural variations, and no population-level impacts are expected. This determination is based on mitigation outlined in Section 6.4 of this EA.

In accordance with the MSFCMA, the identification of potential impacts to fish and fish habitat and associated mitigation and monitoring also are required. After reviewing the proposal, MMS has reached a “no-effect” determination under MSFCMA.

A copy of the effect determination can be found at Appendix 9.6 of this EA.

5.3 Marine and Coastal Birds.

5.3.1 ESA-Listed Birds.

The MMS and the Corps of Engineers have consulted with the FWS on the potential impacts of programmatic seismic surveys (see Appendix 9.7 of this EA), as well as the proposed action (see Appendix 9.8 of this EA). The site-specific consultation concluded:

> While it is possible that spectacled eiders will encounter project vessels and activities adverse effects are expected to be limited to the displacement of a small number of individuals to other comparable areas of the Beaufort Sea, and are hence, considered to be insignificant. Therefore, consultation on the proposed seismic survey is concluded informally by this letter.

This conclusion remains predicated on implementation of mitigation measures identified in those consultation documents, reiterated in Section 6.5 of this EA.

5.3.2 Other Marine and Coastal Birds.

The MMS incorporates by reference the Bird Report (BPXA, 2007c) for a general description of the affected environment regarding marine and coastal birds, but this report contains some inconsistencies and vague commitments to mitigate impacts to coastal and marine birds. We accept the report's conclusions and effect determinations only with the implementation of mitigation measures described in Section 6.5 of this EA.

5.4 Marine Mammals - Whales and Seals.

A total of three cetacean species (beluga, gray, and bowhead whale) and three species of pinniped managed by NMFS (ringed, bearded, and spotted seals) are known to occur or may occur in the Beaufort Sea in or near the Liberty area. Five additional cetacean species—narwhal, killer whale, harbor porpoise, minke whale, and fin whale—could occur in the Beaufort Sea, but each of these species is rare or extralimital and unlikely to be encountered in the Liberty area. Of these species, only the bowhead whale is listed as endangered under the ESA.

The marine mammal species expected to be encountered most frequently throughout the seismic survey in the Liberty area is the ringed seal. The bearded and spotted seal also can be observed, but to a far lesser extent than the ringed seal. Presence of beluga, bowhead, and gray whales in the shallow-water environment within the barrier islands is possible but expected to be very limited. Some seals may be displaced temporarily during seismic activities.

The response of marine mammals to seismic-survey activities depends on the species of cetacean or pinniped, the behavior of the animal at the time of reception of the stimulus, and the distance to and received level of the sound. Disturbance reactions such as avoidance are very likely to occur among marine mammals in the vicinity of the source vessel. No serious injury to marine mammals is anticipated (e.g., due to collisions with vessels) given the nature of the activity in combination with the planned mitigation measures. Mitigation measures for whales and seals will be determined by NMFS through the IHA process and will include marine mammal observers on all vessels. Seismic operations will shut down if marine mammals are observed within the safety zone. The MMS concurs with BPXA that no more than negligible impacts to cetaceans or seals are likely to occur at the population level as long as the terms of the IHA are followed.

The bathymetric survey discussed in Section 2.3 of this EA is not part of Geological and Geophysical Permit Application (08-05). However, the bathymetric survey is a "connected action," as described in 40 CFR 1508.25. Connected actions are actions that are closely related, and they automatically trigger other actions that have environmental impacts. They cannot or will not proceed, unless other actions have been taken previously or simultaneously, or they are interdependent parts of a larger action and/or depend on the larger action for their justification. The bathymetric survey (connected action) does not require a NMFS-issued IHA, because the activities will be performed on ice in <9 ft of water.

Because the Liberty seismic survey will take place shoreward of the barrier islands in very shallow waters from 3-30 ft (1-9.1 m), few bowhead whales are likely to occur in the project area during the proposed activity period. Due to the low energy and smaller zone of influence it is unlikely that the proposed action would result in biological or major effect on bowhead whales. Bowhead whales most likely would occur in or near the project area during fall migration in September and October. If the contingency of activity occurring after the subsistence hunt at Cross Island is implemented, the project acoustic zone of influence would extend beyond the barrier islands and could affect low numbers of migrating bowhead whales. Slight deflection of migration could occur, but migration would remain within the long-term migration corridor. The MMS concurs with BPXA that biological or population-level effects are not expected.

Section 6 of the IHA request (BPXA, 2007a) provides detailed discussion of potential animals exposed to sound, sound propagation characteristics, and safety zones. Section 13 of the IHA request describes specific mitigation measures applicable to this activity. Required mitigation remains predicated on implementation of any additional mitigation measures that may be identified during ongoing ESA consultation and subsequently required by a NMFS IHA.

Per telephone conversation between MMS and NMFS biologists on February 27, 2008, NMFS considers and confirmed the proposed OBC seismic surveys for the Liberty Project to be covered under the June, 16, 2006 Arctic Regional Biological Opinion (ARBO) that addresses Endangered Species Act Section 7 consultation for 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 (MMPA).

The MMS will continue ESA Section 7 consultation with NMFS to issue a 2008 seismic-survey supplemental Biological Opinion for the Beaufort and Chukchi Seas, Alaska. The Authorization of Small Takes under the Marine Mammal Protection Act provides assessment of seismic actions during the following stages of oil and gas activities and may require additional mitigation through the applied-for IHA (Incidental Harassment Authorization): (1) leasing and exploration; (2) development, production and transportation; and (3) abandonment on the continued existence of the bowhead whale, humpback whale, and fin whale and provides measures to conserve these species and mitigate impact.

5.5 Marine Mammals – Polar Bear and Walrus.

Two marine species managed by the FWS occur within the project area, walrus and polar bear. Due to its distribution, encounters with the walrus are possible but not expected. However, anecdotal reports suggest that walruses may be occurring somewhat more frequently in the project area than they have in the past. Based on polar bear sightings in 2007 and previous years, polar bears could be present along the shore of the main land or the barrier islands during the Liberty seismic survey. Polar bear are proposed for listing under the ESA.

There is the potential for interactions with polar bears and disturbance to polar bear dens within the proposed project area. BPXA has requested an LOA from the FWS (BPXA, 2007b) and will work directly with FWS to take whatever measures FWS deems necessary to avoid disturbing polar bears or polar bear dens. These measures may include surveys to locate dens and avoidance of any known den sites. Mitigation measures will be dictated by the Marine Mammals Management branch of the FWS. The MMS concurs with BPXA that no more than negligible impacts to walruses or polar bears are likely to occur, as long as the terms of the LOA are followed.

A copy of the effect determination can be found at Appendix 9.9 of this EA.

5.6 Cultural Resources.

According to the BPXA Project Description, a field archeological and cultural resource reconnaissance has been conducted (August 15, 2007) within the scope of the project location. There is one identified archaeological site on Howe Island within the area of activity. Additional archaeological sites lay outside the survey area adjacent the perimeter of the survey. BPXA will request approval of setbacks from archaeological sites from the SHPO to deter access to these sites.

On February 4, 2008, MMS concluded that the proposed action would have no effect on properties eligible for the National Register of Historic Places, and has requested concurrence from the SHPO. A copy of the effect determination can be found in Appendix 9.10 of this EA.

5.7 Subsistence-Harvest Practices.

Because seismic-survey activities are within a few miles of Cross Island and could coincide with the bowhead whale migration past Cross Island and the community of Nuiqsut's bowhead whale subsistence hunt, potential disturbance to the hunt could occur. For this reason, a plan of cooperation-type agreement, usually in the form of a conflict avoidance agreement (CAA), between BPXA and the whaling captains' association of Nuiqsut would have to be mutually agreed upon and successfully implemented to avoid potential noise disturbances of the local subsistence hunt. We understand that BPXA is conducting CAA negotiations with the Nuiqsut whaling captains' association and the AEWC. If BPXA's 50-day schedule for data acquisition can be maintained, seismic-noise sources would be demobilized from the area before conflicts to the hunt would occur. If data acquisition extends past the 50-day window into September, conflicts with Nuiqsut's whaling season would occur, as 92% of the bowhead whales harvested by Nuiqsut whalers in the last decade have been landed between September 1 and September 18. Shutdown of seismic operations would likely have to occur during this period to avoid conflict to the local subsistence hunt.

An IHA, in concert with BPXA's CAA or plan of cooperation, will identify stipulating procedures (shutdown periods, marine mammal monitoring, etc.) to prevent unmitigable adverse impacts to the subsistence harvest. Because BPXA has applied for an IHA from the NMFS as part of its proposed action, it is MMS' policy that active seismic survey data acquisition will only be allowed to begin after the seismic operator receives its IHA from the NMFS.

5.8 Cumulative Effects.

5.8.1 Boulder Patch.

The cumulative effects described in the Boulder Patch Report are adopted by reference. The report states:

> The cumulative effects described in this section relate to potential effects to the Boulder Patch communities that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil & gas developments.
>
> In the cumulative sense, benthos could be buried by construction of offshore pipelines and islands. The reasonably foreseeable developments with offshore facilities would be Sandpiper, Flaxman, Stinson, and Hammerhead/Kuvlum, outside of the barrier islands, and none of them are near the Boulder Patch. The only development inside the barrier islands close to the Boulder Patch is the Liberty development. However, this development does not include the construction of new pipelines and islands but will use uERD from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. The development and, therefore, the cumulative risk to these future developments would be similar to the Liberty development-specific risk. Another cumulative aspect is the scientific long term monitoring program on the Boulder Patch, funded by MMS. These activities include anchoring on the Boulder site at monitoring stations, sampling of kelp and other species as required and conducting experiments. The potential impacts from these activities are not distinguishable from natural disturbances to the Boulder Patch. The proposed OBC seismic survey is not expected to result in significant impacts to the Boulder Patch communities and as such does not add to the cumulative risk.

5.8.2 Fish and Fish Habitat.

The cumulative effects described in the Fish/EFH Report are incorporated herein by reference. The report states:

> The cumulative effects described in this section relate to potential effects to fish and fish habitat that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil development.

The initial development work for the Prudhoe Bay oil fields began around 1968. Since then the number of production pads increased from 16 in 1973 to 115 in 2001 (NRC 2003). The number of miles of gravel road increased from 100 in 1973 to 400 in 2001. The developed area, which was originally confined to the Prudhoe Bay area, currently extends from the Colville to the Sagavanirktok River. In addition, production facilities for the Badami Unit, located about 30 miles east of the Sagavanirktok River, are connected to the Endicott development by a pipeline. Further oil field expansion is also planned west of the Colville River into the National Petroleum Reserve, Alaska.

Recent and future negotiations between the State of Alaska and various industry groups regarding development of a gas pipeline from Prudhoe Bay to Canadian and U.S. markets could result in future development of the Point Thomson Unit located about 50 miles east of Prudhoe Bay. Other exploratory activities which could lead to future development are proposed for offshore areas east of the Liberty project area in the central and eastern Alaskan Beaufort Sea during 2008. The types of impacts that could result from future development could include potential impacts from habitat loss, effects of disturbance, and oil spills.

The proposed seismic survey activities in the Liberty project area are not likely to add incrementally to existing or planned developments. The need for developers and wildlife managers to address all of the issues related to the potential impacts of future oil field development will continue. Many stipulations and required operating procedures which have helped mitigate the effects of North Slope oil field development are included in various permitting and EIS documents. Continued oversight of North Slope development will help to ensure that the impacts of future development on the environment are minimized."

5.8.3 Marine and Coastal Birds

The cumulative effects described in the Bird Report are incorporated herein by reference. The report states:

The cumulative effects described in this section relate to potential effects to birds in offshore areas or the adjacent coast that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil development.

The initial development work for the Prudhoe Bay oil fields began around 1968. Since then the number of production pads increased from 16 in 1973 to 115 in 2001 (NRC 2003). The number of miles of gravel road increased from 100 in 1973 to 400 in 2001. The developed area, which was originally confined to the Prudhoe Bay area, currently extends from the Colville to the Sagavanirktok River. In addition, production facilities for the Badami Unit, located about 30 miles east of the Sagavanirktok River, are connected to the Endicott development by a pipeline. Further oil field expansion is also planned west of the Colville River into the National Petroleum Reserve, Alaska.

Recent and future negotiations between the State of Alaska and various industry groups regarding development of a gas pipeline from Prudhoe Bay to Canadian and U.S. markets could result in future development of the Point Thomson Unit located about 50 miles east of Prudhoe Bay. Other exploratory activities which could lead to future development are proposed for offshore areas east of the Liberty project area in the central and eastern Alaskan Beaufort Sea during 2008. The types of impacts that could result from future development could include potential impacts from habitat loss, effects of disturbance, increased predation, and oil spills.

The proposed seismic survey activities in the Liberty project area may add incrementally to disturbance impacts of development on marine birds. Mitigation, including scheduling of activities to occur after completion of the nesting season and monitoring of nests if seismic activities occur during the nesting season, will minimize or eliminate impacts to nesting birds. Disturbance to molting and brood-rearing birds may cause temporary displacement of some birds from preferred feeding or resting area, but these impacts will be short-term. Cumulative impacts to marine birds resulting from the proposed offshore seismic exploration activities associated with the Liberty project will likely not be significant.

The need for developers and wildlife managers to address all of the issues related to the potential impacts of future oil field development will continue. Many stipulations and required operating procedures which have helped mitigate the effects of North Slope oil field development are included in various permitting and EIS documents. Continued oversight of North Slope development will help to ensure that the impacts of future development on birds in offshore areas of the Liberty project and other wildlife are minimized."

The proposed action was not anticipated to result in more than minor disturbance impacts to coastal and marine birds, because coastal and marine birds may be displaced a short distance to similar habitats. Another potential project to be completed by Shell Offshore Incorporated in nearby marine areas (USDOI, MMS, 2007b), currently being litigated. If legal objections to the Shell program are resolved, the program may proceed in 2008. The MMS considered the two programs to be sufficiently separated in space and time to allow birds from one project area to not be affected by the other, and resultant cumulative effects are negligible.

5.8.4 Marine Mammals: Whales and Seals.

The proposed seismic-survey activities in the Liberty project area may add incrementally to disturbance impacts of development to bowhead whales and seals, as noted in Section 5.4. Mitigation, including scheduling of activities to occur outside the periods of spring and fall bowhead migration would minimize or avoid potential impacts. Disturbance to low numbers of bowhead whales feeding within the influence of the activity may cause temporary displacement from feeding or resting areas, but these impacts would be short-term. The area of influence of the activity has not been an area where aggregations of feeding or resting bowhead whales have occurred. Cumulative impacts to bowhead whales resulting from the proposed offshore seismic activities associated with the Liberty project would be temporary and negligible.

Continued oversight and assessment of North Slope and OCS exploration and development will help to minimize the impacts of future development on bowhead whales in offshore areas of the Liberty project.

Disturbance to low numbers of seals, primarily ringed seals, within the influence of the activity may cause temporary displacement from feeding or resting areas, but these impacts likely would be short-term. Ringed seal lairs are not likely to occur within the proposed work area. Cumulative impacts to seals resulting from the proposed offshore seismic-exploration activities associated with the Liberty project would be temporary and likely not be major.

5.8.5 Marine Mammals: Polar Bears and Walruses.

The proposed seismic-survey activities in the Liberty project area may add incrementally to disturbance impacts of development to polar bears, as noted in Section 5.5. Effects on walruses are not likely to occur, because very few walruses occur in the area of the proposed activity. Mitigation, including avoiding areas where polar bear dens occur, would minimize or avoid potential impacts. Disturbance to low numbers of polar bears may cause temporary displacement from feeding or resting areas, but these impacts are likely to be short term. Cumulative impacts to polar bears resulting from the proposed offshore seismic-exploration activities associated with the Liberty project would be temporary and likely not be major.

5.8.6 Subsistence-Harvest Practices.

The proposed seismic-survey activities in the Liberty project area may add incrementally to disturbance impacts of development on local subsistence whaling. Mitigation, including scheduling of activities to occur before or after completion of the bowhead whale harvest season (normally specified in a negotiated CAA agreement between operators and whalers) and marine mammal monitoring procedures stipulated in BPXA's IHA application, will minimize or eliminate impacts to the local bowhead whale harvest by Nuiqsut hunters at Cross island. Cumulative impacts to the local bowhead whale hunt resulting from the proposed offshore seismic-exploration activities associated with the Liberty project likely would not be major.

6.0 MITIGATION MEASURES

6.1 Permitting Authorities

Besides the MMS, the Corps of Engineers, Alaska District (Corps) and the State of Alaska, Department of Natural Resources/Division of Oil and Gas (ADNR/DOG) have permitting authority over BPXA's plans to conduct OBC seismic surveys in the Beaufort Sea. Attempts were made to coordinate the permitting agencies' jurisdictional responsibilities and the development of complementary mitigation measures to make sure all direct, indirect, and cumulative impacts are addressed and permit stipulations are properly implemented, monitored and enforced.

According to an email from the Corps to MMS on February 7, 2008, Nationwide Permit (NWP) #6 (Survey Activities) authorizes activities as described in BPXA's application, and includes terms and conditions that mitigate the potential direct and indirect (i.e. cumulative) impacts associated with the proposed project. The FWS and NMFS have recommended to the Corps that special conditions are needed to further mitigate the potential impacts to the Boulder Patch. The applicant, BPXA, is involved in negotiations with both of these resource agencies to clarify the potential project impacts and to request that these agencies allow deviation from the strictest of these proposed stipulations. The Corps is awaiting the outcome of these negotiations/meetings before finalizing and issuing BPXA their NWP #6.

According to an email from the ADNR/DOG to MMS on February 8, 2008, the State Geophysical Exploration Permit traditionally seeks to minimize potential conflicts during the fall bowhead whale subsistence hunt; facilitate communication with whaling crews and local communities; and reduce potential effects on fish, wildlife, and other uses of the area. The permit seeks to achieve the objectives of the Alaska Coastal Management Program (ACMP) and local district plans. To the extent advisable, Corps and MMS mitigation measures and FWS/NMFS IHA stipulations will be integrated with the requirements for State lands to achieve a unified set of requirements for operators.

6.2 BPXA's and CGGVeritas' Mitigation Plan.

BPXA and CGGVeritas has stated that they will implement mitigation measures to protect the fish, wildlife, and subsistence resources of the Beaufort Sea, and plan to conduct the proposed seismic operation in full compliance with all Federal, State, and local regulations. Therefore, MMS incorporates BPXA and CGGVeritas' Mitigation Plan into its NEPA analysis and assumes its implementation through the combined permitting authority of the State of Alaska, Corps and MMS.

BPXA and CGGVeritas plan to implement a Health Safety and Environmental (HSE) Plan, inclusive of an Interface Plan, Emergency Response Plan, and Environmental Management Plan to guide the conduct of work. All employees, subcontractors, and visitors will be trained at a minimum to the applicable standards set forth by the North Slope Training Cooperative. Additionally, all personnel will participate in specific project-related training programs, which include vessel and overall operational safety and marine mammal and other wildlife interaction.

The Captain on each vessel and HSE Advisors from CGGVeritas have the responsibility to ensure compliance with permits and regulations and the HSE Plan. An HSE Consultant, BPXA Management, and HSE staff plan to provide oversight and assurance.

6.2.1 Boulder Patch.

The mitigation described in the Boulder Patch Report is incorporated herein by reference.

The use of lightweight equipment should limit impacts to the Boulder Patch, and there will be no anchoring of any vessels in the Boulder Patch. Also, according to an interagency briefing on January 28, 2008, a 100-m radius exclusion zone will be implemented around the following long-term Boulder Patch monitoring sites (datum NAD 27):

Site	Location
B-1	Lat. 70 17.825 N, Long. 147 38.44 W.
DS-11	Lat. 70 19.330 N. Long. 147 34.927 W. (150-m exclusion zone for site DS-11)
E-1	Lat. 70 18.879 N. Long. 147 44.075 W.
E-2	Lat. 70 19.088 N. Long. 147 43.074 W.

E-3	Lat. 70 19.452 N. Long. 147 38.978 W.
L-1	Lat. 70 17.328 N. Long. 147 36.621 W.
L-2	Lat. 70 18.063 N. Long. 147 34.65 W.

Dates of any scientific activity at these monitoring sites will be coordinated with BPXA's OBC survey schedule so that a simultaneous operations plan can be developed and implemented[1].

The 3D OBC seismic survey in the Liberty area, in particular the deployment and retrieval of the receiver cables onto the seafloor, has the potential to damage the flora and fauna on the Boulder Patch. The magnitude of the impact, however, is not distinguishable from natural factors that can cause disturbance to the Boulder Patch community and unlikely to have a major permanent impact. Nevertheless, BPXA plans to adopt the following mitigation measures to further reduce any potential damage of the Boulder Patch communities and intends to implement some monitoring activities to document damage in case it occurs.

Mitigation measures implemented during the planning and design include:

- The receiver cables that will be used during the proposed seismic survey are smaller than the ones that have been used in previous OBC surveys.
- The field digitizing unit is among the lightest and smallest recording equipment available.
- The chain that will be attached to the hydrophone to prevent movements will be entirely taped to the hydrophone pigtail and, as such, will form an integrated part of the hydrophone. This will prevent entanglement of plants.

Mitigation measures implemented during survey include:

- BPXA will report to MMS if damage to the Boulder Patch occurs as a result of their operations. Additionally, BPXA shall notify MMS if they detect any fragile biocenoses otherwise not documented in their permit application.
- Vessels will not anchor within any documented Boulder Patch areas, unless an emergency situation involving human safety specifically exists and there are no other feasible sites to anchor at the time.
- No refueling of vessels will occur in the Boulder Patch area.
- The deployment of cables or batteries is prohibited within a 100-m radius (i.e. exclusion zone) around the following long-term Boulder Patch monitoring sites (datum NAD 27):

Site	**Location**
B-1	Lat. 70 17.825 N, Long. 147 38.44 W.
DS-11	Lat. 70 19.330 N. Long. 147 34.927 W. (150-m exclusion zone for site DS-11)
E-1	Lat. 70 18.879 N. Long. 147 44.075 W.
E-2	Lat. 70 19.088 N. Long. 147 43.074 W.
E-3	Lat. 70 19.452 N. Long. 147 38.978 W.

[1] Boulder Patch researchers Ken Dunton and Brenda Konar will likely be in the area during the OBC shoot and have already started working with BPXA staff on a plan for simultaneous operations.

L-1 Lat. 70 17.328 N. Long. 147 36.621 W.
L-2 Lat. 70 18.063 N. Long. 147 34.65 W.

- Navigators will be supplied with the coordinates of the aforementioned Boulder Patch exclusion zones.
- All possible options will be investigated to avoid or minimize the use of surface buoys on the batteries that will be deployed on the Boulder Patch.
- Caution with cable deployment and retrieval is an important factor for data quality and, as such, part of the operational procedures. However, captains of the vessels involved in the retrieval of receiver cables will receive extra instructions to operate their vessels in a manner that will minimize the chance of dragging cables when operating in the Boulder Patch. A specific speed will not be dictated, because vessel control in varying weather conditions must be left to the captain's discretion.
- An awareness video and/or presentation will be provided to all crew members. This orientation will include instructions on the implementation of the above mitigation measures. This orientation session will be documented with an attendance list.
- A toolbox meeting will be held among the crew prior to the start of the operations within the Boulder Patch area to remind them of the Boulder Patch mitigation requirements.

Mitigation monitoring includes:

- The crew of the cable vessels will document if kelp plants are entangled in the receiver cable lines, hydrophones, or batteries when they are retrieved and will bag the samples. The number of plants, approximate coordinates on the Boulder Patch, water depth and a short description of the plant (e.g., length, signs of damage) will be recorded and reported to MMS after seismic-data acquisition on the Boulder Patch is completed.

The above mitigation measures would moderate the level of effect on Boulder Patch organisms and research sites due to cable laying and retrieval, suspended sediments, and possible fuel spills. The mitigation would prevent effects on research sites and effects from fuel spills. With the above mitigation measures, we expect no project-induced effects on Boulder Patch research sites and only minimal and local long-term damage to Boulder Patch organisms due to cable laying and retrieval and to suspended sediments.

6.2.2 Essential Fish Habitat.

The mitigation measures described in BPXA's Fish/EFH Report are incorporated herein by reference. The report states the following measures have been implemented during the planning and design of the survey that reduce the potential impact to the environment:

- The area for which seismic data is required, i.e. the well path from SDI to the Liberty prospect, has been minimized. This has led to a reduction in the shallow water and land areas where receiver cables need to be deployed.
- The total airgun-discharge volume has been reduced to the minimum volume needed to obtain the required data.

Based on the assessment described in the Fish/EFH Report, it is unlikely that seismic activities will have a long-term adverse impact on fish species or their habitat. However, the implementation of marine mammal-related power-down and ramp-up procedures during the seismic survey may reduce any potential impact to individual fish even more.

6.2.3 Marine and Coastal Birds.

The following measures have been implemented by BPXA during the planning and design of the OBC seismic survey to reduce the potential impacts to marine and coastal birds:

- The area for which seismic data is required, i.e. the well path from SDI to the Liberty prospect, has been minimized. This has led to a reduction in the shallow water and land areas where receiver cables need to be deployed.
- The total airgun discharge volume has been reduced to the minimum volume needed to obtain the required data.
- Due to the short open-water window in which seismic surveys can be conducted, the data acquisition has been prioritized. Acquisition of data sound around Howe Isalnd and Lion Point will occur in mid-August well after the nesting period.

BPXA plans to implement the following mitigation measures during the seismic survey to reduce any impacts to marine and coastal birds:

- Endicott causeway and Duck Island 1 and 2 will be surveyed for the presence of eider nests prior to the start of the deployment of receiver cables in these areas if birds are still nesting. A biologist will walk the perimeter of the causeway and search the driftwood accumulations for eider nests. Precaution will be used to ensure that eiders are not flushed from nests during the search.
- GPS coordinates of nest locations with buffer zones will be recorded and provided to the crews deploying the cables.
- The biologist will mark active nests with two flagged survey stakes located ~20 meters on either side of the nest to allow cable deployment crews to identify physical locations of nests and avoid cable deployment in the immediate vicinity of active nests. If nesting eiders are present on the Endicott causeway and Duck Island 1 and 2 during cable deployment and retrieval, caution will be used to ensure that eiders are not flushed from nests, although nesting eider hens are not easily displaced from nests. If any eiders are flushed from nests, the eggs will be covered with the down from the nest to reduce visibility to predators if possible.

In recent meetings and conversations with BPXA staff, BPXA has also agreed to implement the following mitigation measures as part of their proposed action:

- Receiver-cable deployment within the area bounded by the western edge of the Endicott Causeway, the MPI, and Howe Island, shall be allowed up to the time an on-site biologist (knowledgeable in avian nesting behavior) determines that snow goose nesting has begun and after nesting has ended. However, survey activities can continue during the nesting period if the on-site biologist determines, in consultation the Fish and Wildlife Service, that the locations of the nesting sites are such that the potential for causing adverse impacts is low. The nesting period is estimated to be between May 15 and July 15.

- No active seismic-data acquisition on and within 100 meters of Howe Island is permitted before August 15 to protect brood-rearing snow geese.
- Potential disturbance of nesting birds on Howe Island, Lion Point, the Endicott causeway and Duck Island 1 and 2 could occur during receiver-cable placement activities. To protect nesting birds, particularly common eiders, on the eastern side of the Endicott Causeway and Duck Island 1 and 2, and the Lion Point vicinity the following stipulations will be followed to the maximun extent practicable:
    1. Cable deployment at these sites could occur prior to June 10 (prenesting), without nest surveys.
    2. No receiver-cable deployment shall occur within 100 m of these areas between June 10 and June 30 (nest-initiation period).
    3. For receiver-cable deployment after June 30 (postnesting), these sites will be surveyed for the presence of eider nests prior to receiver-cable deployment. A biologist will walk these areas and search driftwood accumulations for eider nests. The biologist will mark active nests with flagged survey stakes located ~20 m on both sides of the nest in such a manner that cable-deployment crews can identify nest locations and avoid disturbances near active nests. The biologist will record GPS coordinates of nest locations and provide this information to the cable crews prior to receiver-cable deployment.
    4. Precaution will be used so that eiders are not flushed from nests during the search. If nesting eiders inadvertently are flushed from nests, any exposed eggs will be covered with the down from the nest to reduce visibility to predators.

Very little information is available describing the reactions of marine birds to seismic activities. While MMS concurs that: "Observations of localized responses of birds to seismic activities may help increase understanding of potential effects of these activities on marine birds" (BPXA, 2007c), MMS does not anticipate that MMO's on seismic-source vessels would record reactions of birds to source vessels.

6.2.4 Whale- and Seal-Monitoring Program.

BPXA has submitted a proposed monitoring plan and mitigation measures for whales and seals to NMFS as part of its IHA request (Appendix 9.4 of this EA). Mitigation herein is predicated on any additional mitigation measures identified in a NMFS-issued IHA for this action being implemented. The following is a brief summary of BPXA's proposed monitoring:

<u>Vessel-Based Visual Monitoring</u>

The plan has three MMO's on each source vessel during the entire survey. These vessel-based MMO's will monitor marine mammals near the seismic-source vessels during all daylight hours and during any ramp-up of air guns at night. If marine mammals are detected within the designated safety radii, shutdown procedures will be implemented. BPXA intends to work with experienced MMO's that have had previous experience working on seismic-survey vessels. At least one Alaskan Native resident who speaks Inupiat and is knowledgeable about the marine mammals of the area is expected to be included as one of the team members aboard each source vessel and the mother ship (*Arctic Wolf*).

In case the source vessels are not shooting but are involved in the deployment or retrieval of receiver cables, the MMO's will remain on the vessels and will continue their observations. The main purpose of the MMO's is to monitor the established safety zones and to implement the mitigation measures as described in the IHA.

Two MMO's also will be placed on the *Arctic Wolf* during its transit from Homer or Anchorage via the Chukchi Sea and around Barrow to the survey area. The presence of MMO's on this vessel is to address concerns regarding the spring beluga whale subsistence hunt. This is in addition to communication with the whale hunters of Point Lay and Kotzebue. At least one Alaskan Native resident who speaks Inupiat will be placed on this vessel.

Aerial Surveys

During the July and August timeframe, no bowhead whales are expected to be present in or close to the survey area, so no aerial surveys are planned during this timeframe. If the survey continues into September or October, after the bowhead whale hunt and in compliance with the CAA, aerial surveys would be conducted twice a week, if conditions allow, until 3 days after the seismic survey and cover the area immediately offshore of the barrier islands. If other operators conduct surveys in the vicinity, cooperation regarding sharing data or flight time would be considered, provided that an acceptable methodology and business relationship can be worked out in advance.

Acoustical Measurements

Prior to and during the seismic survey, acoustic measurements and monitoring will be conducted for three different purposes: (1) to verify the distances of the safety zones; (2) to measure source levels (i.e., received levels referenced to 1 m from the sound source) of each vessel of the seismic vessels, to obtain knowledge on the sounds generated by the vessels; and (3) to measure received levels offshore of the barrier islands from the seismic-sound source.

6.2.5 Polar Bear and Pacific Walrus

BPXA has submitted proposed mitigation measures for polar bears and walrus to the FWS as part of its LOA request (Appendix 9.5 of this EA). The following summarizes what BPXA has proposed to FWS to minimize impacts from seismic survey sounds on polar bear and walrus in water and walrus hauled out on land or ice, and forms an integral part of the survey in the form of specific procedures such as: (i) speed and course alterations; (ii) power-down, ramp up and shutdown procedures; and (iii) provisions for poor visibility conditions: (1) marine mammal observers on board the source vessels will monitor a safety radius and seismic operations will be shut down if walruses are sighted within the 180-dB (Level A harassment according to MMPA) safety zone and polar bears are sighted within the 190-dB safety zone; (2) seismic-survey and associated vessels shall observe a 0.5-mi (~800 m) safety radius around walrus groups hauled out onto land or ice. BPXA also plans that all personnel will receive polar bear awareness instruction which will provide them with information on the law regarding polar bears, BPXA's polar bear policy, and the design and maintenance of camp facilities and other survey-specific aspects designed to increase bear safety. Selected personnel will have completed a FWS-approved hazing-training program.

Prior to the start of the operations on ice and during the open-water season, but close to shore or on land, BPXA plans to confer with the FWS on the locations of radio-collared bears and any sightings made by FWS in the course of aerial surveys that may have been conducted during the year. Information on probable and historical den locations also will be reviewed. BPXA plans to work directly with FWS to take whatever measures FWS deems necessary to avoid disturbing polar bears or polar bear dens.

6.3 MMS-Recommended Mitigation Measures and Permit Stipulations

In addition to the mitigation measures BPXA has stated they intend to implement (see Section 6.2) as part of their proposed action, the following additional mitigation is required to: (1) be consistent with environmental policy as required by NEPA, ESA, and MMPA; and (2) comply with 40 CFR 1500.2(f) regarding the requirements for Federal agencies to avoid or minimize any possible adverse (direct and indirect) effects of their actions upon the quality of the human environment. Implementing mitigation measures also fulfills MMS's statutory mission and responsibilities, i.e., to issue G&G exploration permits for seismic surveys that are technically safe and environmentally sound while considering environmental, technical, and economic factors.

The following mitigation measures are associated with MMS's standard G&G stipulations (http://www.mms.gov/alaska/re/permits/stips1-5.htm).

- No solid or liquid explosives shall be used without specific approval.
- Permittee operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. Any difficulty encountered with other uses of the area or any conditions that cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the MMS Regional Supervisor/Resource Evaluation (RS/RE). Serious or emergency conditions shall be reported without delay.
- Permittee operations shall maintain a minimum spacing of 15 miles between the seismic-source vessels for separate operations. The MMS RS/RE must be notified by means of the weekly report whenever a shut down of operations occurs in order to maintain this minimum distance.
- Permittee operators shall use the lowest sound levels feasible to accomplish their data-collection needs.
- Vessels and aircraft shall avoid concentrations or groups of whales. Permittee operators shall, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, shall aircraft be operated at an altitude lower than 1,000 feet above sea level (ASL) when within 1,500 lateral feet of groups of whales. Helicopters shall not hover or circle above such areas or within 1,500 lateral feet of such areas.

- When weather conditions do not allow a 1,000-foot ASL flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot ASL altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet ASL because of weather conditions, the operator must avoid known whale-concentration areas and should take precautions to avoid flying directly over or within 1,500 yards of groups of whales.
- When the Permittee operates a vessel near a concentration of whales, every effort and precaution shall be taken to avoid harassment of these animals. Therefore, vessels shall reduce speed when within 900 feet of whales and those vessels capable of steering around such groups should do so. Vessels shall not be operated in such a way as to separate members of a group of whales from other members of the group.
- Vessel operators shall avoid multiple changes in direction and speed when within 900 feet of whales. In addition, operators shall check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.
- Small boats shall not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels shall adjust speed accordingly to avoid the likelihood of injury to whales.
- When any operator becomes aware of the potentially harassing effects of operations on whales, or when any operator is unsure of the best course of action to avoid harassment of whales, every measure to avoid further harassment shall be taken until the NMFS is consulted for instructions or directions. However, human safety shall take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of whales.
- The Permittee shall notify MMS RS/RE, NMFS, and FWS in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals and other wildlife resources.
- The deployment of cables or batteries is prohibited within a 100-m radius (i.e. exclusion zone) around the following long-term Boulder Patch monitoring sites (datum NAD 27):

Site	**Location**
B-1	Lat. 70 17.825 N, Long. 147 38.44 W.
DS-11	Lat. 70 19.330 N. Long. 147 34.927 W.
	(150-m exclusion zone for site DS-11)
E-1	Lat. 70 18.879 N. Long. 147 44.075 W.
E-2	Lat. 70 19.088 N. Long. 147 43.074 W.
E-3	Lat. 70 19.452 N. Long. 147 38.978 W.
L-1	Lat. 70 17.328 N. Long. 147 36.621 W.
L-2	Lat. 70 18.063 N. Long. 147 34.65 W.

- Navigators will be supplied with the coordinates of the aforementioned Boulder Patch exclusion zones.
- The use of lightweight equipment should limit impacts to the Boulder Patch, and there will be no anchoring of any vessels in the Boulder Patch. Dates of any scientific activity at these monitoring sites will be concluded so that if any work will be occurring during the time of the proposed survey, a simultaneous operations plan can be developed. The chain that will be attached to the

hydrophone to prevent movements will be entirely taped to the hydrophone pigtail and, as such, will form an integrated part of the hydrophone. This will prevent entanglement of plants.

- BPXA will report to MMS RS/RE if damage to the Boulder Patch occurs as a result of their operations. Additionally, BPXA shall notify MMS if they detect any fragile biocenoses otherwise not documented in their permit application.
- Vessels will not anchor within any documented Boulder Patch areas, unless an emergency situation involving human safety specifically exists and there are no other feasible sites to anchor at the time.
- No refueling of vessels will occur in the Boulder Patch area.
- All possible options will be investigated to avoid or minimize the use of surface buoys on the batteries that will be deployed on the Boulder Patch.
- Caution with cable deployment and retrieval is an important factor for data quality and, as such, part of the operational procedures. However, captains of the vessels involved in the retrieval of receiver cables will receive extra instructions to operate their vessels in a manner that will minimize the chance of dragging cables when operating in the Boulder Patch. A specific speed will not be dictated, because vessel control in varying weather conditions must be left to the captain's discretion.
- An awareness video and/or presentation will be provided to all crew members. This orientation will include instructions on the implementation of the above mitigation measures. This orientation session will be documented with an attendance list.
- A toolbox meeting will be held among the crew prior to the start of the operations within the Boulder Patch area to remind them of the Boulder Patch mitigation requirements.
- The crew of the cable vessels will document if kelp plants are entangled in the receiver cable lines, hydrophones, or batteries when they are retrieved and will bag the samples. The number of plants, approximate coordinates on the Boulder Patch, water depth and a short description of the plant (e.g., length, signs of damage) will be recorded and reported to MMS RS/RE after seismic-data acquisition on the Boulder Patch is completed.
- To help avoid causing bird collisions with seismic survey and support vessels, seismic and surface support vessels will minimize the use of high-intensity work lights, especially within the 20-meter-bathymetric contour. High-intensity lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog) otherwise they shall be turned off. Deck lights, interior lights, and lights used during navigation could remain on for safety.[2]
- All bird collisions (with vessels and aircraft) shall be documented and reported within 3 days to the MMS RS/RE, or his designee. Minimum information shall include species (if possible), date/time, location, weather, identification of the vessel or aircraft involved and its operational status when the strike occurred. Bird

[2] Nothing in this mitigation measure is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.

photographs are not required, but would be helpful in verifying species. Permittees/operators are advised that the FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

- Ledyard Bay Critical Habitat Unit (Unit) – Except for emergencies or human/navigation safety, surface vessels associated with seismic survey operations shall avoid travel within the Unit between July 1 and November 15. To the maximum extent practicable, aircraft supporting seismic survey operations shall avoid operating below 1,500 feet ASL over the Unit between July 1 and November 15. Vessel travel within the Unit and altitude deviations by aircraft over the Unit for emergencies or human safety shall be reported within 24 hours to MMS RS/RE.
- Seismic surveys (i.e. no active seismic data collection) shall commence no earlier than June 10 to allow pre-nesting birds using nearshore waters time to disperse to onshore nesting sites.

The following monitoring and mitigation measures are related to MMS complying with the requirements of the Marine Mammal Protection Act, Endangered Species Act and Migratory Bird Treaty Act. However, comparable mitigation and monitoring requirements defined in any: (1) NMFS (the Federal agency having MMPA management authority for cetaceans and pinnipeds, less Pacific walrus) and FWS (the Federal agency in having MMPA management authority for Pacific walrus, polar bear, and sea otter) ITA and/or Letters of Authorization (LOA) obtained by the seismic survey operator; and (2) FWS Fish and Wildlife Coordination Act review of the BPXA's Section 10/404 Corps Permit <u>will have precedence over any related measures listed below</u>:

- Exclusion Zone – A 180/190 dB isopleth exclusion zone from the seismic-survey sound source shall be free of marine mammals before the survey can begin and must remain free of marine mammals during the survey. The purpose of the exclusion zone is to protect marine mammals from Level A harassment (injury).The 180 dB applies to cetaceans and the Pacific walrus, and the 190 dB applies to pinnipeds other than the Pacific walrus. The exclusion zones specified in ITAs and/or LOAs will take precedence over the MMS-identified exclusion zone.
- Monitoring of the Exclusion Zone – Individuals (marine mammal biologists or trained observers) shall monitor the area around the survey for the presence of marine mammals to maintain a marine mammal-free exclusion zone and monitor for avoidance or take behaviors. Visual observers monitor the exclusion zone to ensure that marine mammals do not enter the exclusion zone for at least 30 minutes prior to ramp up, during the conduct of the survey, or before resuming seismic-survey work after shut down. The NMFS will set specific requirements for the marine mammal monitoring program and observers.
- Shut Down/Power Down – A seismic survey shall be suspended until the exclusion zone is free of marine mammals. All observers shall have the authority to, and will, instruct the vessel operators to immediately stop or de-energize the airgun array whenever a marine mammal is seen within the exclusion zone or to power down to a sound level where the marine mammal in no longer in the exclusion zone. If the airgun array is completely powered down for any reason

during nighttime or poor sighting conditions, it shall not be re-energized until daylight or whenever sighting conditions allow for the exclusion zone to be effectively monitored from the source vessel and/or through other passive acoustic, aerial, or vessel-based monitoring.

- Ramp Up – Ramp up is the gradual introduction of sound to deter marine mammals from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of at 20-to-40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures may begin after observers ensure the absence of marine mammals for at least 30 minutes. Ramp-up procedures shall not be initiated when monitoring the exclusion zone is not possible. A single airgun operating at a minimum source level can be maintained for routine activities, such as making a turn between line transects, for maintenance needs or during periods of impaired visibility (e.g., darkness, fog, high sea states), and does not require a 30-minute clearance of the exclusion zone before the airgun array is again ramped up to full output.
- Field Verification – Before conducting the survey, the operator shall verify the radii of the exclusion zones within real-time conditions in the field. This provides for more accurate exclusion-zone radii rather than solely relying on modeling techniques before entering the field. When moving a seismic-survey operation into a new area, the operator shall verify the new radii of the exclusion zones by applying a sound-propagation series.
- Reporting Requirements – Operators must report immediately any shut downs/power downs due to a marine mammal entering the exclusion zones and provide the regulating agencies and MMS RS/RE with information on the frequency of occurrence and the types and behaviors of marine mammals (if possible to ascertain) entering the exclusion zones.
- Walrus - Vessels and aircraft should avoid concentrations or groups of walruses. Operators should, at all times, conduct their activities at a maximum distance from such aggregations. Seismic-survey and associated support vessels shall observe a 0.5-mile safety radius around Pacific walrus groups hauled out onto land or ice. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,500 feet ASL when within 0.5-mile of walrus groups. Helicopters may not hover or circle above such areas or within 2,500 lateral feet of such areas.
- Polar Bear - Seismic survey operators shall adhere to any mitigation measures identified by the FWS to protect polar bears from being harassed and/or injured.

7.0 REFERENCES

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8.0 FIGURES & TABLES

9.0 APPENDICES

9.1 *Liberty Shallow Water Seismic Survey 2008, Biological Assessment Boulder Patch Area,* LGL Report 988-1, submitted to BPXA in December 2007 (BPXA, 2007a). Appendix 9.1 of this EA. [Boulder Patch Report]

9.2 *Liberty Shallow Water Seismic Survey 2008, Biological Assessment for Fish and Fish Habitat*, LGL Report 988-2, submitted to BPXA in December 2007 (BPXA, 2007b). Appendix 9.2 of this EA. [Fish/EFH Report]

9.3 *Liberty Shallow Water Seismic Survey 2008, Biological Assessment for Marine and Coastal Birds*, LGL Report 988-3, submitted to BPXA in December 2007 (BPXA, 2007c). Appendix 9.3 of this EA. [Bird Report]

9.4 Request for an Incidental Harassment Authorization (IHA) pursuant to Section 101(A)(5) of the Marine Mammal Protection Act covering incidental harassment of marine mammals during an OBC seismic survey in the Liberty Prospect, Beaufort Sea, Alaska in 2008 - Submitted to National Marine Fisheries Service, November 2007

9.5 Request of Letter of Authorization (LOA) pursuant to Section 101(A)(5) of the Marine Mammal Protection Act covering 3D OBC Liberty seismic survey and bathymetry survey – Submitted to US Fish and Wildlife Service, December 14, 2007

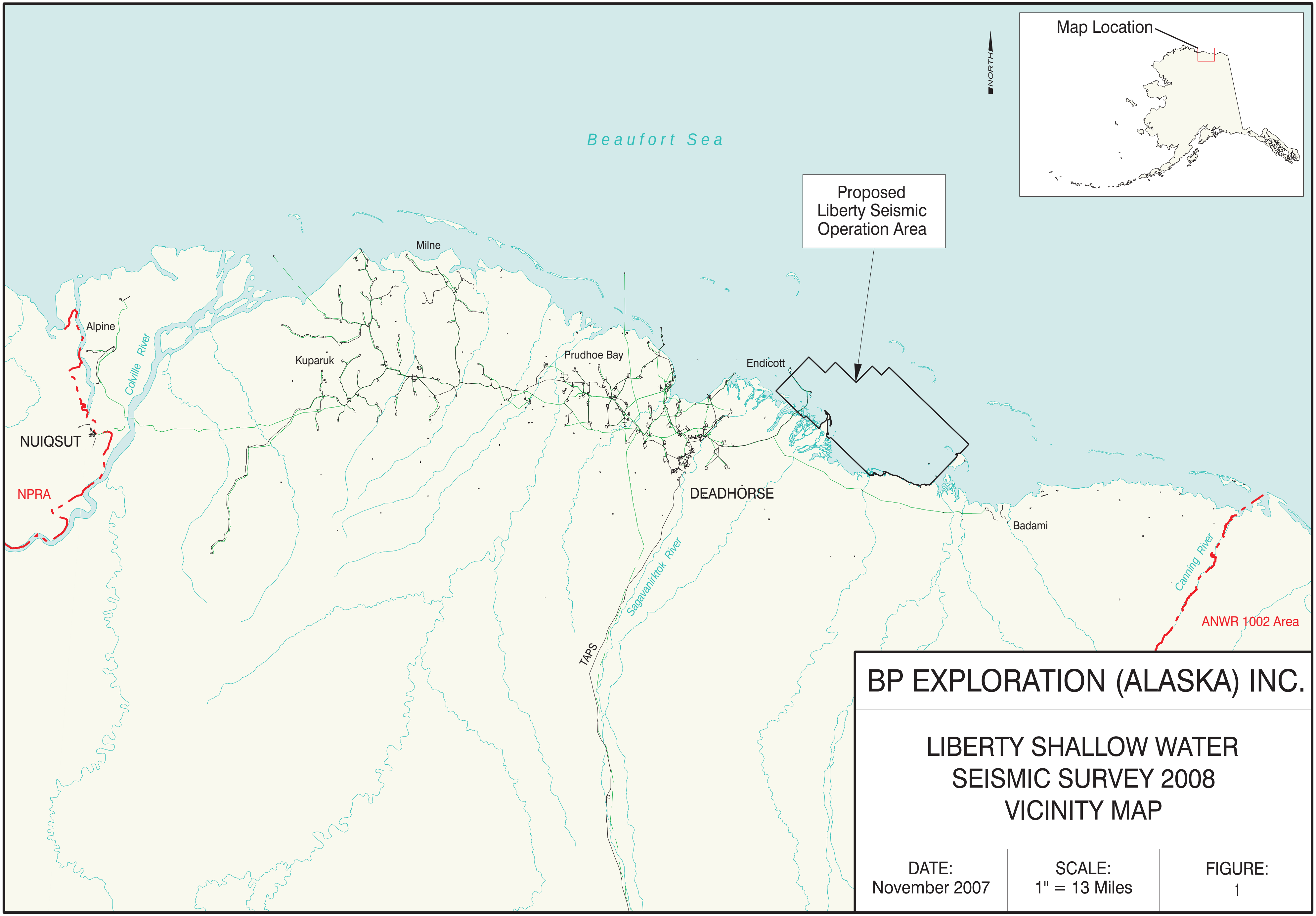
9.6 Effect Determination for Essential Fish Habitat

9.7 Marine Birds, ESA Section 7 Consultation 2007

9.8 Marine Birds, ESA Section 7, Consultation 2008

9.9 Effect Determination for Proposed Species, Polar Bear

9.10 Effect Determination for Cultural Resources



BP EXPLORATION (ALASKA) INC.

LIBERTY SHALLOW WATER
SEISMIC SURVEY 2008
VICINITY MAP

DATE:	SCALE:	FIGURE:
November 2007	1" = 13 Miles	1

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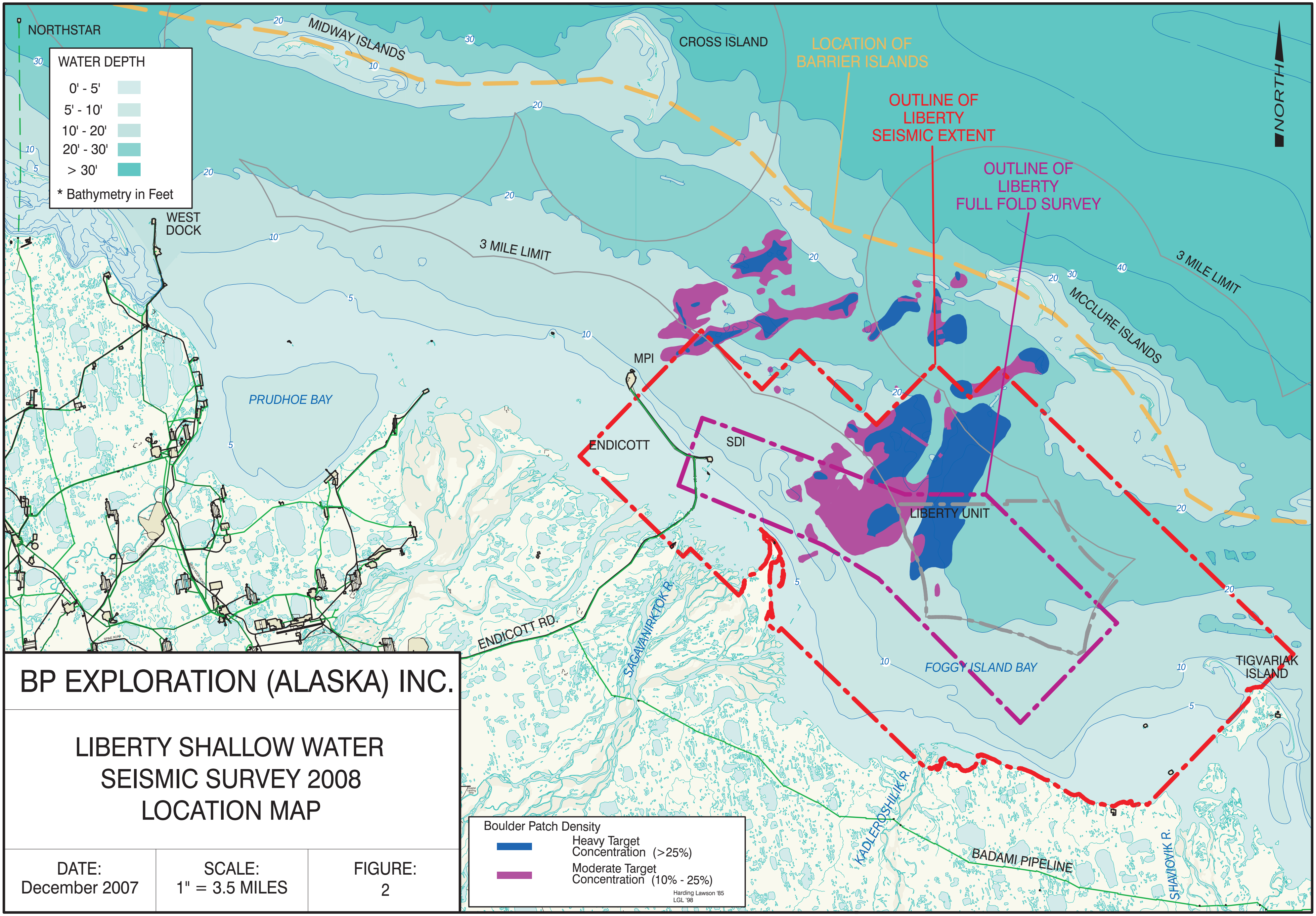

BP EXPLORATION (ALASKA) INC.

LIBERTY SHALLOW WATER SEISMIC SURVEY 2008 LOCATION MAP

DATE:	SCALE:	FIGURE:
December 2007	1" = 3.5 MILES	2

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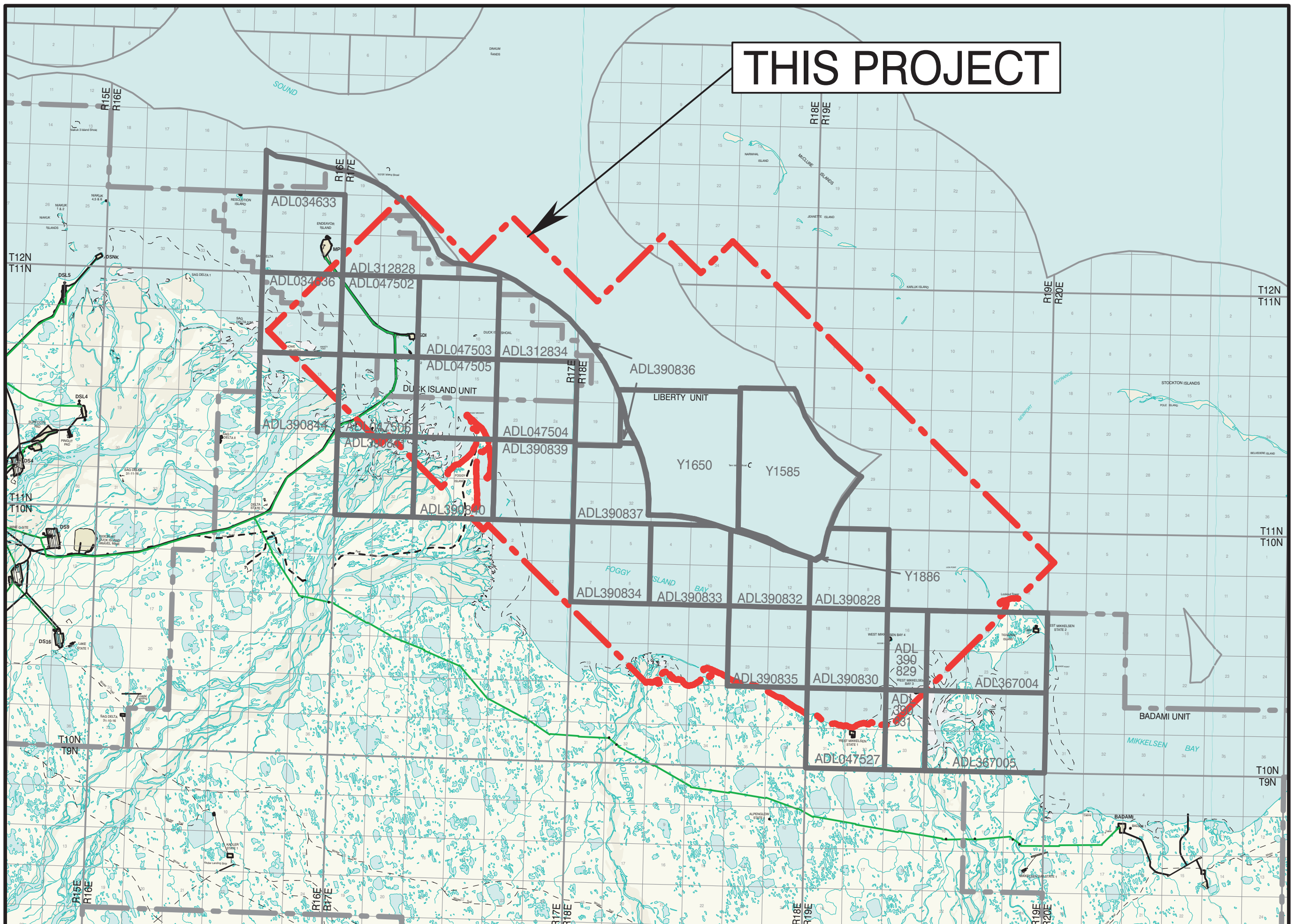

This map is based on U.S.G.S. quad Beechey Point (A-1, A-2, B-1, B-2)
and on the Unit Operator's Facility Maps.

NORTH

PROJECT LOCATION:

LIBERTY PLANNING AREA CENTROID

NAD83
LAT. = 70° 16' 46.92"
LONG. = -147° 34' 55.50"

ALASKA STATE PLANE ZONE 3, NAD 83

X = 1,444,904.91 FEET
Y = 5,954,260.83 FEET

SEC. 36 T12N, R16E UMIAT M.
SEC. 28-35 T12N, R17E UMIAT M.
SEC. 27-29, 32-36 T12N, R18E UMIAT M.
SEC. 1-2, 11-14, 24 T11N, R16E UMIAT M.
SEC. 1-30, 33-36 T11N, R17E UMIAT M.
SEC. ALL T11N, R18E UMIAT M.
SEC. 7-8, 16-22, 26-36 T11N, R19E UMIAT M.
SEC. 1-3, 11-13 T10N, R17E UMIAT M.
SEC. 1-28 T10N, R18E UMIAT M.
SEC. 1-12, 14-22, 28-30 T10N, R19E UMIAT M.
SEC. 6 T10N, R20E. UMIAT M.

ADL # 034633, 034636, 047502, 047504, 047505, 047506, 047527, 312828, 312834, 367004, 367005, 390828, 390829, 390830, 390831, 390832, 390833, 390834, 390835, 390836, 390837, 390839, 390840, 390841, 390844, Y1585, Y1650, Y1886

DATUM: MEAN SEA LEVEL

PURPOSE: SEISMIC PLANNING

ADJACENT PROPERTY OWNER:
STATE OF ALASKA

BP EXPLORATION (ALASKA) INC.

LIBERTY SHALLOW WATER SEISMIC SURVEY 2008 PERMIT MAP

DATE:	SCALE:	FIGURE:
November 2007	1" = 1 Mile	3

si15669.dgn

Table 1
Planned Vessel Inventory

VESSEL NAME	OPERATION	VESSEL OWNER	REGISTRY #
Arctic Wolf	Housing / Fuel	Fairweather Marine LLC	687450
M/V Peregrine	Source Vessel	Peregrine Falcon Inc.	950245
M/V Maxime	Source Vessel	Red Bill Marine LLC	1196716
M/V Alaganik & M/V Hook Point	Recording & Staging Vessel	Rob Eckley	567877 682023
4 each Bow Pickers			
F/V Cape Fear	Cable deployment/retrieval	Rob Eckley	1063695
F/V Canvasback	Cable deployment/retrieval	John Bocci	1093742
F/V Sleep Robber	Cable deployment/retrieval	Jeff Jensen	1047324
F/V Rumpleminz	Cable deployment/retrieval		1099109
M/V Qayaq Spirit	Personnel transport, work vessel, support	Gordon Heddell	1160606
F/V Weather or Knot	HSE support vessel	American Marine Corp	1168719
Arctic Hawk (hovercraft)	Personnel transport, work vessel, support	Crowley Maritime Corp.	

This table identifies planned vessels for the survey. In the event a specific vessel is not available for the survey, a similar vessel may be substituted. Any substitution will be in accordance with the Incidental Harassment Authorization (IHA) requirements. Note: To deploy and retrieve cables in shallow water (depths less than 2 feet) equipment such as the hovercraft, swamp buggies, and/or Jon boats will be used.

Table 2
Air Source Configuration and Acoustical Outputs

Energy Source	Eight 2000 psi sleeve air guns: 4 of 70 in^3 and 4 of 150 in^3
Source Output (downward)	0-peak is 6.6 bar-meters Peak-peak is 13.9 bar-meters
Number of Impulses per Linear Mile (of source line)	32 to 64
Towing Depth of Energy Source	3-13 ft (1-4 m)
Air Discharge Volume	880 in^3
Dominant frequency components	5-135 Hz

Table 3
Regulatory Requirements and Agreements

PERMIT/APPROVAL	AGENCY
FEDERAL	
Geophysical Exploration Permit	U.S. Minerals Management Service
Incidental Harassment Authorization (IHA) for Marine Mammals	National Marine Fisheries Service
Letter of Authorization (LOA) for Polar Bears and Pacific Walrus	U.S. Fish and Wildlife Service
Section 10 Permit for Structures in or Affecting Navigable Waters[1]	U.S. Army Corps of Engineers
STATE	
Miscellaneous Land Use Permit (Geophysical Exploration)	Alaska Department of Natural Resources, Division of Oil and Gas
National Historic Preservation Act, Sec 106	Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation
Alaska Coastal Management Plan Coastal Consistency Review	Alaska Department of Natural Resources, Division of Oil and Gas
LOCAL	
Development Permit	North Slope Borough
Conflict Avoidance Agreement/Plan of Cooperation	Alaska Eskimo Whaling Commission and North Slope communities Whaling Captains' Associations
Revocable Use (Private Native Allotment) Permits	Inupiat Community of the Arctic Slope / Bureau of Indian Affairs
OTHER	
Letters of Non-Objection	Affected lease and right-of-way owners

1 activity authorized under USACE Nationwide Permit #6

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OTHER	
Letters of Non-Objection	Affected lease and right-of-way owners

1 activity authorized under USACE Nationwide Permit #6

LIBERTY SHALLOW WATER SEISMIC SURVEY 2008
BIOLOGICAL ASSESSMENT FOR MARINE AND COASTAL BIRDS

Prepared by

LGL Alaska Research Associates, Inc.

1101 E. 76th Ave. Suite B, Anchorage, AK 99518

For

BP EXPLORATION (ALASKA) INC.
P.O. Box 196612
Anchorage, Alaska 99519-6612

LIBERTY SHALLOW WATER SEISMIC SURVEY 2008

BIOLOGICAL ASSESSMENT FOR MARINE AND COASTAL BIRDS

Prepared by:

Robert Rodrigues, Lisanne A.M. Aerts, PhD

LGL Alaska Research Associates
1101 E. 76th Ave. Suite B, Anchorage, AK 99518

for

BP EXPLORATION (ALASKA) INC.
Dept. of Health, Safety & Environment
900 East Benson Blvd.
P.O. Box 196612
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LGL Report P988-3

December 2007

Suggested format for citation:

Rodrigues, R. and L.A.M. Aerts. 2007. Liberty Shallow Water Seismic Survey 2008: Biological Assessment for Marine and Coastal Birds. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for BP Exploration (Alaska) Inc., Anchorage, AK.

TABLE OF CONTENTS

SUMMARY

BP Exploration (BPXA) plans to develop an oil reservoir in the Liberty project area located offshore in the Beaufort Sea east of Prudhoe Bay, Alaska. This reservoir will be developed using ultra-extended-reach drilling (uERD) techniques from the existing Endicott facilities and will substantially reduce the environmental footprint compared to the originally proposed offshore stand-alone development. To increase the probability of successful implementation of the proposed uERD technique, BPXA plans to conduct a 3D ocean bottom cable (OBC) seismic survey during the open-water season 2008.

Approximately 70 bird species occur regularly within the Liberty project area although most of these are associated with terrestrial habitats and are not expected to occur in offshore areas of the proposed seismic activities. However, limited activities will be conducted close to shore or on land where several bird nesting areas are located. Howe Island supports a large snow goose nesting colony and several other species, including brant and common eider, may also nest on the island. Common eiders are also known to nest on Lion Point, the Endicott causeway, and Duck Island 1 & 2. The lagoon system between the mainland and the barrier islands within the survey area also supports large numbers of molting waterfowl, mainly long-tailed ducks, but common eiders, scoters, and several other species also use the lagoon system for feeding and resting. The mainland shore along the south side of the survey area is an important brood-rearing area for snow geese, and brood-rearing eiders have been reported in the lagoon system. Loons and several seabird species may also occur within the open-water habitats of the survey area. Additionally, two species listed as threatened under the Endangered Species Act, the spectacled and Steller's eiders, could potentially occur in the survey area in small numbers.

To ensure that the seismic survey activities will comply with requirements of the Endangered Species Act and the Migratory Bird Treaty Act, BPXA requested LGL to prepare an assessment of the potential impacts of the seismic survey on marine and coastal birds. Potential impacts to marine birds from seismic activities could result in disturbance to birds at nest sites or to molting and resting birds.

Seismic activities on Howe Island will likely occur after completion of the nesting season. However, seismic activities on the Endicott causeway and Duck Island 1 & 2 are planned around early to mid July when some eiders may still be nesting at these locations. Disturbance to nesting birds can be minimized or eliminated by locating and marking active nests prior to OBC deployment which would allow deployment crews to avoid laying cables near active nests. Disturbance from vessel and seismic activity in open-water habitats may temporarily displace some birds from preferred habitats but is not expected to cause significant impacts to molting or brood-rearing birds. The effects of seismic activities on food sources for marine and coastal birds is expected to be negligible, and collision risk of birds with vessels is low and not expected to have significant impacts.

1 INTRODUCTION

1.1 Background of Proposed Seismic Survey

The Liberty field contains one of the largest undeveloped light-oil reservoirs near North Slope infrastructure, and the development of this field could recover an estimated 105 million barrels of oil. The field is located in federal waters of the Beaufort Sea about 5.5 miles offshore in 20 ft of water and approximately 5 to 8 miles east of the existing Endicott Satellite Drilling Island (SDI) (Figure 1). The Liberty development project design and scope has been changed from an offshore stand-alone development (manmade production/drilling island and sub-sea pipeline) to the use of uERD from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. As a result of this change in scope, BP Exploration (BPXA) believes that Liberty can be developed with a substantially reduced environmental footprint and impact than the originally proposed offshore stand-alone development.

The currently available seismic data of the Liberty area focus primarily on deeper targets and hence does not optimally image the shallow overburden sections of the well bore. To obtain better imaging of these shallow sections, BPXA plans to conduct an offshore 3D ocean bottom cable (OBC) seismic survey from west of Endicott causeway to Tigvariak Island in offshore waters shoreward of the barrier islands during the 2008 open-water period (Fig. 2). The acquisition of additional marine 3D seismic survey data will increase the probability of successful implementation of the proposed uERD techniques by providing higher resolution data to assist in imaging for well planning and drilling operations.

The dataset obtained with the proposed seismic survey will replace and augment the data from the Endicott 3D (1983) and NW Badami (Liberty) (1995) 3D on-ice vibroseis surveys. Various seismic acquisition methods and sound source reduction technologies have been identified and assessed on their technical and environmental performance. The proposed 3D OBC seismic survey method is the most appropriate for the specific survey goal and objectives of the current Liberty seismic survey.

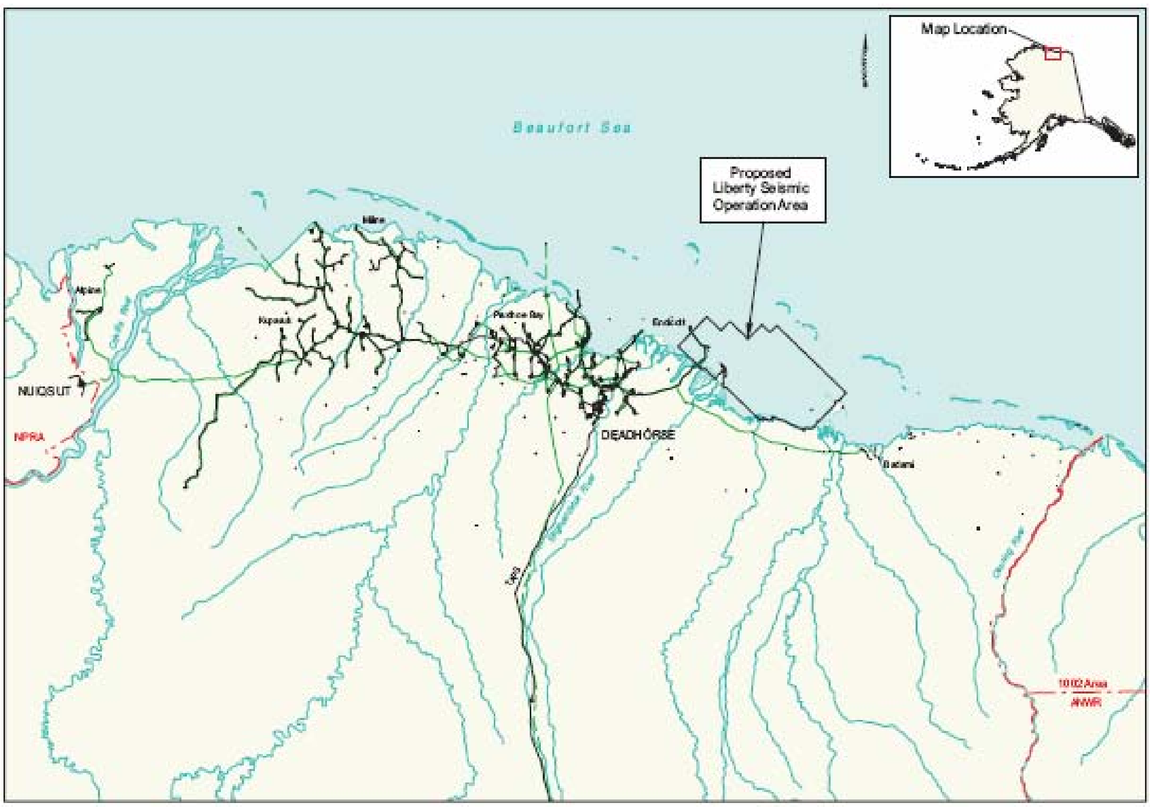

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FIGURE 1. OVERVIEW OF THE LIBERTY SEISMIC SURVEY AREA.

1.2 Purpose of this Assessment

Under the Outer Continental Shelf (OCS) Lands Act, the federal agencies must ensure that the seismic survey data and information collected by industry and government are obtained in a technically safe and environmentally sound manner. The Minerals Management Service (MMS) regulations (30 C.F.R. Part 251) specifically state that geological and geophysical activities cannot cause harm or damage to aquatic life, property, or to the marine, coastal, or human environments. In addition MMS must assess the potential environmental impacts and proposed mitigation in advance of survey operations as described by the National Environmental Policy Act (NEPA, 1969) for any permit applications through an Environmental Assessment (EA) or Environmental Impact Statement (EIS) process. The purpose of this assessment is to provide supporting documentation to facilitate the review of the proposed project under NEPA requirements related to bird species. The identification of potential impacts, such as those related to nesting birds, and associated mitigation and monitoring are also required under the Endangered Species Act (ESA) and/or the Migratory Bird Treaty Act. The preparation of this assessment was also driven by BPXA's corporate goals which require precautions to ensure that no harm to the environment results from development activities. This document contains the following information:

- Identification of potential sources of disturbance to marine birds that may result from the proposed seismic survey activities in the Liberty project area;
- Assessment of the impacts that may result from those activities; and
- Proposed mitigation to minimize or eliminate potential impacts to birds.

Note that the information provided in this report is for planning purposes, and while all information is believed to be accurate minor changes may occur as planning and implementation progress.

2 DESCRIPTION OF THE PROPOSED OBC SEISMIC SURVEY

OBC seismic surveys in the Alaskan Arctic are used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. This type of seismic survey requires the use of multiple vessels for cable deployment/retrieval, recording, shooting, and utility boats. The planned 3D OBC seismic survey in the Liberty area will be conducted by CGGVeritas for a period of maximum ~60 days during July/August 2008, with an "as needed" extension of additional days after the whaling season (in accordance with the CAA), given the uncertainties in ice conditions and other factors that can influence the survey.

The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay of which 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft, 43% in water depths of 10-20 ft, and 25% in water depths of 20-30 ft (Figure 2). The approximate boundaries of the total surface area are between 70°11'N and 70°23'N and between 147°10'W and 148°02'W (Figure 2).

A detailed overview of the activities of the seismic survey is provided below, with focus on the mobilization procedure, seismic and other sound sources, the deployment and retrieval of the receiver cables, and the recording procedure.

2.1 Mobilization

Seismic data acquisition is planned to start as soon as ice conditions allow (i.e. < 10% ice coverage), which in this area normally occurs around 20 July (± 14 days). Limited layout of receiver cables might be possible on the Endicott causeway and mudflats in the Sagavanirktok River delta areas before the ice has cleared.

Data acquisition will be prioritized based on the starting date of the survey and weather conditions. The vessel fleet involved in the seismic survey activities will consist of approximately 11 vessels as listed below.

- Two source vessels, the *M/V Peregrine* (90 x 24 ft) and the *M/V Maxime* (55[1] x 16 ft).
- One recorder boat/barge, with *M/V Alaganik* barge (80 x 24 ft) and *Hook Point* boat (32 x 15 ft).
- Four small bow picker vessels to deploy and retrieve the receiver cables; these are the *F/V Canvasback* (32 x 14 ft), *F/V Cape Fear* (32 x 12 ft), *F/V Rumplemimz* (32 x 14 ft) and *F/V Sleep Robber* (32 x 14 ft). These vessels can operate in very shallow waters up to ~18 inch (0.5 m) water depth.
- HSE vessel *Weather or Knot* (38 x 15 ft).
- Crew transport vessel *M/V Qayak Spirit* (42 x 14 ft) and (Northstar's) hovercraft *M/V Arctic Hawk* (42 x 20 ft).
- Crew housing and fuel vessel *M/V Arctic Wolf* (135 x 38 ft).

Most of the survey vessels will be transported overland to West Dock in late May/early June where they will be mobilized prior to the start of the field season. The *M/V Arctic Wolf* will transit by water from Homer or Anchorage to the site when ice conditions allow and in consideration of the spring beluga hunt in the Chukchi Sea. Vessel mobilization will include assembly of navigation and source equipment, cable deployment and retrieval systems and safety equipment. The mobilization process will require about 35 days with most activities occurring at West Dock. Once assembled, the deployment, retrieval, navigation and source systems will be tested prior to departure to the project site.

Preparation of the cables ("cable dressing") will be conducted and completed at the CGGVeritas shop in Anchorage. Cable dressing includes attaching lead line and weighting systems to hydrophones to reduce any chance for movement on the sea floor. After completion of the final quality control check, the cables will be transported together with the vessels to West Dock where they will be loaded onto the vessels prior to departure to the project site. Some equipment might be staged at the Endicott facilities. To deploy and retrieve cables in water depths less than those accessible by the bow pickers, equipment such as swamp buggies and Jon boats may be used.

2.2 Seismic survey area details

The well path is the area of primary interest that needs to be fully covered by the seismic data. The size of this zone has been reduced to an absolute minimum of 35.6 mi^2 (92.1 km^2). To obtain full data coverage in this area of interest a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The total extent of the seismic survey will be 135.8 mi^2 (351.8 km^2) and may include some areas of mudflat (Figure 2).

Receiver cable lines will consist of a hydrophone and a Field Digitizing Unit (FDU) placed on the cables at 110 ft intervals. The cables will be placed on the seafloor according to a predefined configuration to record the reflected source signals from the airguns.

[1] For this specific survey it is planned to increase the length of the *M/V Maxime* from 40 to 55 ft.

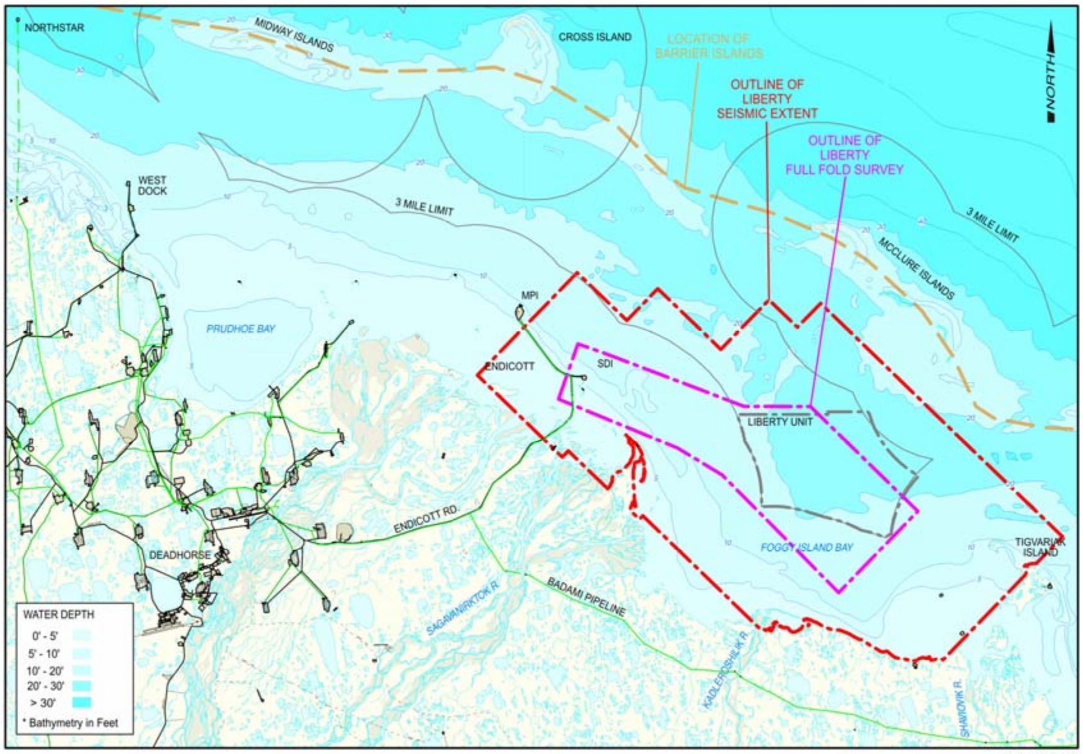

FIGURE 2. LIBERTY SEISMIC SURVEY AREA. THE PINK LINE REPRESENTS THE AREA WERE DATA NEEDS TO BE FULLY IMAGED AND THE RED DASHED LINE SHOWS THE OUTLINE OF THE LIBERTY SEISMIC EXTENT, WHICH IS THE AREA COVERED BY THE RECEIVER AND SOURCE LINES.

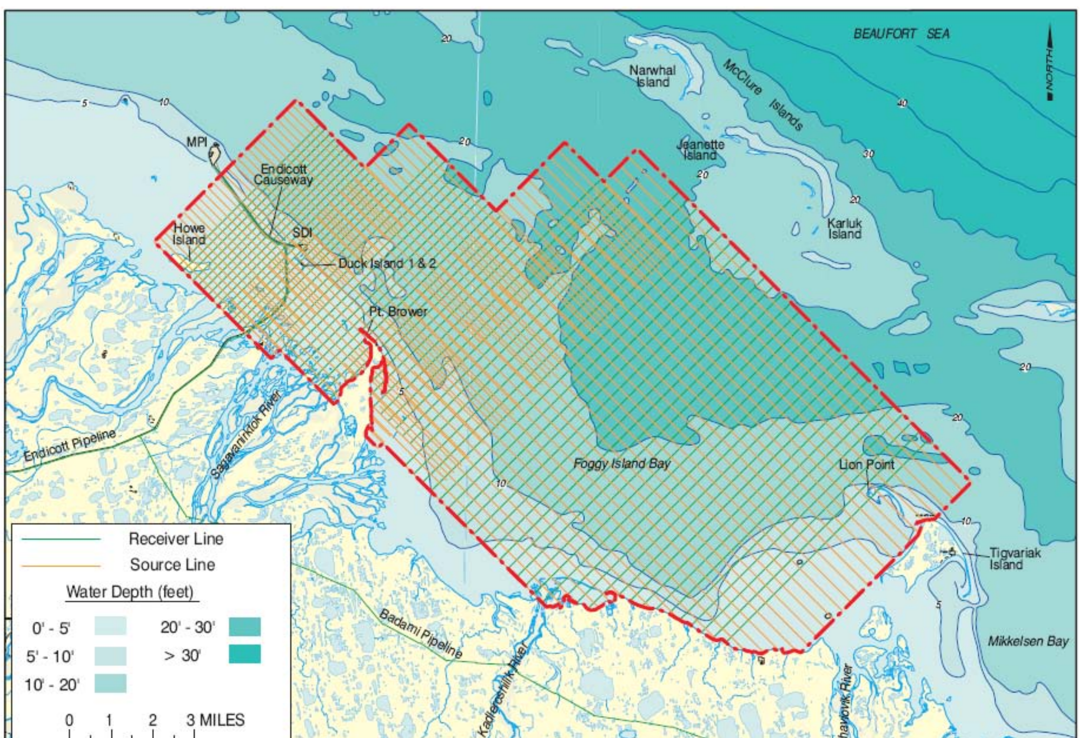

FIGURE 3. LIBERTY SEISMIC SURVEY AREA, INCLUDING THE RECEIVER LINES (GREEN) AND SOURCE LINES (ORANGE). ALTHOUGH THE SOURCE LINES AROUND THE ENDICOTT CAUSEWAY ARE SHOWN ALL THE WAY TOWARDS THE COAST, THE MINIMUM WATER DEPTH WHERE SEISMIC ACQUISITION IS POSSIBLE IS 3 FT. THE MAP SHOWS LOCATIONS OF POTENTIAL BIRD NESTING AREAS IN RELATION TO THE SEISMIC SURVEY AREA.

The cables that will be deployed on mudflats and in very shallow water will utilize marsh phones and will be placed in a similar configuration as those deployed at the seafloor. The receiver cables will be oriented in a NE-SW direction. A total of approximately 66 NE-SW oriented receiver lines will be deployed with increasing line spacing from west to east of ~880 ft to ~2,000 ft. Total receiver line length will be ~490 miles (~788 km) of which ~10 miles (16 km) will be laid on mudflats. The source vessels will travel perpendicular over these receiver cables along lines which will have a NW to SE orientation and a varying total length of 2 to 3.5 miles (3.2 to 5.6 km). The total source line length will be ~2000 miles (~3220 km) in water depths varying from 3 to 30 ft (1 to 9.1 m). Source vessels will not operated in waters less than ~ 3 ft. Source lines have been extended to shore since the exact location of the 3 ft contour is unknown (see Figure 3). A bathymetric survey will be conducted during the winter season to define this 3 ft contour. The most critical data along the well path will be collected early in the season, and lower priority data will be collected later when environmental conditions may limit survey activities.

2.3 Seismic source

To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the *M/V Peregrine* and *M/V Maxime* owned by Peregrine Marine. The sources used for seismic data acquisition will be sleeve airgun arrays with a total discharge volume of 880 in^3 divided over two arrays. Each source vessel will have two 440 in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. More detailed sound specifications of the 8-airgun arrays are summarized in Table 1.

TABLE 1. AIRGUN ARRAY SPECIFICATION

Item	Specification
Energy Source	Eight 2000 psi Sleeve airguns; four of 70 in^3 and four of 150 in^3.
Source output (downward)	0-peak is 6.6 bar-m (236.4 dB re µPa @ 1m 0-pk) Peak-peak is 13.9 bar-m (242.9 dB re µPa @ 1 m pk-pk)
Towing depth of energy source	Between 1-4 m
Air discharge volume	880 in^3
Dominant frequency components	5-135 Hz

The arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths varying from 1-4 m (3-13 ft), depending on the water depth. The vessel will travel along pre-determined lines at ~1 to 5 knots, depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4-second shot intervals with two operating source vessels. The seismic data acquisition will occur over a 24-hr/day schedule.

2.4 Cable deployment and retrieval

The *M/V Peregrine*, *M/V Maxime* and 4 bow pickers (*Canvas Back*, *Cape Fear*, *Rumplemimz*, and *Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels will be powered with twin jet diesels and will be rigged with hydraulically driven deployment and retrieval systems ("Squirters"). The *M/V Peregrine* and *M/V Maxime* will function both as source and cable vessels and will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are extremely small (width of about 0,5 inch) while still allowing a pull of 800 pounds. The smaller bow picker cable vessels will also carry 120 hydrophone stations and will be capable of beach landings. All cable vessels will maintain 24-hr operations.

Some receiver cables will be deployed on mudflats to record reflected source signals and allow for full interpretation of the data in the area of interest, i.e. well path (pink line in figure 2). The deployment of these receiver cables will be conducted with equipment that can operate in shallow waters and marshy conditions (i.e., swamp buggies, Jon boats).

The position of each receiver needs to be established. Due to the variable bathymetry in the survey area, receiver positioning may require more than one technique. A combination of Ocean Bottom Receiver Location (OBRL), GPS, and acoustic pingers will be used. For OBRL, the source vessel will fire a precisely positioned single gun multiple times along either side of the receiver cables. Multiple gun locations are then calculated at a given receiver to triangulate an accurate position for the receiver. In addition, Dyne acoustical pingers will be located at predetermined intervals at the receiver lines. The pinger locations can be determined using a transponder and allow for interpolation of the receiver locations between the acoustical pingers and as calibration/verification of the OBRL method. The sonar Dyne pingers operate at 19-36 kHz and have a source level of 188-193 dB re μPa at 1m. Because OBRL methods are not accurate in shallow water (< 15 ft), the receiver locations at these depths will be recorded as "as laid" positions, which will be the GPS location where the receivers are deployed.

2.5 Recording

A Sercel 428 FDU (Field Digitizer Unit) will be located at each hydrophone. This system is lightweight and robust and rated to 14 m (45 ft) of water depth, which will allow it to operate well in the water depths for this survey. For approximately each 30 recorder-hydrophone units one or two battery pack(s) will be deployed at the sea bottom. Battery packs will be equipped with a buoy (or acoustic release) and a pinger, to ensure that the battery packs can be located and retrieved when needed.

The data received at each FDU will be transmitted through the cables to a recorder for further processing. This recorder will be installed on a pin-together boat/barge combination and positioned close to the area where data are being acquired. While recording, the pin-together boat/barge will be stationary and is expected to utilize a four-point anchoring system.

2.6 Crew housing and transfer

The *M/V Peregrine* is able to house 10 crew including marine mammal observers (MMOs). The *M/V Maxime* can accommodate 6 people, including the MMOs. These source vessels will maintain 24-hr operations; crew transfers will take place by crew boats and/or hovercraft. The four bow pickers will be too small to house their crew and these crews will be accommodated onshore at Endicott (MPI) camp or other Deadhorse facility or offshore on the *M/V Arctic Wolf*. The seismic activity will be a 24-hr operation to allow for efficient data acquisition in the short summer season, so crew change vessels will transfer crews approximately every 12 hours. Shifts for crews on the source vessels and cable vessels will be staggered to maximize transport efficiency. Two vessels will be used for these crew transfers, a crew boat (*M/V Qayaq Spirit*) and, if available, the Northstar hovercraft (*Arctic Hawk*).

In addition to housing crew at Endicott facilities, there will be a mother ship mobilized, the *M/V Arctic Wolf*. This vessel will house up to 30 crew members, and store cable parts and fuel for the other vessels. The *M/V Arctic Wolf* is a propeller driven vessel. Because of its size, the vessel can not be transported by truck to Prudhoe Bay and will mobilize from either Homer or Anchorage and sail around Barrow to the survey area when ice conditions allow and in consultation with beluga whale hunters in the Chukchi Sea. Two marine mammal observers will conduct observations off of this vessel during the transits from and to Anchorage/Homer (see Section 13.1). Crews will be housed in other camps in Deadhorse or other operating areas if the *M/V Arctic Wolf* arrives after seismic acquisition begins.

The recorder barge/boat (*M/V Alaganik* and *Hook Point*) can currently accommodate 4 people on the boat portion. The barge portion is dedicated to recording and staging of cables, hydrophones and batteries and can not be used to create additional housing due US Coast Guard restrictions.

Refueling of vessels at sea will be conducted from the vessel *M/V Arctic Wolf*, following approved U.S. Coast Guard procedures. Refuel of the boat storage on the *Arctic Wolf* will take place at West Dock, Endicott dock or by delivery from an approved Crowley vessel.

3 DESCRIPTION OF MARINE AND COASTAL BIRDS WITHIN THE PROJECT AREA

Approximately 70 bird species occur regularly within the Liberty project area although most of these are associated with terrestrial habitats and are not expected to occur in offshore areas of the proposed seismic activities. The species likely to occur in offshore areas are migratory and present in the area from approximately May to October. The most abundant group of birds within the area of the proposed seismic surveys is waterfowl which includes ducks, geese, and swans. More waterfowl species and individuals are likely to occur in the project area than for any other species group.

Other bird species groups that are represented within the survey area include loons and seabirds (jaegers, gulls, and terns). Loons and seabirds also nest predominantly in freshwater habitats although some, such as arctic tern (*Sterna paradisaea*), may also nest in marine habitats along the shore of barrier islands or the mainland coast.

The presence of waterfowl, loons, and seabirds is discussed briefly below focusing on the species which are most abundant in the survey area, or for which the survey area is important for nesting or other activities. Two species listed as threatened under the ESA, the spectacled and Steller's eiders, could occur in marine waters of the proposed Liberty survey area and are discussed below.

Shorebirds and passerines occur in the general vicinity of the Liberty project but most are not likely to occur in offshore locations where the seismic activities will occur. An exception is red phalarope (*Phalaropus fulicaria*) which may occur along the coast or within the marine waters of the survey area after the breeding season. Red phalarope is not a species likely to be affected by seismic activities and is not discussed further.

3.1 Threatened and Endangered Species

Two species listed as threatened under the ESA could potentially occur in the Liberty project area. Steller's eider (*Polysticta stelleri*) historically nested across the Arctic coasta Plain (ACP) from Wainwright to the Canadian Northwest Territories (Johnson and Herter 1989; Quakenbush et al. 2002). Steller's eiders have been reported in the Prudhoe Bay area where they are considered rare (TERA 1997), but no recent sightings have been reported east of the Sagavanirktok River (Quakenbust et al. 2002). Steller's eider is not expected to occur in the Liberty project area.

Spectacled eiders (*Somateria fischeri*) nest across the ACP to at least the Shaviovik River and possibly the Badami area. Spectacled eiders breed regularly in the Prudhoe Bay area including the Sagavanirktok River delta in low densities (TERA 1995, 1996, 1997; Rodrigues and

Ireland 2006). Nests are located on tundra usually near freshwater lakes and ponds. Most males depart the breeding grounds in mid-June after the onset of incubation and move to coastal bays and lagoons including Harrison Bay and Simpson Lagoon to molt and stage for fall migration (TERA 1999; Troy 2003). Hatching occurs by mid-July and successful females with young move to freshwater lakes and ponds for brood-rearing. Troy (2003) reported that unsuccessful female spectacled eiders used Beaufort Sea waters from east of the Sagavanirktok River west to Barrow from mid-July to mid-August. Successful nesting females and young-of-the-year do not move to offshore areas until late August or early September. Fischer et al. (2002) reported that spectacled eiders were generally uncommon during offshore surveys from Harrison Bay to Brownlow Point. It is possible that small numbers of male and/or female spectacled eiders could occur in the Liberty project area during the proposed seismic activities. Males would be most likely to occur from late June to late July and females from late June through August or early September.

3.2 Waterfowl

Waterfowl are likely to occur within the survey area throughout the entire period of the proposed seismic survey. The most abundant species are long-tailed duck (*Clangula hyemalis*), common eider (*Somateria molissima*), and lesser snow goose (*Chen caerulescens*). Other waterfowl species which may also be common within or adjacent to the survey area include scoters (*Melanitta* spp.), scaup (*Aythya* spp.), northern pintail (*Anas acuta*), red-breasted merganser (*Mergus serrator*), king eider (*Somateria spectabilis*), brant (*Branta bernicla*), and tundra swan (*Cygnus columbianus*).

Although most waterfowl nest on terrestrial habitats associated with freshwater lakes, ponds, and associated tundra, some species, such as common eider, snow goose, and brant may also breed in habitats within or close to the proposed seismic survey area. These species may also be fairly common or abundant in the marine waters of the Liberty area during the post-breeding period.

3.2.1 Long-tailed duck

Long-tailed duck is the most abundant species in the proposed seismic survey area and may comprise 80% of the total number of birds (Fischer and Larned 2004). Although long-tailed ducks are relatively abundant, there has been concern for this species, as well as other seaducks, due to regional population declines (Wilbor 1999; Suydam et al. 2000; Mallek et al. 2007).

Long-tailed ducks nest on tundra habitats but move to offshore areas in the lagoon systems formed between the mainland and barrier islands where they undergo a molt migration after breeding. Males enter the lagoon systems in late June after onset of incubation by females. Females with broods remain on tundra ponds and lakes until the first stages of freeze-up when they move to coastal lagoons to feed until fall migration in late September or early October (Johnson and Richardson 1981). During their molt migration long-tailed ducks are flightless and occur in large flocks sometimes numbering in the several thousands along the lee sides of barrier islands and mainland bays and spits in the late afternoon. During much of the day long-tailed ducks feed throughout open-water habitats (Johnson 1984; Flint et al. 2003).

Long-tailed duck density is consistently high in the lagoon system from mid-July to mid- to late August (Johnson et al. 2005). During aerial surveys conducted from 1998 through 2001 in July and August, Noel et al. (2002a) reported concentrations of long-tailed ducks within the proposed survey area at Lion Point near Tigvariak Island, at Point Brower, and in the lagoon system west of the Endicott causeway. Long-tailed ducks also occur in lower densities in open-water habitats in the central portion of the lagoon systems. However, long-tailed ducks appear to concentrate along the barrier islands and mainland shore in the late afternoon.

3.2.2 Common eider

Common eiders nest on barrier islands and along the mainland shore in areas where accumulated drift wood provides cover (Johnson et al. 1993; Noel et al. 2005; Dau and Larned 2005; Kendall 2005). Common eiders arrive in the project area in mid- to late May but do not initiate nesting until mid- to late June. Most males depart the project area after onset of incubation although some may remain to molt. The incubation period is ~26 days and most clutches hatch by mid-July. Common eiders may occur in flocks with long-tailed ducks during molt migration. Brood-rearing flocks have been reported in the lagoon systems in July and August.

Common eiders are known to nest at several locations within the proposed seismic survey area including the Endicott causeway, Duck Island 1 & 2 located south of SDI, and Lion Point near Tigvariak Island (Figs. 2 and 3). Small numbers of common eiders have also been reported nesting on Howe Island.

Common eiders began colonizing the Endicott causeway after its construction in 1984-1985 (Johnson 1990), and the number of nest sites on the causeway steadily increased to 20 and 19 nests in 1990 and 1991, respectively (Johnson et al. 1993). In 1992 only three common eider nests were reported on the causeway, none of which were successful. A dramatic increase in predation pressure from arctic foxes was thought to be the cause of the decline in nests and the poor success in 1992 (Johnson et al. 1993). Surveys have been conducted sporadically since 1992 and common eiders have continued to nest on the Endicott causeway in small numbers (e.g., Noel et al. 2001, 2002b). No surveys of the Endicott causeway for common eider nests have been conducted in recent years.

The man-made Duck Island 1 & 2 located south of SDI has also been surveyed sporadically for nesting common eiders (Johnson et al. 1993; Noel et al. 2002b). Johnson et al. (1993) reported that Duck Island 1 & 2 was constructed in summer 1978 to support oil-well drilling and was abandoned in 1985. A large amount of driftwood accumulated on the island and it became an important area for common eider nesting. Noel et al. (2002b) reported at least 22 active common eider nests on Duck Island 1 & 2 in 2001. No surveys of Duck Island 1 & 2 for common eider nests have been conducted in recent years.

Lion Point is a gravel spit located near the northwest corner of Tigvariak Island. Lion Point has been surveyed sporadically for common eider nesting since at least 1976. The maximum number of common eider nests reported on Lion Point was 90 in 1987 (in Noel et al. 2002b). In 2000 and 2001, 42 and 16 common eider nests, respectively, were reported on Lion Point (Noel et al. 2002b).

3.2.3 Lesser snow goose

The Sagavanirktok River delta population of lesser snow geese was until recent years the only established nesting colony of this species in the United States and remains the only nesting colony in proximity to an active oilfield. Most of the Sagavanirktok River delta population nests on Howe Island near the western edge of the proposed survey area. Snow geese were first observed nesting on Howe Island in the early 1970s and the colony has steadily increased in size although heavy predation by arctic fox and grizzly bears caused total failure of the colony during some years in the early to mid-1990s (Johnson and Noel 2005; Rodrigues et al. 2007). Predation pressure has not been a factor negatively impacting the Howe Island colony in recent years. BPXA conducts an annual nest survey of Howe Island as part of its long-term monitoring program. A total of 761 nests was recorded during the 2007 monitoring study which was the highest nest count ever recorded on the island (Rodrigues et al. 2007).

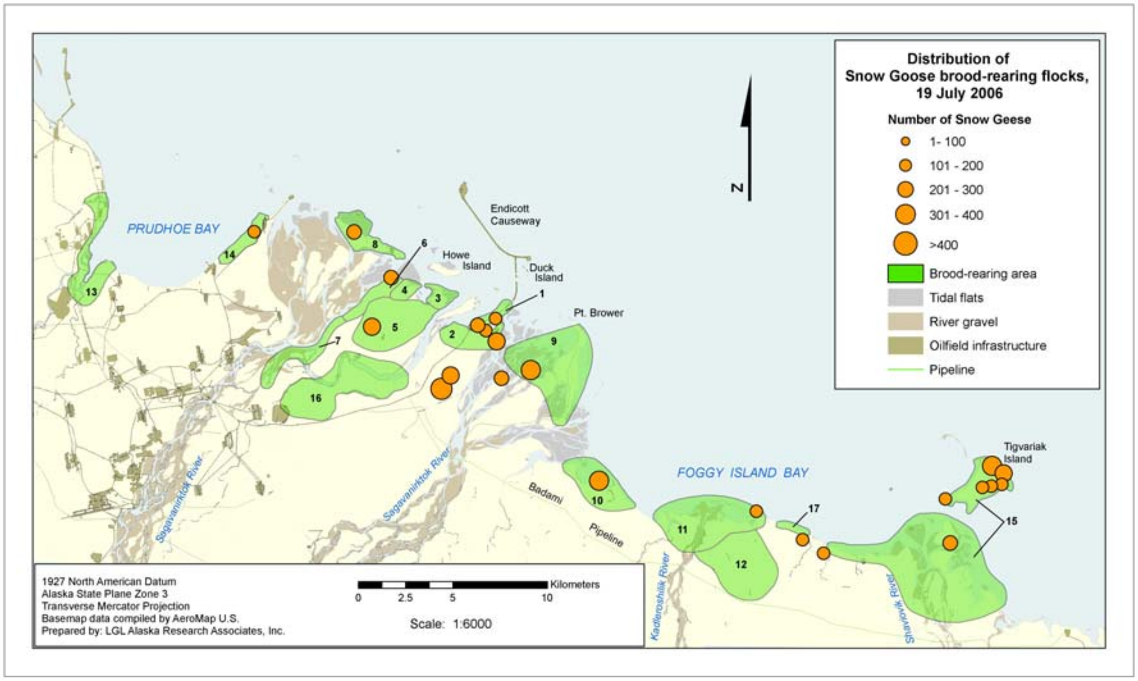

FIGURE 4. SNOW GOOSE BROOD-REARING AREAS IN THE SAGAVANIRKTOK RIVER DELTA, ALASKA. ORANGE CIRCLES REPRESENT LOCATIONS OF BROOD-REARING FLOCKS REPORTED BY RODRIGUES AND MCKENDRICK (2006) DURING AERIAL SURVEYS ON 19 JULY 2006.

FIGURE 5. LESSER SNOW GOOSE BROOD-REARING FLOCK IN THE SAGAVANIRKTOK RIVER DELTA, 2006.

Snow geese arrive on Howe Island in late May and begin prospecting for nest sites. Eggs are laid in early June and the incubation period continues through June with clutches hatching on Howe Island by early to mid-July. Adults with broods swim from Howe Island to the mainland along the Endicott road and occupy traditional brood-rearing areas in the Sagavanirktok River delta (Figure 4) within a few days of hatching. These brood-rearing areas are characterized by escape habitat near large waterbodies with adjacent feeding areas (Wilkinson et al. 1994). Through July and into August brood-rearing flocks may range west to the east shore of Prudhoe Bay, and east at least as far as Tigvariak Island (Figure 4). Brood-rearing flocks may inhabit locations immediately adjacent to the proposed seismic activities along the mainland shore through August (Figure 5).

3.3 Loons

Loons are diving birds that feed on fish and invertebrates. Loons nest on islands or along the shore of freshwater tundra ponds but may feed in marine waters during and after the breeding season. Three species of loons may occur within the survey area during the open-water period. Pacific loon (*Gavia pacifica*) is the most abundant loon species in the Prudhoe Bay area. However, red-throated loons (*G. stellata*) generally nest at locations within a few km of the coast and probably use marine habitats for feeding more regularly than Pacific loons.

Yellow-billed loon (*G. adamsii)* is the least abundant loon species in the Prudhoe Bay area and is currently under consideration for listing under the ESA (USFWS 2007). Yellow-billed loons are most abundant in the central ACP at locations west of Teshekpuk Lake and near the southeast end of the lake (Larned et al. 2006). The Liberty project area is located near the eastern edge of the range of yellow-billed loons where densities are low. Yellow-billed, as well as Pacific and red-throated loons could occur in low densities in the project area during the entire period for which seismic activities are proposed.

3.4 Seabirds

Seabirds, including jaegers, gulls, terns, and guillemots may occur in low densities within the proposed survey area during the open-water period. Glaucous gull (*Larus hyperboreus*) is the most abundant gull species in the survey area although Sabine's gulls (*Xema sabani*) and black-legged kittiwakes (*Rissa tridactyla*) may also occur, especially during fall migration in August and September. Glaucous gulls nest on the barrier islands, on Howe Island and Duck Island 1 & 2, and on islands in tundra lakes and ponds. Egg laying begins in mid-June but may continue into late June (Johnson and Herter 1989). Hatching occurs by mid-July. Glaucous gulls are most abundant along the shores of barrier islands and the mainland but may also occur in open-water habitats of the survey area.

Arctic terns nest in low densities on barrier islands and small nesting colonies are sometimes located in marshy areas along the shores of tundra ponds. Arctic terns are probably most abundant in the survey area during fall migration as they pass through the area in August and September.

Jaegers are pelagic for most of the year but nest on tundra habitats across Alaska's ACP. Parasitic jaeger (*Stercorarius parasiticus*) is the most abundant jaeger species in the project area, but pomarine (*S. pomarinus*) and long-tailed (*S. longicaudus*) jaegers may also occur in the area.

4 POTENTIAL IMPACTS ON MARINE AND COASTAL BIRDS FROM THE PROPOSED SEISMIC SURVEY

During the proposed OBC seismic survey, airgun sound and vessel activities are the two main factors that have the potential to impact birds. These potential impacts could result in:

- Disturbance of nests
- Disturbance of brood-rearing, molting or feeding birds

Nesting birds are particularly susceptible to disturbance that may cause temporary (or permanent) nest abandonment. Temporary nest abandonment can result in greater predation pressure from gulls, jaegers, ravens and foxes at unattended nests. After the nesting period vessel activities and noise may have the potential to displace brood-rearing and/or molting birds from preferred feeding or resting locations. Disturbance to brood-rearing and molting waterfowl may be energetically costly if birds are displaced from preferred feeding areas and have to move to other potentially less optimal feeding habitat. This could result in a protracted molt period or a reduction in the growth and survival rates of young birds.

If incidents involving the release of oil and fuel during offshore refueling activities occur, they are likely small, and will follow applicable U.S. Coast Guard and other regulatory requirements. Also, no unauthorized discharges from the seismic vessel, such as the discharge of engine oil, will occur. Given that the risk of a fuel spill is unlikely and an oil spill contingency plan will be in place, fuel exposure is not addressed as a specific category below.

4.1 Disturbance of nests

4.1.1 Receiver cable deployment and retrieval

Receiver cable deployment and retrieval during the proposed seismic survey may occur on the Endicott causeway and mudflats in the Sagavanirktok delta and requires the presence of personnel and shallow water vessels (i.e. Jon boats) in locations where nesting birds could be present. These activities could cause incubating birds to flush from nest sites and cause temporary or permanent nest abandonment, with the potential of lost clutches and reduced productivity. Nests could also be physically destroyed by equipment or personnel during cable deployment or retrieval.

Deployment and retrieval of cables across the Endicott causeway and Duck Island 1 & 2 is planned around mid-July, at the start of the survey. During this period, nesting common eiders may still be present at the Endicott causeway and Duck Island 1 & 2. Cable deployment activities on Howe Island and Lion Point are not expected to occur before mid-August. Because bird species, most commonly the lesser snow geese, nest on Howe Island from late May to early or mid-July the cable deployment and retrieval activities will have no impact on nests or breeding birds. Likewise, common eider nesting on Lion Point will be completed prior to seismic activities in that area.

4.1.2 Vessel activity and airgun sounds

Some of the seismic survey will occur in very shallow water (minimum of 3 ft). In these cases, the airgun array will be very close to the seafloor and the air bubble released by the airguns will partially break through the water surface, resulting in surface water disruption associated with in-air sounds. Vessel and airgun sounds in waters close to Howe Island are not expected to have an impact on nesting birds. No seismic activities will take place at Howe Island during the nesting season and the island is sufficiently far (2-3 miles) from the Endicott causeway, where seismic activities might occur during the nesting period, that no disturbance to nesting birds is expected. Howe Island is also elevated well above sea level. Nesting geese and other birds would be shielded from vessel activity and airgun sounds.

Vessel activity near low-lying nesting habitats such as the Endicott causeway and Duck Island 1 & 2 may have more potential to disturb nesting birds. However, eiders are tenacious when incubating and are not easily displaced from nest sites. Additionally, the sound source will be moving in an east-west direction and nesting eiders would likely habituate to the gradual increase and decrease of vessel and airgun sounds.

4.2 Disturbance of brood-rearing, molting or feeding birds

4.2.1 Receiver cable deployment and retrieval

Disturbance to molting or feeding birds from seismic activities in offshore habitats could result from vessel activity during deployment and retrieval of the receiver cables. Marine birds sometimes appear to be displaced (at least temporarily) by vessel activity, but are also known to habituate to vessel traffic (Johnson 1984; Kuletz 1996; Speckman et al. 2004). However, Rodgers and Schwikert (2002) reported that vessels often have approached fairly close to birds before initiating an avoidance response.

During the deployment and retrieval of the receiver cables close to shore, feeding or resting birds could be displaced from preferred habitats by vessel traffic and/or presence of people. Aerial surveys have indicated that Lion Point, the Point Brower area, and possibly the open water west of the Endicott causeway may be used consistently by long-tailed ducks and other marine birds during the open-water season (Noel et al. 2002a). Long-tailed ducks and other waterfowl may also be distributed in lower densities throughout open-water habitats in the survey area. Birds that were disturbed by vessel traffic during deployment and retrieval of the receiver cables could move to adjacent habitats or return to preferred habitats after the vessels passed through the area. This temporary disturbance would be unlikely to significantly impact molting waterfowl.

Brood-rearing snow geese could also be disturbed by vessel activity or other equipment used for deployment and retrieval of the receiver cables at locations close to shore. Rodrigues and McKendrick (2006) reported over 3000 snow geese in brood-rearing locations along the coast from east of the Endicott road to Tigvariak Island in July 2006 (Figure 4). The presence of vessels or other equipment may cause some geese to move to adjacent habitats. Disturbance to brood-rearing snow geese would likely be temporary and would not be expected to significantly impact snow geese.

4.2.2 Vessel presence and airgun sounds

Little information is available describing the impact of seismic activities on marine birds. Lacroix et al. (2003) conducted aerial surveys using radio transmitters to investigate possible effects of underwater seismic activities on abundance, diving behavior and site fidelity of long-tailed ducks in Simpson Lagoon in relation to seismic survey activities. Aerial survey data did not detect significant differences in long-tailed duck abundance in seismic vs. control areas in response to seismic activities. Additionally, data from radio-equipped long-tailed ducks indicated no significant differences in diving indices or site fidelity between pre-seismic and seismic periods in control vs. seismic areas. However, the radio telemetry portion of the study could only detect presence of radio-equipped ducks within 2.5 km of monitoring stations located along the shore, but could not detect movements or location within that radius. Thus, the radio telemetry study may not have been rigorous enough to detect localized responses of long-tailed ducks to seismic activities. Impacts of seismic activities on long-tailed ducks and other marine birds is likely subtle and more studies may be required to determine the extent of possible impacts of seismic activity on marine birds. Based on the currently known information disturbance from seismic activities is unlikely to result in significant impacts.

4.3 Effects of seismic activity on food availability

Loons may feed on marine fish species, and waterfowl in the seismic survey area feed primarily on benthic invertebrates. Seismic energy may have the potential to affect fish and invertebrate food sources of marine birds in the survey area, but little is known about the actual impact to these species groups.

Most studies describing the impact from seismic surveys on fish consist of experiments with caged fish. Responses range from reported startle, distributional shifts, changes in blood chemistry, and partial habituation to seismic sounds (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992; Santulli et al. 1999 McCauley et al. 2000a, 2000b). During the proposed seismic survey, the sound sources will be constantly moving and the distance between seismic source lines will range between ~880 to 1,500 ft (~245 and 460 m). Based on the localized and relatively subtle behavioral responses, it is not expected that seismic noise will significantly reduce the availability of fish as a food source for loons (Fechhelm, 2007).

The molting period is energetically stressful for waterfowl and decreased feeding success due to disturbance from seismic activities could result in a protracted molt period. Several studies have suggested that there are few impacts on benthic invertebrates from seismic activities unless these animals are very close to the seismic sound source (e.g., Pearson et al. 1994; Christian et al. 2004; Andriguetto-Filho et al. 2005). Impacts to the benthic food sources of molting long-tailed ducks and eiders will likely be negligible.

4.4 Potential impacts resulting from collision with vessels

Seaducks and other marine birds often fly at relatively low elevation over the water (Johnson and Richardson 1982) and may be susceptible to mortality from collision with vessels in the seismic survey area. The potential for collision would be greatest during periods of poor visibility such as foggy conditions or during periods of darkness. Most, if not all, of the proposed seismic activity for the Liberty project will be conducted during periods of daylight which would reduce the potential for bird collisions with vessels. Increased risk of vessel collision could occur during foggy conditions that are common in the seismic survey area. However, in most situations birds would likely be able to avoid collisions with vessels, even under foggy conditions. Additionally, because all vessels used during the seismic activities will be traveling at slow speed and are relatively small, they will likely pose little threat to migrating birds.

4.5 Summary

Few studies have assessed the potential effects of seismic survey activities on marine birds. The greatest potential for impacts to birds would be the disturbance to nesting birds from activities during the deployment and retrieval of receiver cables at the Endicott causeway and at other locations where cable-lay vessels and people operate close to land areas (Table 2). The potential for vessels and seismic noise to disturb nesting birds during data acquisition is not expected to occur as the source vessels will not operate in waters of less than ~3 ft (~1 m) deep and the birds will likely habituate to this moving sound source. Vessel presence and seismic sounds could cause disturbance to molting and brood-rearing waterfowl resulting in displacement of some birds from preferred feeding or resting habitats. Displaced birds would likely move to adjacent habitats and because the vessels and sound source move, no habitat will be permanently unavailable and impacts will be minimal. There is little likelihood that seismic activities will have a significant impact on the availability of food sources for marine birds. The potential for bird mortality to result from collision with vessels is also not expected to occur and unlikely to affect marine birds significantly.

TABLE 2. SUMMARY OF POTENTIAL IMPACTS TO MARINE AND COASTAL BIRDS FROM PROPOSED OBC SEISMIC SURVEY IN THE LIBERTY AREA.

Section	Potential Impact	Source	Description of potential impact
4.1	Disturbance of nests	Activity during cable deployment and retrieval	Temporary or permanent nest abandonment resulting in lower production. Potential impacts likely eliminated with mitigation.
		Vessel and airgun sounds	No temporary or permanent nest abandonment expected. Impacts likely negligible.
4.2	Disturbance of brood-rearing, molting and feeding birds	Vessel activity during cable deployment and retrieval	Potential temporary displacement of long-tailed ducks and brood-rearing snow geese from preferred habitats. Disturbance unlikely to result in significant impacts.
		Vessel presence and airgun sounds	Potential temporary displacement of long tailed ducks and other marine birds from preferred habitats. Disturbance unlikely to result in significant impacts.
4.3	Food availability	Airgun sound energy	Changes in fish and invertebrate food sources likely negligible.
4.4	Risk of bird-vessel collisions	Vessel presence	Impact from bird-vessel collision likely minimal or negligible.

5 MITIGATION MEASURES AND MONITORING

Disturbance from deployment and retrieval of receiver cables in shallow waters and land, vessel activities and airgun sounds during the proposed shallow water seismic survey in the Liberty area may have the potential to impact bird nests, and molting, brood-rearing and feeding birds. Impacts resulting from this disturbance could be minimized or eliminated with mitigation measures as discussed below.

5.1 Mitigation measures implemented during survey planning and design

The following measures have been implemented during the planning and design of the survey that reduce any potential impact to marine and coastal birds:

- The area for which seismic data is required, i.e. the well path from SDI to the Liberty prospect, has been minimized. This has led to a reduction in the shallow water and land areas where receiver cables need to be deployed.

- The total airgun discharge volume has been reduced to the minimum volume needed to obtain the required data.
- Due to the short open-water window in which seismic surveys can be conducted, the data acquisition has been prioritized. Acquisition of data around Howe Island and Lion Point will occur in mid-August well after the nesting period.

5.2 Mitigation measures during survey

Based on the assessment described in this report, it is likely that seismic activities may be conducted on the Endicott causeway and Duck Island 1 & 2 during the nesting season. The following mitigation measures will be implemented during the seismic survey to reduce any impact:

- Endicott causeway and Duck Island 1 & 2 will be surveyed for the presence of eider nests prior to the start of the deployment of receiver cables in these areas if birds are still nesting. A biologist will walk the perimeter of the causeway and search the driftwood accumulations for eider nests. Precaution will be used to ensure that eiders are not flushed from nests during the search.
- GPS coordinates of nest locations with buffer zones will be recorded and provided to the crews deploying the cables.
- The biologist will mark active nests with two flagged survey stakes located ~20 m on either side of the nest to allow cable deployment crews to identify physical locations of nests and avoid cable deployment in the immediate vicinity of active nest sites. If nesting eiders are present on the Endicott causeway and Duck Island 1 & 2 during cable deployment and retrieval, caution will be used to ensure that eiders are not flushed from nests, although nesting eider hens are not easily displaced from nests. If any eiders are flushed from nests, the eggs will be covered with the down from the nest to reduce visibility to predators if possible.

5.3 Monitoring

Assuming that scheduling of seismic activities eliminates potential disturbance of nesting birds on Howe Island and Lion Point, the Endicott causeway and possibly Duck Island 1 & 2 will be the only locations where nesting birds could potentially be impacted by seismic activities. If active nests are reported on the Endicott causeway (or Duck Island 1 & 2) prior to cable deployment, a land-based observer could monitor cable deployment and retrieval operations, and seismic activities to determine the effects of these activities on nesting birds.

Vessels used during deployment and retrieval of the cables and seismic source vessels will probably encounter individual or flocks of marine birds in open-water and nearshore habitats, particularly in the vicinity of Lion Point, Point Brower, and possibly west of the Endicott causeway. Very little information is available describing the reactions of marine birds to seismic activities. MMOs on seismic source vessels may have opportunities to record reactions of birds to source vessels. Observations of localized responses of birds to seismic activities may help increase understanding of potential effects of these activities on marine birds.

The vessels proposed for seismic activities are relatively small and bird mortality resulting from collisions with vessels is not expected to be an issue. In case bird/vessel collisions occur, a reporting protocol and procedure will be followed by the crew.

6 CUMULATIVE IMPACTS ON MARINE AND COASTAL BIRDS

The cumulative effects described in this section relate to potential effects to birds in offshore areas or the adjacent coast that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil development.

The initial development work for the Prudhoe Bay oil fields began around 1968. Since then the number of production pads increased from 16 in 1973 to 115 in 2001 (NRC 2003). The number of miles of gravel road increased from 100 in 1973 to 400 in 2001. The developed area, which was originally confined to the Prudhoe Bay area, currently extends from the Colville to the Sagavanirktok River. In addition, production facilities for the Badami Unit, located about 30 miles east of the Sagavanirktok River, are connected to the Endicott development by a pipeline. Further oil field expansion is also planned west of the Colville River into the National Petroleum Reserve, Alaska.

Recent and future negotiations between the State of Alaska and various industry groups regarding development of a gas pipeline from Prudhoe Bay to Canadian and U.S. markets could result in future development of the Point Thomson Unit located about 50 miles east of Prudhoe Bay. Other exploratory activities which could lead to future development are proposed for offshore areas east of the Liberty project area in the central and eastern Alaskan Beaufort Sea during 2008. The types of impacts that could result from future development could include potential impacts from habitat loss, effects of disturbance, increased predation, and oil spills.

The proposed seismic survey activities in the Liberty project area may add incrementally to disturbance impacts of development on marine birds. Mitigation, including scheduling of activities to occur after completion of the nesting season and monitoring of nests if seismic activities occur during the nesting season, will minimize or eliminate impacts to nesting birds. Disturbance to molting and brood-rearing birds may cause temporary displacement of some birds from preferred feeding or resting area, but these impacts will be short-term. Cumulative impacts to marine birds resulting from the proposed offshore seismic exploration activities associated with the Liberty project will likely not be significant.

The need for developers and wildlife managers to address all of the issues related to the potential impacts of future oil field development will continue. Many stipulations and required operating procedures which have helped mitigate the effects of North Slope oil field development are included in various permitting and EIS documents. Continued oversight of North Slope development will help to ensure that the impacts of future development on birds in offshore areas of the Liberty project and other wildlife are minimized.

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LIBERTY SHALLOW WATER SEISMIC SURVEY 2008
BIOLOGICAL ASSESSMENT FOR FISH AND FISH HABITAT

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SUMMARY

BP Exploration (BPXA) plans to develop an oil reservoir in the Liberty project area located offshore in the Beaufort Sea east of Prudhoe Bay, Alaska. This reservoir will be developed using ultra-Extended-Reach Drilling (uERD) techniques from the existing Endicott facilities and will substantially reduce the environmental footprint compared to the originally proposed offshore stand-alone development. To increase the probability of successful implementation of the proposed uERD technique, BPXA plans to conduct a 3D ocean bottom cable (OBC) seismic survey during the open-water season 2008.

A total of 28 fish species have been caught in the nearshore waters of the Prudhoe Bay area in the Beaufort Sea over the last 27 years. Only seven species constitute 97% of all fish caught during the summer months. These species include the diadromous[1] species Arctic cisco, least cisco, broad whitefish and Dolly Varden and the marine species Arctic cod, fourhorn sculpin and Arctic flounder. The four diadromous species are designated as key indicator species for detecting anthropogenic impacts associated with oil and gas development in the coastal Beaufort Sea (U.S. Army Corps of Engineers 1980, 1984).

The potential impacts on the four diadromous and three marine fish species and their habitat from increased sound levels from seismic airguns are: 1) damage to fish eggs, larvae, fry, juvenile and adult fish, and 2) behavioral responses that may lead to avoidance of feeding or migrating habitat.

Seismic sounds can affect the various life stages of fish only when they are in very close proximity to the source and potential mortality or injury is not expected to be distinguishable from natural mortality. Impacts to eggs and larvae are not an issue since they are not present in the survey area. Behavioral responses to seismic sounds that can lead to the avoidance of feeding or migrating habitats are not expected to have significant impacts on the fish populations as the acoustic footprint of the sound source in the shallow nearshore waters is relatively small compared to the available habitat. Stress from prolonged low level sounds is unlikely to occur due to the temporary nature of the seismic sounds in combination with constant movements of migrating and feeding fish.

Based upon estimates of airgun sound attenuation, the life-history characteristics of the major fish species, and the structure and physical processes of the North Slope coastal environment, population level effects of fish species and impacts to their habitat are not expected to occur.

1 INTRODUCTION

1.1 Background of Proposed Seismic Survey

The Liberty field contains one of the largest undeveloped light-oil reservoirs near North Slope infrastructure, and the development of this field could recover an estimated 105 million barrels of oil. The field is located in federal waters of the Beaufort Sea about 5.5 miles offshore in 20 ft of water and approximately 5 to 8 miles east of the existing Endicott Satellite Drilling Island (SDI) (Figure 1). The Liberty development project design and scope has been changed from an offshore stand-alone development (manmade production/drilling island and sub-sea pipeline) to the use of uERD from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. As a result of this change in scope, BP Exploration (BPXA)

[1] Diadromous refers to migrating fish species that travel between salt and fresh water.

believes that Liberty can be developed with a substantially reduced environmental footprint and impact than the originally proposed offshore stand-alone development.

The currently available seismic data of the Liberty area focus primarily on deeper targets and hence does not optimally image the shallow overburden sections of the well bore. To obtain better imaging of these shallow sections, BPXA plans to conduct an offshore 3D ocean bottom cable (OBC) seismic survey from west of Endicott causeway to Tigvariak Island in offshore waters shoreward of the barrier islands during the 2008 open-water period (Fig. 2). The acquisition of additional marine 3D seismic survey data will increase the probability of successful implementation of the proposed uERD by providing higher resolution data to assist in imaging for well planning and drilling operations.

The dataset obtained with the proposed seismic survey will replace and augment the data from the Endicott 3D (1983) and NW Badami (Liberty) (1995) 3D on-ice vibroseis surveys. Various seismic acquisition methods and sound source reduction technologies have been identified and assessed on their technical and environmental performance. The proposed 3D OBC seismic survey method is the most appropriate for the specific survey goal and objectives of the current Liberty seismic survey.

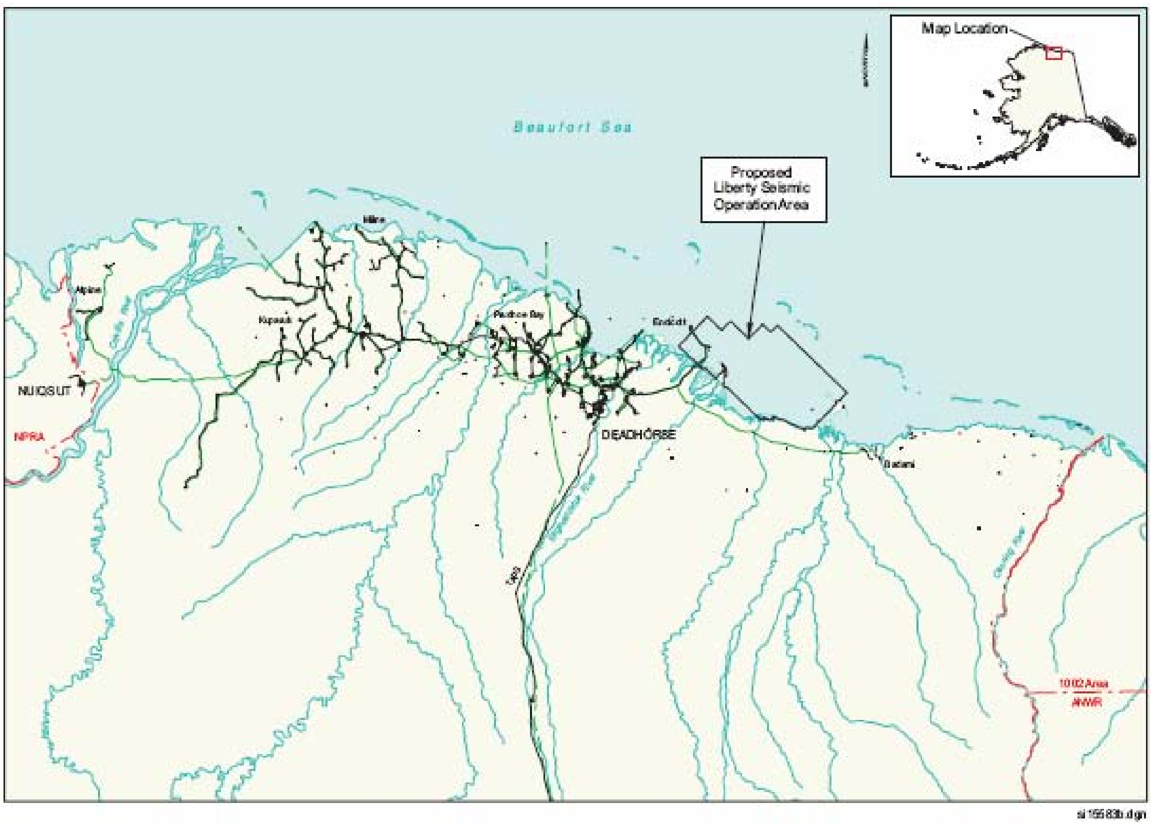

FIGURE 1. OVERVIEW OF THE LIBERTY SEISMIC SURVEY AREA.

1.2 Purpose of this Assessment

Under the Outer Continental Shelf (OCS) Lands Act, the federal agencies must ensure that the seismic survey data and information collected by industry and government are obtained in a technically safe and environmentally sound manner. The Minerals Management Service (MMS) regulations (30 C.F.R. Part 251) specifically state that geological and geophysical activities cannot cause harm or damage to aquatic life, property, or to the marine, coastal, or human environments. In addition MMS must assess the potential environmental impacts and proposed mitigation in advance of survey operations as described by the National Environmental Policy Act (NEPA, 1969) for any permit applications through an Environmental Assessment (EA) or Environmental Impact Statement (EIS) process. The identification of potential impacts to fish and fish habitat and associated mitigation and monitoring are also required under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). The purpose of this assessment is to provide supporting documentation to facilitate the review of the proposed project under NEPA requirements related to the potential impacts to fish and fish habitat. It was also driven by BPXA's corporate goals which require precautions to ensure that no harm to the environment results from development activities. This document contains the following information:

- Identification of potential sources of disturbance to fish and fish habitat that may result from the proposed seismic survey activities in the Liberty project area;
- Assessment of the impacts that may result from those activities; and
- Proposed mitigation and monitoring to minimize or eliminate potential impacts to fish and their habitat.

Note that the information provided in this report is for planning purposes, and while all information is believed to be accurate minor changes may occur as planning and implementation progress.

2 DESCRIPTION OF THE PROPOSED OBC SEISMIC SURVEY

OBC seismic surveys, in the Alaskan Arctic are used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. This type of seismic survey requires the use of multiple vessels for cable deployment/retrieval, recording, shooting, and utility boats. The planned 3D OBC seismic survey in the Liberty area will be conducted by CGGVeritas for a period of maximum ~60 days during July/August 2008, with an "as needed" extension of additional days after the whaling season (in accordance with the CAA), given the uncertainties in ice conditions and other factors that can influence the survey.

The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay of which 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft, 43% in water depths of 10-20 ft, and 25% in water depths of 20-30 ft (Figure 2). The approximate boundaries of the total surface area are between 70°11'N and 70°23'N and between 147°10'W and 148°02'W (Figure 2).

A detailed overview of the activities of the seismic survey is provided below, with focus on the mobilization procedure, seismic and other sound sources, the deployment and retrieval of the receiver cables, and the recording procedure.

2.1 Mobilization

Seismic data acquisition is planned to start as soon as ice conditions allow (i.e. < 10% ice coverage), which in this area normally occurs around 20 July (± 14 days). Limited layout of receiver cables might be possible on the Endicott causeway and/or mudflats in the Sagavanirktok River delta areas before the ice has cleared.

Data acquisition will be prioritized based on the starting date of the survey and weather conditions. The vessel fleet involved in the seismic survey activities will consist of approximately 11 vessels as listed below.

- Two source vessels, the *M/V Peregrine* (90 x 24 ft) and the *M/V Maxime* (55[2] x 16 ft).
- One recorder boat/barge, with *M/V Alaganik* barge (80 x 24 ft) and *Hook Point* boat (32 x 15 ft).
- Four small bow picker vessels to deploy and retrieve the receiver cables; these are the *F/V Canvasback* (32 x 14 ft), *F/V Cape Fear* (32 x 12 ft), *F/V Rumplemimz* (32 x 14 ft) and *F/V Sleep Robber* (32 x 14 ft). These vessels can operate in very shallow waters up to ~18 inch (0.5 m) water depth.
- HSE vessel *Weather or Knot* (38 x 15 ft).
- Crew transport vessel *M/V Qayak Spirit* (42 x 14 ft) and (Northstar's) hovercraft *M/V Arctic Hawk* (42 x 20 ft).
- Crew housing and fuel vessel *M/V Arctic Wolf* (135 x 38 ft).

Most of the survey vessels will be transported overland to West Dock in late May/early June where they will be mobilized prior to the start of the field season. The *M/V Arctic Wolf* will transit by water from Homer or Anchorage to the site when ice conditions allow and in consideration of the spring beluga hunt in the Chukchi Sea. Vessel mobilization will include assembly of navigation and source equipment, cable deployment and retrieval systems and safety equipment. The mobilization process will require about 35 days with most activities occurring at West Dock. Once assembled, the deployment, retrieval, navigation and source systems will be tested prior to departure to the project site.

Preparation of the cables ("cable dressing") will be conducted and completed at the CGGVeritas shop in Anchorage. Cable dressing includes attaching lead line and weighting systems to hydrophones to reduce any chance for movement on the sea floor. After completion of the final quality control check, the cables will be transported together with the vessels to West Dock where they will be loaded onto the vessels prior to departure to the project site. Some equipment might be staged at the Endicott facilities. To deploy and retrieve cables in water depths less than those accessible by the bow pickers, equipment such as swamp buggies and Jon boats may be used.

2.2 Seismic survey area details

The well path is the area of primary interest that needs to be fully covered by the seismic data. The size of this zone has been reduced to an absolute minimum of 35.6 mi^2 (92.1 km^2). To obtain full data coverage in this area of interest a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The total extent of the seismic survey will be 135.8 mi^2 (351.8 km^2) and may include some areas of mudflat (Figure 2).

Receiver cable lines will consist of a hydrophone and a Field Digitizing Unit (FDU) placed on the cables at 110 ft intervals. The cables will be placed on the seafloor according to a predefined configuration to record the reflected source signals from the airguns. The cables that will be deployed on mudflats and in very shallow water will utilize marsh phones and will be placed in a similar configuration as those deployed at the seafloor. The receiver cables will be oriented in a NE-SW direction. A total of approximately 66 NE-SW oriented receiver lines will be deployed with increasing line spacing from west to east of ~880 ft to ~2,000 ft. Total receiver line length will be ~490 miles (~788 km) of which ~10 miles (16 km) will be laid on mudflats. The source vessels will travel perpendicular over these receiver cables along lines which will have a NW to SE orientation and a varying total length of 2 to 3.5 miles (3.2 to 5.6 km).

[2] For this specific survey it is planned to increase the length of the *M/V Maxime* from 40 to 55 ft.

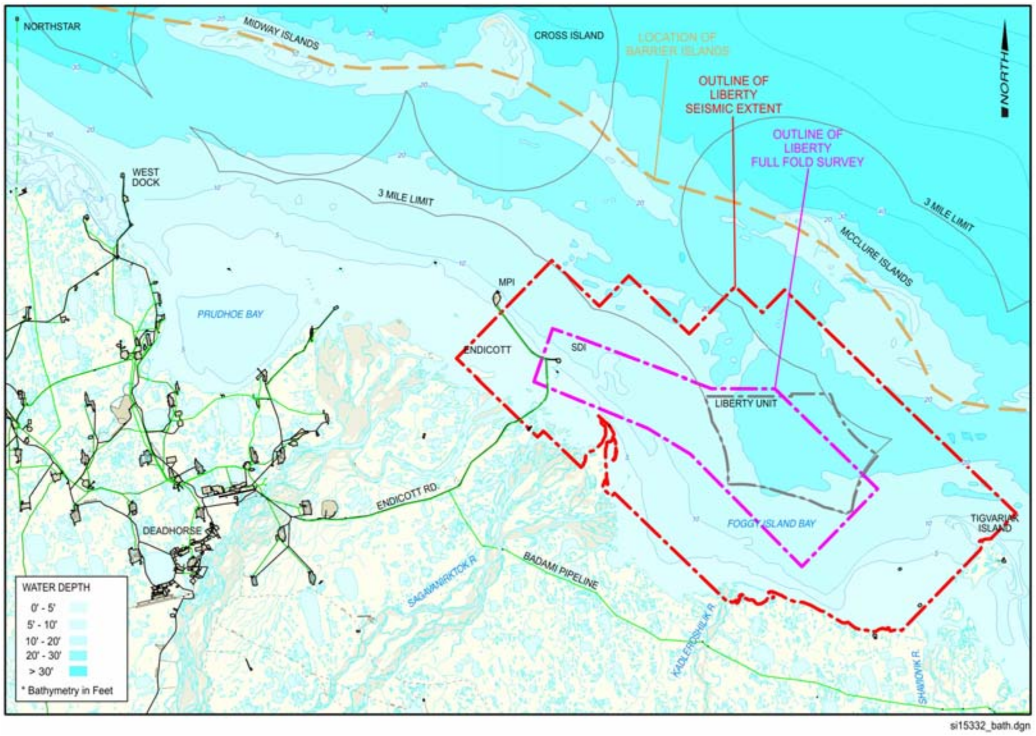

FIGURE 2. LIBERTY SEISMIC SURVEY AREA. THE PINK LINE REPRESENTS THE AREA WERE DATA NEEDS TO BE FULLY IMAGED AND THE RED DASHED LINE SHOWS THE OUTLINE OF THE LIBERTY SEISMIC EXTENT, WHICH IS THE AREA COVERED BY THE RECEIVER AND SOURCE LINES.

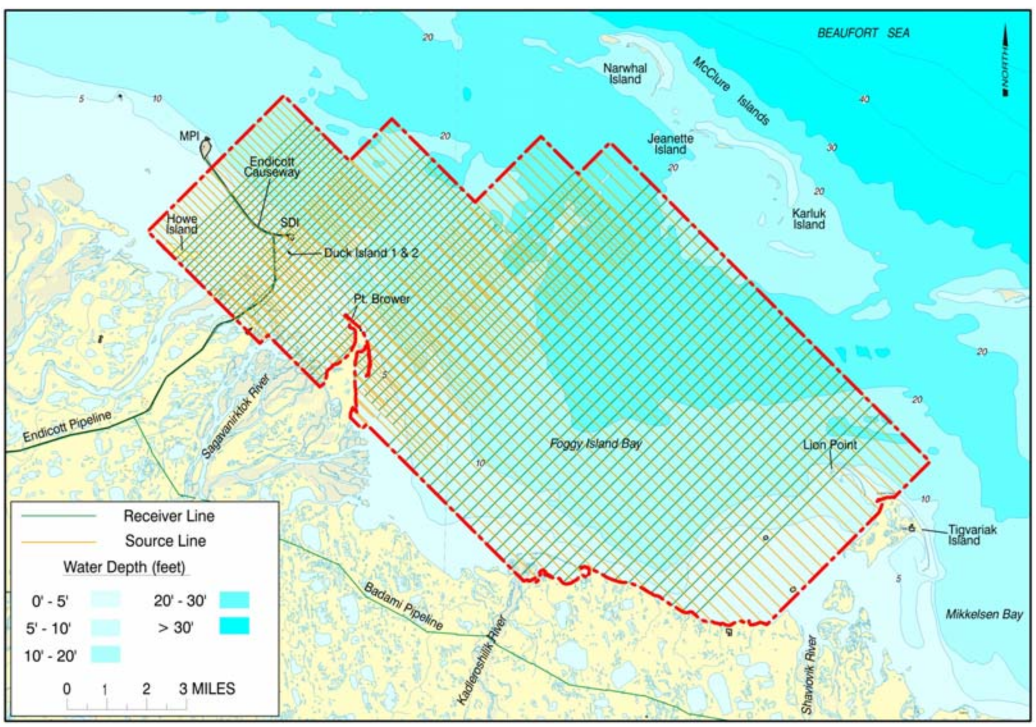

FIGURE 3. LIBERTY SEISMIC SURVEY AREA, INCLUDING THE RECEIVER LINES (GREEN) AND SOURCE LINES (ORANGE). ALTHOUGH THE SOURCE LINES AROUND THE ENDICOTT CAUSEWAY ARE SHOWN ALL THE WAY TOWARDS THE COAST, THE MINIMUM WATER DEPTH WHERE SEISMIC ACQUISITION IS POSSIBLE IS 3 FT. THE WATER DEPTH NEARSHORE OF THE ENDICOTT CAUSEWAY IS EXPECTED TO BE MUCH SHALLOWER.

The total source line length will be ~2000 miles (~3220 km) in water depths varying from 3 to 30 ft (1 to 9.1 m). The most critical data along the well path will be collected early in the season, and lower priority data will be collected later when environmental conditions may limit survey activities.Source vessels will not operate in water depths of less than ~3 ft. For planning purposes the source lines are extended to the shore since the exact location of the 3 ft contour is unknown. A bathymetry survey will be conducted during the winter season to define the 3 ft contour. To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the *M/V Peregrine* and *M/V Maxime* owned by Peregrine Marine. The sources used for seismic data acquisition will be sleeve airgun arrays with a total discharge volume of 880 in^3 divided over two arrays. Each source vessel will have two 440 in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. More details on the sound specifications of the 8-airgun arrays are specified in Table 1.

TABLE 1. AIRGUN ARRAY SPECIFICATION

Item	Specification
Energy Source	Eight 2000 psi Sleeve airguns; four of 70 in^3 and four of 150 in^3.
Source output (downward)	0-peak is 6.6 bar-m (236.4 dB re µPa @ 1m 0-pk) Peak-peak is 13.9 bar-m (242.9 dB re µPa @ 1 m pk-pk)
Towing depth of energy source	Between 1-4 m
Air discharge volume	880 in^3
Dominant frequency components	5-135 Hz

The arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths varying from 1-4 m (3-13 ft), depending on the water depth. The vessel will travel along pre-determined lines at ~1 to 5 knots, depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4-second shot intervals with two operating source vessels. The seismic data acquisition will occur over a 24-hr/day schedule.

2.3 Cable deployment and retrieval

The *M/V Peregrine*, *M/V Maxime* and 4 bow pickers (*Canvas Back*, *Cape Fear*, *Rumplemimz*, and *Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels will be powered with twin jet diesels and will be rigged with hydraulically driven deployment and retrieval systems ("Squirters"). The *M/V Peregrine* and *M/V Maxime* will function both as source and cable vessels and will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are extremely small while still allowing a pull of 800 pounds. The smaller bow picker cable vessels will also carry 120 hydrophone stations and will be capable of beach landings. All cable vessels will maintain 24-hr operations.

The lay-out of the receiver cables will occur in ~22 swaths of 3 lines each, moving from west to east starting just east of Endicott MPI (west of SDI). The bow pickers will place and retrieve the cables at speeds between ~1.5 to 3 knots (depending on water depth). The cable lines will be laid on the seafloor according to a predetermined grid (Figure 3). While the seismic source vessels are acquiring data traveling perpendicular to these lines, bow pickers will be laying a new 3-line cable swath and will retrieve the cables were data has been acquired. Data acquisition of each swath will on average take 2 days

Some receiver cables will be deployed on mudflats to record reflected source signals and allow for full interpretation of the data in the area of interest, i.e. well path (pink line in figure 2). The deployment of these receiver cables will be conducted with equipment that can operate in shallow waters and marshy conditions (i.e., swamp buggies, Jon boats).

The position of each receiver needs to be established. Due to the variable bathymetry in the survey area, receiver positioning may require more than one technique. A combination of Ocean Bottom Receiver Location (OBRL), GPS, and acoustic pingers will be used. For OBRL, the source vessel will fire a precisely positioned single gun multiple times along either side of the receiver cables. Multiple gun locations are then calculated at a given receiver to triangulate an accurate position for the receiver. In addition, Dyne acoustical pingers will be located at predetermined intervals at the receiver lines. The pinger locations can be determined using a transponder and allow for interpolation of the receiver locations between the acoustical pingers and as calibration/verification of the OBRL method. The sonar Dyne pingers operate at 19-36 kHz and have a source level of 188-193 dB re μPa at 1m. Because OBRL methods are not accurate in shallow water (< 15 ft), the receiver locations at these depths will be recorded as "as laid" positions, which will be the GPS location where the receivers are deployed.

2.4 Recording

A Sercel 428 FDU (Field Digitizer Unit) will be located at each hydrophone. This system is lightweight and robust and rated to 14 m (45 ft) of water depth, which will allow it to operate well in the water depths for this survey. For approximately each 30 recorder-hydrophone units one or two battery pack(s) will be deployed at the sea bottom. Battery packs will be equipped with a buoy (or acoustic release) and a pinger, to ensure that the battery packs can be located and retrieved when needed.

The data received at each FDU will be transmitted through the cables to a recorder for further processing. This recorder will be installed on a pin-together boat/barge combination and positioned close to the area where data are being acquired. While recording, the pin-together boat/barge will be stationary and is expected to utilize a four-point anchoring system.

2.5 Crew housing and transfer

The *M/V Peregrine* is able to house 10 crew including marine mammal observers (MMOs). The *M/V Maxime* can accommodate 6 people, including the MMOs. These source vessels will maintain 24-hr operations; crew transfers will take place by crew boats and/or hovercraft. The four bow pickers will be too small to house their crew and these crews will be accommodated onshore at the Endicott (MPI) base camp or other Deadhorse facility, or offshore on the M/V Arctic Wolf. The seismic activity will be a 24-hr operation to allow for efficient data acquisition in the short time window available, so crew change vessels will transfer crews approximately every 12 hours. Shifts for crews on the source vessels and cable vessels will be staggered to maximize transport efficiency. Two vessels will be used for these crew transfers, a crew boat (*M/V Qayaq Spirit*) and, if available, the Northstar hovercraft (*Arctic Hawk*).

In addition to housing crew at Endicott facilities, there will be a mother ship mobilized, the *M/V Arctic Wolf*. This vessel will house up to 30 crew members, and store cable parts and fuel for the other vessels. The *M/V Arctic Wolf* is a propeller driven vessel. Because of its size, the vessel can not be transported by truck to Prudhoe Bay and will mobilize from either Homer or Anchorage and sail around Barrow to the survey area when ice conditions allow and in consultation with beluga whale hunters in the Chukchi Sea. Two marine mammal observers will conduct observations off of this vessel during the transits from and to Anchorage/Homer (see Section 13.1). Crews will be housed in other camps in Deadhorse or other operating areas if the *M/V Arctic Wolf* arrives after seismic acquisition begins.

The recorder barge/boat (*M/V Alaganik* and *Hook Point*) can currently accommodate 4 people on the boat portion. The barge portion is dedicated to recording and staging of cables, hydrophones and batteries and can not be used to create additional housing due US Coast Guard restrictions.

Refueling of vessels at sea will be conducted from the vessel *M/V Arctic Wolf,* following applicable U.S. Coast Guard and regulatory requirements. Refuel of the boat storage on the *Arctic Wolf* will take place at West Dock, Endicott dock or by delivery from an approved Crowley vessel.

3 DESCRIPTION OF FISH AND FISH HABITAT WITHIN THE PROJECT AREA

Over the past 27 years, a total of 28 fish species (8,421,683 total fish) have been caught in the nearshore coastal water of the Beaufort Sea in and around the Prudhoe Bay area during a long term monitoring fish studies. Of these, seven species constitute 97% of all fish caught during summer: Arctic cod, Arctic cisco, fourhorn sculpin, least cisco, Arctic flounder, broad whitefish and Dolly Varden. The U.S. Army Corps of Engineers (1980, 1984) designated the Arctic cisco, least cisco, broad whitefish, and Dolly Varden as the four key indicator species for detected anthropogenic impacts associated with oil and gas development in the coastal Beaufort Sea. Arctic cod, fourhorn sculpin, and Arctic flounder are the dominant marine species of the area.

3.1 Arctic Cisco

Arctic cisco is believed to originate from spawning grounds in the Mackenzie River system of Canada (Gallaway et al., 1983; 1989; Bickham et al., 1989; Morales et al., 1993). In spring, emergent young (age-0) are flushed from spawning areas downstream into ice-free coastal waters. Some young-of-the-year are transported westward into Alaska by wind-driven coastal currents (Gallaway et al., 1983; Fechhelm and Fissel, 1988; Moulton, 1989; Fechhelm and Griffiths, 1990; Schmidt et al., 1991; Colonell and Gallaway, 1997). During summers characterized by strong and persistent east winds, enhanced westward transport can carry fish to Alaska's Colville River where they will overwinter. Arctic cisco remain in the Colville River until the onset of sexual maturity beginning at about age 7, at which point they are believed to migrate back to the Mackenzie River to spawn (Gallaway et al., 1983).

The Colville River is the only watershed west of the Mackenzie River that can support substantial overwintering populations of subadult and adult Arctic cisco. The Colville contains about 75 km of deep-water main-channel habitat (Schmidt et al. 1989) much of it in the river's lower reaches where brackish conditions persist during winter and where Arctic cisco can survive. Moulton (1997) estimated that the number of overwintering Arctic cisco in the Colville system with lengths greater than 250 mm fluctuates between 200,000 to over a million fish. Although the Sagavanirktok River is the second largest drainage in the Alaskan Beaufort Sea, it contains far less overwintering habitat than the Colville River (Schmidt et al. 1989, Adams and Cannon 1987). Despite this limitation, the Sagavanirktok River does support newly-recruited, young-of-the-year fish for their first few years (Fechhelm et al. 2007).

In the summer of 2007, the BP Beaufort Sea Long Term Fish Monitoring Program recorded the strongest recruitment of young-of-the-year Arctic cisco from Canada in the 25-year history of the study (Fechhelm et al. 2007). Assuming normal survival through the 2007-2008 winter, the waters in and around the seismic survey area will likely be heavily populated with yearling Arctic cisco in the summer of 2008. In contrast, many years of poor wind-driven recruitment prior to 2007 has left the central Alaskan Beaufort Sea Arctic cisco population largely depleted of subadult and adult fish (Fechhelm et al. 2007). There should be very few of these larger individuals in North Slope coastal waters in the summer of 2008.

Adult Arctic cisco from the Colville River are regularly reported to occur as far east as Pokok Bay located some 240 km east of Prudhoe Bay (Griffiths et al. 2002). It is likely that some component of the Colville River population forages westward into Harrison Bay. This gives them an approximate coastal range of ~600 km. The coastal range for juveniles is proportionately smaller. Their eastward distribution extends to Mikkelsen Bay, 35 km east of the Endicott Causeway but low catch numbers suggest this may be near the eastern limit of their summer dispersal range (Fechhelm et al. 1996). Some juveniles likewise would be expected to forage west of the Colville River in Harrison Bay. This translates to a coastal range of ~300 km. There is no evidence to suggest that fish of any age class move more than several kilometers offshore into the marine environment.

3.2 Dolly Varden

The northern form of the amphidromous[3] Dolly Varden spawns in many of the larger river systems of the Alaskan/Canadian Beaufort Sea (Craig 1984, Everett and Wilmot 1987). The Sagavanirktok River supports one of the larger Dolly Varden populations on the Alaskan North Slope (McCart and Craig 1971, Yoshihara 1972, Furniss 1975, Bendock 1983). They are alternate-year spawners that reach sexual maturity at 7 to 9 years in the Arctic (Morrow 1980). Juveniles remain within their natal streams for several years prior to their first seaward migration to food-rich coastal waters (Craig 1977a, 1977b, 1989). After smolting, Dolly Varden generally exhibit an amphidromous life-history strategy wherein they disperse out into coastal waters to feed each summer, then return upriver to overwinter (Craig 1989). There is also a component of the population that consists of non-amphidromous males which remain within their natal rivers for their entire life (Craig 1977a, 1977b, 1989).

In the Sagavanirktok River, Dolly Varden adults and smolts (2-3 year olds) begin migrating out into coastal waters at breakup. Abundance in the Sagavanirktok Delta is typically bimodal, with the highest densities occurring early and late in the summer interspersed with a notable mid-summer period when few fish are in the area (Fechhelm et al. 1997). This pattern represents the early summer migration away from overwintering areas in the Sagavanirktok River, possibly along the coast and/or out to sea, and a migration back to the overwintering areas in late summer. The Sagavanirktok Delta represents the primary migratory route for all age classes of this species but does not represent essential summer feeding grounds (Fechhelm et al. 1997).

3.3 Least Cisco

Least cisco spawn and overwinter in the Colville River, located approximately 90 km west of Prudhoe Bay, but are not found in any Alaskan River to the east including the Sagavanirktok River (Craig, 1984, 1989). Thus, virtually all least cisco found in the area of Prudhoe Bay and the Sagavanirktok Delta during summer originate from spawning and overwintering populations from the Colville River (Fechhelm et al. 1994, 1999). The eastward summer dispersal for adult least cisco is considerable and fish have been collected in large numbers as far east as Brownlow Point, some 85 km east of Prudhoe Bay (Griffiths et al. 2002). Some segment of the least cisco population probably forages west of the Colville River in Harrison Bay. This represents a coastal range in the vicinity of 400 km. The seismic survey area is well within their summer dispersal range.

The presence of juvenile fish (<200 mm) in the seismic study area varies considerably from year to year and is strongly dependant on wind-driven coastal currents (Fechhelm et al. 1994). Juveniles are transported eastward from the Colville River by wind-driven currents within

[3] Amphidromous fish move between fresh and salt water during some part of their life cycle, but not for breeding.

Simpson Lagoon during the month of July. Prevailing east winds create westward flowing currents within the lagoon that prevents the eastward dispersal to Prudhoe Bay. In some years juvenile least cisco can be one of the most numerically dominant groups in the Prudhoe Bay/Sagavanirktok Delta area while in other years there may be virtually no fish present. If there are prevailing west winds in July, small least cisco have been reported as far east as Mikkelsen Bay although, like juvenile Arctic cisco, this appears to be the eastern limit of their dispersal range (Fechhelm et al. 1996). This gives them a coastal range of about 300 km.

3.4 Broad Whitefish

Both the Colville and Sagavanirktok rivers harbor spawning populations of broad whitefish (Gallaway et al. 1997, Patton et al. 1997). Despite the proximity of the two river systems, there is limited gene flow between the two respective broad whitefish stocks, which represent semi-isolated spawning populations (Patton et al. 1997).

Adult broad whitefish, probably from the Sagavanirktok River population, have been reported as far east as Brownlow Point (Griffiths et al. 2002). The extent of their westward dispersal is difficult to determine. In the field, there is no way to distinguish among individuals from the Colville and Sagavanirktok stocks. Large broad whitefish are regularly reported to occur in the delta of the Kuparik River located 15-20 km west of Prudhoe Bay, but there is no way to determine the origin of these fish. Mark-recapture studies indicate some movement around West Dock Causeway which makes it likely that some adults in Simpson Lagoon are of Sagavanirktok River origin (Moulton et al. 1986). In all likelihood, adult broad whitefish disperse westward into eastern Simpson Lagoon. Assuming that the westward dispersal is equivalent to the known eastern dispersal limit, their coastal range is in the order of 150 km.

The most restricted coastal range of any group is for juvenile broad whitefish. Because of their intolerance of high salinities, the distribution of young fish is largely restricted to the brackish to fresh waters of the Sagavanirktok Delta (Fechhelm et al. 1992). During summer, most yearling broad whitefish are caught between Heald Point on the west and Point Brower on the east, a distance of some 15 km. Assuming a maximum seaward distribution of 4 km, the primary summer feeding habitat for juvenile fish is approximately 60 km^2 (Figure 4) Because of the restricted range of juvenile fish, the Sagavanirktok Delta can be considered the primary nursery area for the Sagavanirktok River stock.

3.5 Marine Species

The Arctic flounder and fourhorn sculpin are bottom-dwelling circumpolar marine species typically found in shallow coastal waters during summer (Walters 1955, Morrow 1980, Scott and Crossman 1973). Both species live permanently near the coast and do not undergo any extensive migrations. In winter, they remain in marine waters just outside the limits of bottomfast ice. During the open-water summer season, they migrate into the nearshore zone as bottomfast ice dissipates and it has been reported that they may actually move considerable distances upriver (Morrow 1980).

The Arctic cod is one of the most abundant fish species collected in coastal waters during late summer. Cod typically associate with highly productive transition layers that separate cold marine bottom water and warm brackish surface water. The onshore movement of such layers is an important factor in coastal aggregations of fish (Moulton and Tarbox 1987). Cod do not actively move into freshwater or low-salinity habitats. The movement of large schools into coastal areas can be dramatic and can be either short-lived (Craig and Haldorson 1981) or sustained (Glass et al. 1990). Hop et al. (1997) point out that occurrence of Arctic cod schools in any particular area is both unpredictable and ephemeral.

3.6 Essential Fish Habitat

A background discussion of Essential Fish Habitat (EFH) is provided in USDOI, MMS (2002) and USDOI, BLM (2005). According to the Preliminary Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska (NMFS 2005), the only two species of fish found in the Beaufort Sea that are amenable to EFH regulation and consideration are the pink salmon and the chum salmon (Jon Kurland, Director, NMFS Habitat Conservation Division, Juneau, pers. comm.; Lawrence Peltz, NMFS Habitat Conservation Division, Anchorage, pers. comm.; Jeff Childs, MMS, pers. comm.). All marine and coastal waters of the Beaufort Sea are considered EFH for these two species (NOAA, NMFS 2005). The only documented freshwater drainage in which spawning of these two species has been documented is the Colville River (Fechhelm and Griffiths 2001). The river channels and streams within the drainage would also be considered essential fish habitat. Small runs of pink salmon may occur in the Sagavanirktok River although evidence of such is circumstantial (Fechhelm and Griffiths, 2001).

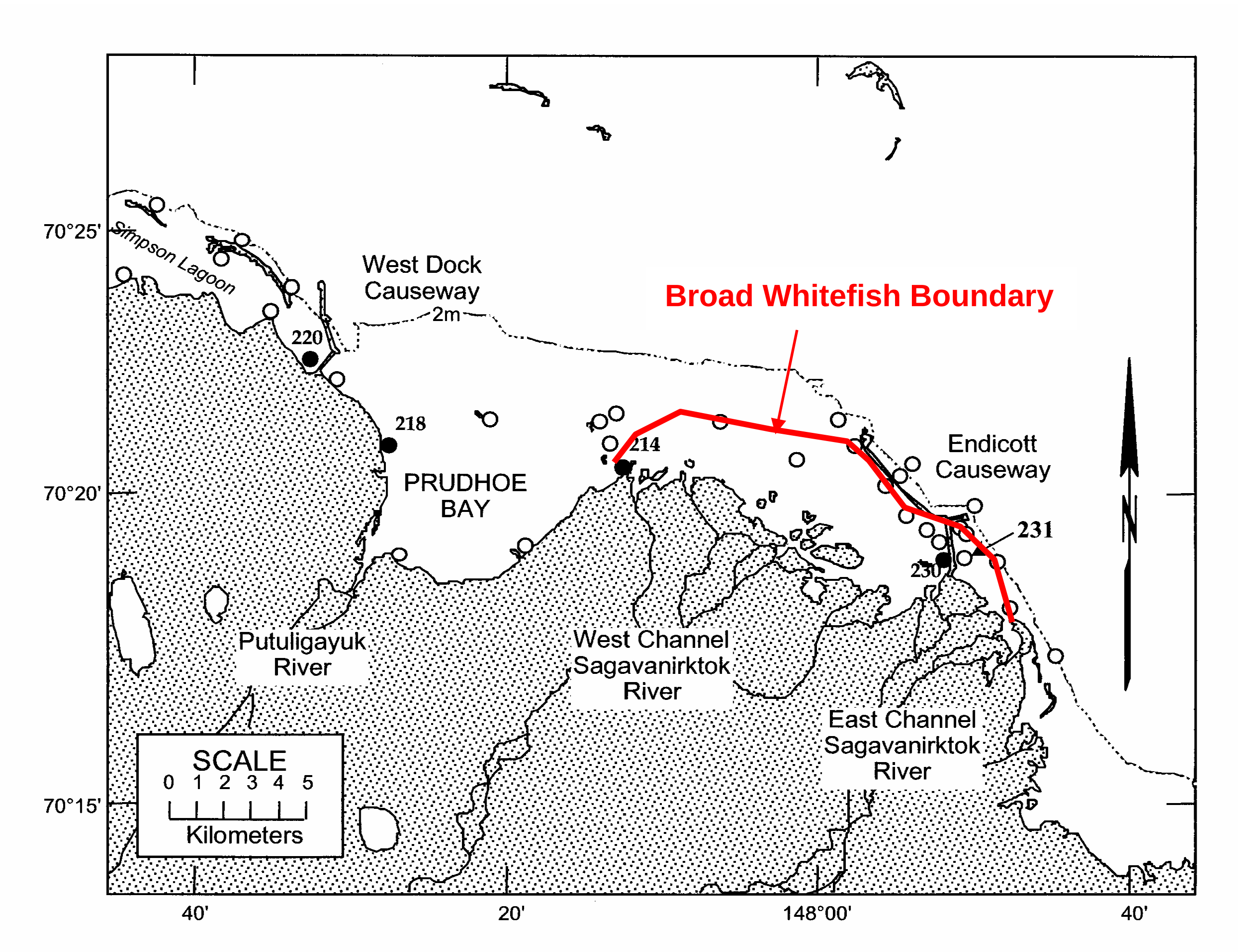

FIGURE 4. ESTIMATED BOUNDARY OF THE BROAD WHITEFISH SUMMER FEEDING HABITAT. THE CIRCLES AND NUMBERS REPRESENT FISH SAMPLING STATIONS.

The actual presence of salmon in the proposed survey area is quite limited. During BPXA's 25-year Beaufort Sea Long Term Fish Monitoring Program only 425 salmon were caught: 378 pink, 46 chum, and 1 chinook. Of the 60 pink salmon collected and measured from 2002 to 2007, all were adults ranged in fork length from 287 mm to 630 mm. Fifty-five of those were greater than 400 mm. Pink salmon typically do not show up in the fyke nets until late July (Fechhelm et al. 2007). This delayed appearance suggests that they immigrate into the area, and given their extensive migratory capabilities, these fish could originate from locations quite distant from Prudhoe Bay. Craig and Haldorson (1986) speculate that the ability to complete long oceanic migrations probably allows salmon that have been spawning in the Beaufort Sea to migrate to, and overwinter in, the more hospitable marine waters of the Bering Sea.

4 POTENTIAL IMPACTS ON FISH AND FISH HABITAT FROM THE PROPOSED SEISMIC SURVEY

During the proposed OBC seismic survey, exposure to airgun sounds is the main factor that has the potential to impact fish. The potential impacts from sound exposure are:

- Damage to fish eggs, larvae and fry
- Physical damage to adult and juvenile fish
- Behavioral responses that may lead to avoidance of migrating or feeding areas

If incidents involving the release of oil and fuel during offshore refueling activities occur, they will likely be very small, and will follow applicable U.S. Coast Guard and other regulatory requirements. Also, no unauthorized discharges from the seismic vessel, such as the discharge of engine oil, will occur. Given that the risk of a fuel spill is unlikely and a spill contingency plan will be in place, fuel exposure is not addressed as a specific category below.

In the sections below the potential impacts on fish from seismic sounds are briefly described and assessed in relation to the proposed seismic survey. A review of the potential impacts of airgun sounds on fish is provided by MMS (2006, 2007). In assessing these impacts, it is important to note that there are many uncertainties related to the interpretation of the existing data. A few examples are:

- The current knowledge of hearing systems of different fish species and the effects of exposure to sound on such different auditory systems remains limited;
- Most data on potential fish mortality, injury or changes in behavior is acquired using caged fishes. Due to the restrictions of these cages, the measured impacts (if any) might not necessarily be related to the sound source only, or represent natural behavior;
- A limited number of fish species has been studied and caution is needed when interpreting the results to other fish species and/or circumstances;
- Potential impact from the handling of fish is mostly not taken into account;
- The available data lacks information on sound measurements, i.e. what is measured and how (appropriate use of units and references, pressure and/or particle velocity, distance from the sound source, water depth, received levels). Sound can be measured as sound exposure levels (SEL) in decibels (dB) re 1 $\mu Pa^2 \cdot s$ or sound pressure level (SPL). The dB number can also differ according to the type of measurement, such as "peak or zero to peak (p or 0–p, hence re $1\mu Pa \cdot m_p$)", "peak to peak (p–p, hence re $1\mu Pa \cdot m_{p-p}$)", or averaged on a root mean square basis ("rms", hence re $1\mu Pa_{rms}$)[4]. Unless measurement types are provided, it is difficult to make direct comparisons between studies.

[4] For more information on sound types, see: Richardson, W.J., C.R. Greene, C.I. Malme and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego. 576 p.

4.1 Damage to fish eggs, larvae and fry

Seismic energy pulses may kill or damage eggs, larvae, and fry of some fishes when in close proximity to an airgun, with harm generally limited to within 5 m of the source and greatest within 1 m (MMS 2006, 2007). Kostyvchenko (1973) reported 25% mortality for eggs (four fish species) exposed to 215-230 dB re 1μPa at a distance of 0.5 m but that this rate decreased to 10% at a distance of 10 m. Booman et al. (1996) exposed the eggs and larvae of various commercially important fish species to sound levels of 220-242 dB re 1μPa. The authors reported some cases of injury and mortality but were limited to exposure distances of less than 15 m. Saetre and Ona (1996) applied a “worst case scenario” mathematical model to investigate the effects of seismic energy on fish eggs and larvae. They concluded that mortality rates caused by exposure are so low that the impact of airgun sounds on the recruitment to a fish stock must be regarded as insignificant. For the proposed survey, the potential impact on eggs and larvae is moot because they are not present in the Liberty seismic survey area.

4.2 Physical damage to adult and juvenile fish

In general, airguns are unlikely to cause immediate deaths of adult and juvenile fish (CDFO 2004, MMS 2006). Sound sources that have resulted in documented physiological damage of adult, juvenile, and larval fish have been at or above a received level of 180 dB re 1μPa (MMS 2006). Fishes with impaired hearing may have reduced fitness, potentially resulting in an increased vulnerability to predators, decreased ability to locate prey or mates, or sense their acoustic environment. The physical damage may not be immediately apparent (MMS 006, 2007). The likelihood of physical damage due to exposure of airgun sounds is related to the characteristics of the sound wave, survey depth, environmental conditions and the life stage and fish species exposed to the sound. Given that injury or depth would only occur to fish in close proximity, any injury to adult or juvenile fish is expected to be limited to a small number of individuals (MMS 2006, 2007).

During the proposed Liberty shallow-water seismic survey, airgun arrays will be used with a total discharge volume of 880 in^3 and an estimated peak level of 236 dB re $1\mu Pa_p$ at 1 m. The minimum depth where seismic data acquisition can take place is ~3 ft (~1 m). In these cases, the airgun array will be very close to the seafloor and the air bubble released by the airguns will partially break through the water surface, resulting in surface water disruption associated with in-air sounds and sound energy loss. Under these shallow water conditions the underwater sound attenuation will be very high and received sound levels of 180 dB re 1μPa are estimated to occur at distances between 50 to 115 m from the source. These estimated distances are based on a 35Log spreading loss (Grachev 1983) and assumed to be conservative for the shallow water portions of the proposed survey area.

Considering the small radius around the source for received sound levels of 180 dB or more, the area potentially ensonified will be a limited portion of the habitat where most fish are present during summer. In addition, fish may tend to avoid these sound sources and ramp-up procedures, that will form an integrated part of the operations, will provide fish with an advanced warning and increases the opportunity to move away from the source.

Young-of-the-year Arctic cisco represent a unique case, because they are transported westward from their Mackenzie River spawning grounds by wind-driven coastal currents (see Section 3.1). In years when east winds are of sufficient strength and frequency, fish typically arrive in the Prudhoe Bay/Sagavanirktok Delta area during the summer season from late June to mid September, although most recruitment occurs in the last three weeks of August (Fechhelm et al. 2007). Fish fork lengths typically range from 50-90 mm depending upon the time of transit. Because of the dominance of wind-driven transport, the recruitment mechanism is largely passive in nature. Fish do actively swim but their trajectory is primarily a function of coastal current patterns.

If summer recruitment occurs in 2008, large numbers of young-of-the-year Arctic cisco will be carried into the coastal area covered by the proposed seismic survey. Their ability to actively avoid areas with sound level of >180 dB will be minimal, their exposure being determined largely by prevailing currents. Given the 15 to 115 m spatial extent of the >180 dB sound level, it is highly unlikely that this year class will be adversely affected by airgun sounds. During recruitment, young-of-the-year fish can be distributed from the shoreline out to 12 km offshore (Thorsteinson et al. 1991). Only a small percentage of fish would pass through the area with sound levels of >180 dB. Current speeds in the vicinity of the Endicott Causeway can range up to 95 cm/s, with mean speeds typically ranging from 10 to 20 cm/s (Morehead et al. 1992, Morehead et al. 1992). At current speeds of 10 m/s, the potential exposure of individual fish to >180 dB has an estimated duration of approximately three hours. In addition, the seismic sound source itself is moving which leads to a further decrease of the potential exposure duration. Overall, the proposed seismic survey is expected to have no significant impact on young-of-the-year Arctic cisco should there be recruitment in 2008.

4.3 Behavioral Responses, potential avoidance of important habitat

Marine fish can hear airgun sounds nearly 2.7-60 km from their sources, depending on the sound characteristics, water depth, environmental conditions, life stage and species involved (MMS 2006). Forms of behavioral response to seismic disturbances include changes in schooling formation, shifts in vertical distribution , avoidance of disturbed areas, changes in orientation, increased levels of swimming activity, and the occurrence of alarm or startle responses. MMS (2006, 2007) contend that the threshold for typical behavioral effects to fish from airgun sources occur within the 160 to 200 dB re 1μPa range.

Several studies have shown that seismic operations have greatly reduced fish catches around areas where airguns were operative. Reduced catches occurred over 20 miles from the sound source and catch reductions continued five days after seismic data acquisition was complete. Other studies indicated that the affected area may extend to 33 km from a seismic survey operating in water depths between 50 and 300m, but this depends on the sensitivity to sound of various arctic fish species involved (MMS 2006).

Hastings and Popper (2005) are critical of many fish and sound studies because of problems with experimental design and execution, measurements, and interpretation. It is often difficult to interpret the results of noise studies because authors often do not provide received sound levels or do not describe important technical criteria of the experiments like the range from the sound source, water depth, and the appropriate units and references. CDFO (2004) points out that field experiments on fish and invertebrates are lacking making it difficult to evaluate the impact of a particular type of seismic sound, or more generally noise, on a particular species.

Potential behavioral responses of fish in relation to the proposed shallow-water seismic survey are assessed in the context of the coastal ecosystem of the Alaskan North Slope. During summer, diadromous fish disperse out into coastal waters to feed. Excluding Dolly Varden, most fish remain within brackish nearshore waters and do not venture far offshore into the marine environment. This nearshore zone is typically quite shallow (< 10 ft or 3 m) and is not believed to extend more than 3-4 miles (5-6 km) offshore. However, within this nearshore corridor fish can forage for considerable distances along the coast. Because of the elongated but relatively narrow summer habitat, environmental assessments have focused on the extent to which anthropogenic impacts can disrupt the integrity of the nearshore corridor and prevent fish from foraging along the coast (e.g., Cannon et al. 1987, Reub et al. 1991, Fechhelm et al. 1989).

The main question related to the behavioral responses of fish that inhabit the shallow waters of the Liberty area is whether the airgun sounds, both in magnitude and duration, lead to avoidance of important habitat. The underlying premises for assessing the potential effects of the proposed seismic survey on fish are:

- Estimation of the expected acoustic footprint of the airgun sound source and to what extent it overlaps with important fish habitat, potentially resulting in avoidance of preferred habitat.
- Assessment of the potential avoidance behavior of fish, based on the estimated acoustic footprint, and the impact on coastal migration and availability to preferred feeding habitat.
- Assessment of the potential impacts of prolonged exposure to low-level seismic sounds.

4.3.1 Avoidance of Preferred Habitat

Potential behavioral responses to fish from seismic sounds are assumed to occur at received levels in the range of 160 to 200 dB re 1μPa_p (Turnpenny and Nedwell 1994, cited in MMS 2006, 2007). The assumption is that fish may start actively avoiding airgun noise somewhere within this range.

During the proposed shallow-water seismic survey, the distance from the source of sound levels of 200 and 160 dB re 1μPa are estimated between 30 and 410 m respectively. These distances are based on a 35Log spreading loss, typically for shallow-water environments (Grachev 1983). Considering the extremely shallow water depths of the proposed survey in the nearshore zones (minimum 3 ft), where the airgun is towed at or very close to the bottom, these distances could even be smaller (15 and 150 m, when assuming a 45Log spreading loss). Assuming that fish potentially elicit behavioral responses when exposed to sound levels in the range of 160 to 200 dB, the estimated area ensonified by these sound levels ranges from 0.00071 to 0.528 km^2 around the source vessel (assuming a spherical spreading loss and using the minimum and maximum distance estimates).

Based on the summer distribution of diadromous fish species, the area potentially ensonified by sound levels of >160 dB represents only a tiny fraction of feeding habitat available to fish during summer. The feeding habitat available to adults and juveniles of all fish species present in the area range over hundreds kilometers along the coast (see Section 3) with an estimated width of 3 to 5 km on average. An area < 0.528 km^2 is virtually meaningless as a proportion of total available habitat.

The only fish species that is more restricted in terms of available feeding habitat during the summer season is juvenile broad whitefish. Due to their intolerance to high salinities the total available summer feeding habitat is approximately 60 km^2 (see Section 3.4 and Figure 4). The seismic survey area around the Endicott causeway overlaps with the eastern part of the broad whitefish feeding habitat. Much of this habitat is very shallow. Under east winds, which is the predominant winds direction during summer, vast expanses of the western delta are exposed mud flats, a condition that will prevent seismic activity altogether. Assuming that limited seismic data acquisition is possible in this area, sound attenuation will be very high because of the shallow water depths and the area potentially ensonified with levels >160 dB quite limited. In addition, the sound sources are moving and as such will never be in one place which results in very localized footprints of short duration that could easily be avoided by feeding fish without forcing them to move out of their restricted habitat. Loss of feeding habitat for juvenile broad whitefish is therefore not expected to occur.

Potential avoidance of 0.00071 to 0.528 km^2 preferred habitat will have a negligible impact on the marine species (Arctic flounder, fourhorn sculpin, Arctic cod). All of these species are widely distributed in large numbers throughout the coastal Arctic Ocean and any localized impact would constitute no threat to their populations.

4.3.2 Blockage of Coastal Migrations

During their summer feeding activities, diadromous fish transverse long distances over irregular coastal topography. Although fish tend to move in close proximity to the shoreline (Craig and Haldorson 1981) they will move out into open water provided salinity conditions remain low to moderate. In the early 1990s, one of the locations sampled by fishery surveys was a small island located in the middle of the Sagavanirktok Delta. Catch rates at this site for all species of diadromous fish was comparable to shoreline sites despite the fact that the island was located 2 km from the nearest shore, including the Endicott Causeway (LGL 1992, 1993, 1994a, 1994b; Griffiths et al. 1995, 1996). In 1984, mark-recapture studies indicated that large least cisco adults moving eastward along the coast passed around the seaward tip of the West Dock Causeway then apparently swam diagonally across the open waters of Prudhoe Bay as opposed to moving down the eastern face of the causeway and continuing along the shore (Fechhelm et al. 1989).

Based on the assumption that migrating fish potentially avoid areas with sound levels ranging from 160 to 200 dB re 1µPa, the distance from the source to these received sound levels ranges from 15 to 410 m, depending on the water depth of the sound source. Seismic data acquisition will be conducted in swaths (each consisting of 3 receiver lines) and will take an average of 2 days over the full length of the receiver lines. Migrating fish mainly concentrate in the shallow water zones, and in these shallow waters the sound levels are expected to attenuate rapidly. In addition, the source vessels are moving constantly during seismic acquisition of a swath and in combination with the relatively short distances to sound levels that might elicit behavioral responses of migrating fish, potential exposure will be localized and of short duration. Considering the fact that fish migration takes place over a 2 to 3 month period, the localized and short duration of sound exposure is not expected to block migration routes of diadromous fish species in any meaningful way.

Seismic airgun sounds are expected to have no impact on the migration of the key marine species. Both Arctic flounder and fourhorn sculpin migrate onshore in early summer but there is no evidence that they undergo extensive alongshore migrations once in nearshore waters. The movements of Arctic cod occur in conjunction with shifting oceanic water masses. The presence in nearshore waters in the vicinity of Prudhoe Bay is essentially random from year to year and when they are in the area they are present in overwhelming numbers (Fechhelm et al. 2007). The small seismic footprint is expected to have no significant impact on these marine species and their movements.

4.4 Stress from prolonged low-level sound exposure.

To what extent the long term exposure to low-level anthropogenic sounds (<160 dB) might have the potential of causing physiological stress that could affect the health of individual fish or their reproductive potential and in theory the impact on fish populations is unknown. The impact of stress in fish has not been extensively studied and the evidence that the effects on non-auditory aspects of an animal's physiology, such as an increase in stress levels, can come from increased background noise as well as exposure to a sudden increase in sound pressure has mainly been derived from studies with human beings (Hastings and Popper 2005). However, it is doubtful that for the proposed seismic survey, any single fish would be exposed to strong seismic and vessel sounds for sufficiently long that significant physiological stress would develop. The sounds generated during the proposed survey are localized, of relative short duration and do not represent a long term alteration to the acoustic environment of the Sagavanirktok Delta region. Given the coastal ranges of the species involved, only a very small fraction of the population is potentially exposed to low level seismic sounds at any time. The constant movements of fish up and down the coast in search of prime feeding locations further limit their time of exposure. Fish might also have some capacity for habituating to seismic sounds (Chapman and Hawkins 1969). Due to the relatively small acoustic footprint of the proposed survey, the exposure duration, natural fish behavior, the lack of information on anthropogenic sound induced physiological stress and the translation of this to the population level, impacts to fish populations from the proposed survey are not expected.

4.5 Summary

Based upon the estimated sound levels from the proposed Liberty shallow-water seismic survey, direct physical damage to juvenile and adult diadromous and marine fish species is expected to be limited and non-significant. Given the small size and localized acoustic footprint of the airgun sounds, fish are not expected to avoid feeding habitats or migrating areas. A summary of the potential impacts from airgun sounds is presented in Table 2.

Table 2. Summary of potential impacts to marine and coastal birds from proposed OBC seismic survey in the Liberty area.

Section	Potential impact	Source of impact	Description of potential impact
4.1	Damage to fish egg, larvae, and fry	Airgun sounds with received levels of >200 dB re 1μPa.	These received levels occur only at very close range from the source. Potential mortality of fry not distinguishable from natural mortality. Impacts to eggs and larvae moot since none will be in the survey area.
4.2	Physical damage to adult and juvenile fish	Airgun sounds with received levels of >180 dB re 1μPa.	These received sound levels occur only in very close proximity to the source and fish will tend to avoid these areas. Population level impacts due to injury or death not expected.
4.3	Behavioral response: avoidance of feeding habitat or coastal migration corridor	Airgun sounds with received levels in the range of 160 to 200 dB re 1μPa	Sound level footprint very small relative to the amount of feeding habitat available to fish. No significant population level impacts are expected.
			Sound level footprint too small to block coastal migration corridor. Seismic footprint continuously moving. No significant population level impacts are expected.

Section	Potential impact	Source of impact	Description of potential impact
4.4	Stress response: prolonged exposure to low-level seismic sounds.	< 160 dB re 1μPa	Sound level footprint very localized relative to the distribution of fish along the coast and of short duration. Only small portions of fish populations are potentially exposed at any time. Constant movement of fish while foraging further limits residency time within the area and exposure to low seismic sounds. No significant population level impacts are expected.

5 MITIGATION MEASURES AND MONITORING

Disturbance from exposure to airgun sounds during the proposed shallow-water seismic survey in the Liberty area may have the potential to impact feeding and migrating fish. The extent of the impact, however, will be sufficiently low that it falls within natural variations and no population level impacts are expected. In this section a short summary is provided of the mitigation measures that have been implemented during the survey design and planning and potential mitigation measures that will be implemented during the survey.

5.1 Mitigation measures

The following measures have been implemented during the planning and design of the survey that reduce any potential impact to the environment:

- The area for which seismic data is required, i.e. the well path from SDI to the Liberty prospect, has been minimized. This has led to a reduction in the shallow water and land areas where receiver cables need to be deployed;
- The total airgun discharge volume has been reduced to the minimum volume needed to obtain the required data.

Based on the assessment described in this report, it is unlikely that seismic activities will have an impact on fish species or their habitat. However, the implementation of power down and ramp-up procedures during the seismic survey may reduce any potential impact to individual fish even more. This type of mitigation measures are standard for marine mammals and will be conducted in compliance with NMFS regulations.

- Ramp-up procedures after operational shutdowns of the airguns will be implemented according to standard international and NMFS protocols.

5.2 Monitoring

No monitoring activities are considered necessary, other than the continuation of BPXA's Beaufort Sea Long Term Fish Monitoring Program.

6 CUMULATIVE IMPACTS ON FISH AND FISH HABITAT

The cumulative effects described in this section relate to potential effects to fish and fish habitat that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil development.

The initial development work for the Prudhoe Bay oil fields began around 1968. Since then the number of production pads increased from 16 in 1973 to 115 in 2001 (NRC 2003). The number of miles of gravel road increased from 100 in 1973 to 400 in 2001. The developed area, which was originally confined to the Prudhoe Bay area, currently extends from the Colville to the Sagavanirktok River. In addition, production facilities for the Badami Unit, located about 30 miles east of the Sagavanirktok River, are connected to the Endicott development by a pipeline. Further oil field expansion is also planned west of the Colville River into the National Petroleum Reserve, Alaska.

Recent and future negotiations between the State of Alaska and various industry groups regarding development of a gas pipeline from Prudhoe Bay to Canadian and U.S. markets could result in future development of the Point Thomson Unit located about 50 miles east of Prudhoe Bay. Other exploratory activities which could lead to future development are proposed for offshore areas east of the Liberty project area in the central and eastern Alaskan Beaufort Sea during 2008. The types of impacts that could result from future development could include potential impacts from habitat loss, effects of disturbance, and oil spills.

The proposed seismic survey activities in the Liberty project area are not likely to add incrementally to existing or planned developments. The need for developers and wildlife managers to address all of the issues related to the potential impacts of future oil field development will continue. Many stipulations and required operating procedures which have helped mitigate the effects of North Slope oil field development are included in various permitting and EIS documents. Continued oversight of North Slope development will help to ensure that the impacts of future development on the environment are minimized.

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LIBERTY SHALLOW WATER SEISMIC SURVEY 2008
BIOLOGICAL ASSESSMENT BOULDER PATCH AREA

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SUMMARY

BP Exploration (BPXA) plans to develop an oil reservoir in the Liberty project area located offshore in the Beaufort Sea east of Prudhoe Bay, Alaska. This reservoir will be developed using ultra-extended-reach drilling (uERD) techniques from the existing Endicott facilities and will substantially reduce the environmental footprint compared to the originally proposed offshore stand-alone development. To increase the probability of successful implementation of the proposed uERD technique, BPXA plans to conduct a 3D ocean bottom cable (OBC) seismic survey during the open-water season 2008 in Foggy Island Bay.

Foggy Island Bay is part of Stefansson Sound, a large barrier island lagoon system off the Sagavanirktok River. Isolated patches of marine life are present in areas where rocks and boulders are widely scattered. In areas with denser rock cover, the rocks harbor a rich flora and fauna, including extensive beds of the kelp *Laminaria solidungula*. This area is referred to as the Boulder Patch and is estimated to be ~70 km^2 in size.

The proposed seismic survey area includes the known Boulder Patch area, where receiver cables will be deployed onto the seafloor and recovered after data acquisition. The potential impacts on the Boulder Patch communities from the proposed seismic survey and associated activities considered in this report are: a) Damage to Arctic kelp beds and other biota from the deployment and retrieval of cables on the seafloor; b) Decrease of Arctic kelp growth due to an increase of re-suspended sediments in the water column; c) Mortality/injury to invertebrate species from airgun sounds. The sessile invertebrate species are especially susceptible to damage as they cannot avoid the area, in contrast with the more mobile invertebrate species and fish.

The main operation during the proposed seismic survey that has the potential to damage the Boulder Patch biota is the deployment and retrieval of the receiver cables and associated equipment. However, the footprint of this equipment is very small relative to the Boulder Patch within the seismic survey area (0.0024 km^2 or 0.012 %) and permanent damage to the ecosystem from cable deployment/retrieval and airgun sounds is not likely to be substantial and probably not distinguishable from factors that cause natural disturbances. The proposed seismic survey is therefore not expected to have any significant and long term impacts on the Boulder Patch communities.

1 INTRODUCTION

1.1 Background of Proposed Seismic Survey

The Liberty field contains one of the largest undeveloped light-oil reservoirs near North Slope infrastructure, and the development of this field could recover an estimated 105 million barrels of oil. The field is located in Federal waters of the Beaufort Sea about 5.5 miles offshore in 20 ft of water and approximately 5 to 8 miles east of the existing Endicott Satellite Drilling Island (SDI) (Figure 1). The Liberty development project design and scope has been changed from an offshore stand-alone development (manmade production/drilling island and sub-sea pipeline) to the use of uERD from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. As a result of this change in scope, BP Exploration (BPXA) believes that Liberty can be developed with a substantially reduced environmental footprint and impact than the originally proposed offshore stand-alone development.

The currently available seismic data of the Liberty area focus primarily on deeper targets and hence does not optimally image the shallow overburden sections of the well bore. To obtain better imaging of these shallow sections, BPXA plans to conduct an offshore 3D ocean bottom cable (OBC) seismic survey from west of Endicott causeway to Tigvariak Island in offshore waters shoreward of the barrier islands during the 2008 open-water period (Fig. 2). The acquisition of additional marine 3D seismic survey data will increase the probability of successful implementation of the proposed uERD techniques by providing higher resolution data to assist in imaging for well planning and drilling operations.

The dataset obtained with the proposed seismic survey will replace and augment the data from the Endicott 3D (1983) and NW Badami (Liberty) (1995) 3D on-ice vibroseis surveys. Various seismic acquisition methods and sound source reduction technologies have been identified and assessed on their technical and environmental performance. The proposed 3D OBC seismic survey method is the most appropriate for the specific survey goal and objectives of the current Liberty seismic survey.

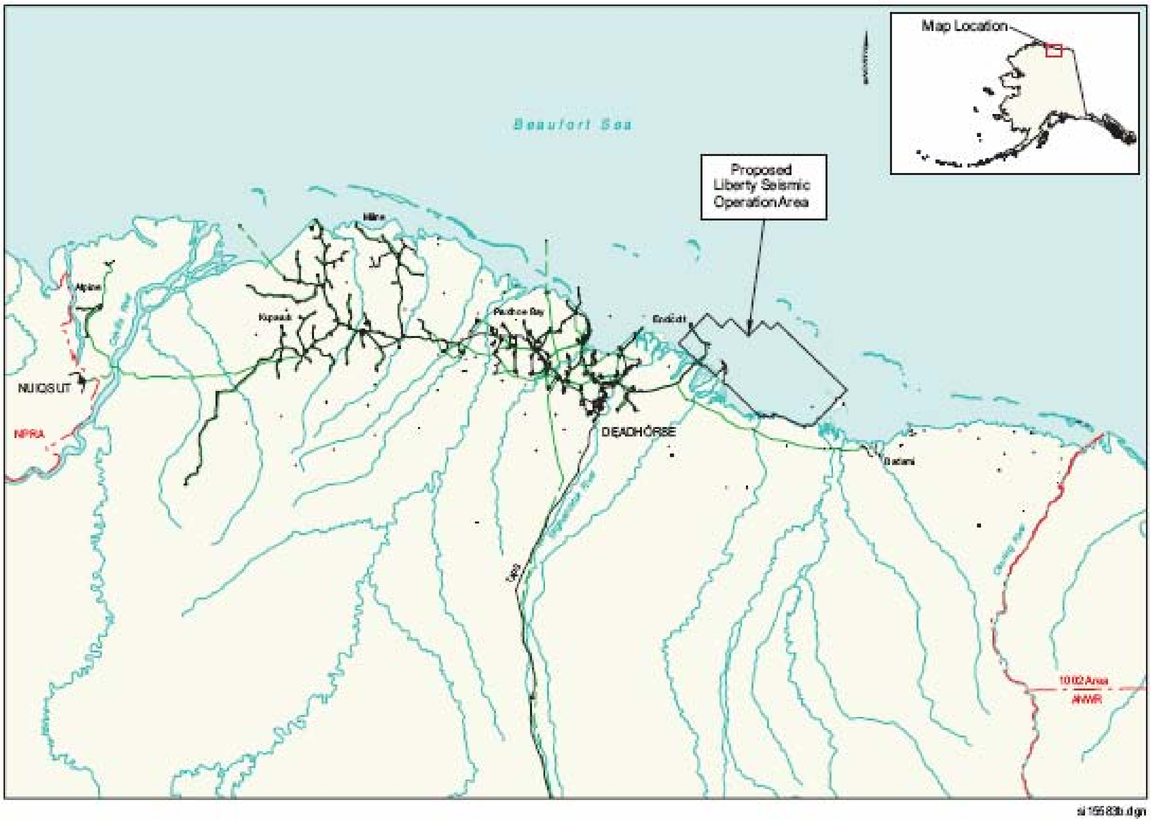

FIGURE 1. OVERVIEW OF THE LIBERTY SEISMIC SURVEY AREA.

1.2 Purpose of this Assessment

Under the Outer Continental Shelf (OCS) Lands Act, the federal agencies must ensure that the seismic survey data and information collected by industry and government are obtained in a technically safe and environmentally sound manner. The Minerals Management Service (MMS) regulations (30 C.F.R. Part 251) specifically state that geological and geophysical activities cannot cause harm or damage to aquatic life, property, or to the marine, coastal, or human environments. In addition MMS must assess the potential environmental impacts and proposed mitigation in advance of survey operations as described by the National Environmental Policy Act (NEPA, 1969) for any permit applications through an Environmental Assessment (EA) or Environmental Impact Statement (EIS) process. The purpose of this assessment is to provide supporting documentation to facilitate the review of the proposed project under NEPA requirements related to the Boulder Patch communities. It was also driven by BPXA's corporate goals which require precautions to ensure that no harm to the environment results from development activities. This document contains the following information:

- Identification of potential sources of disturbance to the Boulder Patch communities that may result from OBC seismic survey activities in the Liberty project area;
- Assessment of the impacts that may result from those activities; and
- Proposed mitigation to minimize or eliminate potential impacts.

Note that the information provided in this report is for planning purposes, and while all information is believed to be accurate minor changes may occur as planning and implementation progress.

2 DESCRIPTION OF THE PROPOSED OBC SEISMIC SURVEY

OBC seismic surveys in the Alaskan Arctic are used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. This type of seismic survey requires the use of multiple vessels for cable deployment/retrieval, recording, shooting, and utility boats. The planned 3D OBC seismic survey in the Liberty area will be conducted by CGGVeritas for a period of ~60 days during July/August 2008, with an "as needed" extension of additional days after the whaling season (in accordance with the CAA), given the uncertainties in ice conditions and other factors that can influence the survey.

The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay of which 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft, 43% in water depths of 10-20 ft, and 25% in water depths of 20-30 ft (Figure 2). The approximate boundaries of the total surface area are between 70°11'N and 70°23'N and between 147°10'W and 148°02'W (Figure 2).

A detailed overview of the activities of the seismic survey is provided below, with focus on the mobilization procedure, seismic and other sound sources, the deployment and retrieval of the receiver cables, and the recording procedure.

2.1 Mobilization

Seismic data acquisition is planned to start as soon as ice conditions allow (i.e. < 10% ice coverage), which in this area normally occurs around 20 July (± 14 days). Limited layout of receiver cables might be possible on the Endicott causeway and/or mudflats in the Sagavanirktok River delta areas before the ice has cleared.

Data acquisition will be prioritized based on the starting date of the survey and weather conditions. The vessel fleet involved in the seismic survey activities will consist of approximately 11 vessels as listed below.

- Two source vessels, the *M/V Peregrine* (90 x 24 ft) and the *M/V Maxime* (55[1] x 16 ft).
- One recorder boat/barge, with *M/V Alaganik* barge (80 x 24 ft) and *Hook Point* boat (32 x 15 ft).
- Four small bow picker vessels to deploy and retrieve the receiver cables; these are the *F/V Canvasback* (32 x 14 ft), *F/V Cape Fear* (32 x 12 ft), *F/V Rumplemimz* (32 x 14 ft) and *F/V Sleep Robber* (32 x 14 ft). These vessels can operate in very shallow waters up to ~18 inch (0.5 m) water depth.

[1] For this specific survey it is planned to increase the length of the *M/V Maxime* from 40 to 55 ft.

- HSE vessel *Weather or Knot* (38 x 15 ft).
- Crew transport vessel *M/V Qayak Spirit* (42 x 14 ft) and (Northstar's) hovercraft *M/V Arctic Hawk* (42 x 20 ft).
- Crew housing and fuel vessel *M/V Arctic Wolf* (135 x 38 ft).

Most of the survey vessels will be transported overland to West Dock in late May/early June where they will be mobilized prior to the start of the field season. The *M/V Arctic Wolf* will transit by water from Homer or Anchorage to the site when ice conditions allow and in consideration of the spring beluga hunt in the Chukchi Sea. Vessel mobilization will include assembly of navigation and source equipment, cable deployment and retrieval systems and safety equipment. The mobilization process will require about 35 days with most activities occurring at West Dock. Once assembled, the deployment, retrieval, navigation and source systems will be tested prior to departure to the project site.

Preparation of the cables ("cable dressing") will be conducted and completed at the CGGVeritas shop in Anchorage. Cable dressing includes attaching lead line and weighting systems to hydrophones to reduce any chance for movement on the sea floor. After completion of the final quality control check, the cables will be transported together with the vessels to West Dock where they will be loaded onto the vessels prior to departure to the project site. Some equipment might be staged at the Endicott facilities. To deploy and retrieve cables in water depths less than those accessible by the bow pickers, equipment such as swamp buggies and Jon boats may be used.

2.2 Seismic survey area details

The well path is the area of primary interest that needs to be fully imaged by the seismic data. The size of this zone has been reduced to an absolute minimum of 35.6 mi^2 (92.1 km^2). To obtain full data coverage in this area of interest a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The total extent of the seismic survey will be 135.8 mi^2 (351.8 km^2) and may include some areas of mudflat (Figure 2).

Receiver cable lines will consist of a hydrophone and a Field Digitizing Unit (FDU) placed on the cables at 110 ft intervals. The cables will be placed on the seafloor according to a predefined configuration to record the reflected source signals from the airguns. The cables that will be deployed on mudflats and in very shallow water will utilize marsh phones and will be placed in a similar configuration as those deployed on the seafloor. The receiver cables will be oriented in a NE-SW direction. A total of approximately 66 NE-SW oriented receiver lines will be deployed with increasing line spacing from west to east of ~880 ft to ~2,000 ft. Total receiver line length will be ~490 miles (~788 km) of which ~10 miles (16 km) will be laid on mudflats. The source vessels will travel perpendicular over these receiver cables along lines which will have a NW to SE orientation and a varying total length of 2 to 3.5 miles (3.2 to 5.6 km). The total source line length will be ~2000 miles (~3220 km) in water depths varying from 3 to 30 ft (1 to 9.1 m). The most critical data along the well path will be collected early in the season, and lower priority data will be collected later when environmental conditions may limit survey activities.

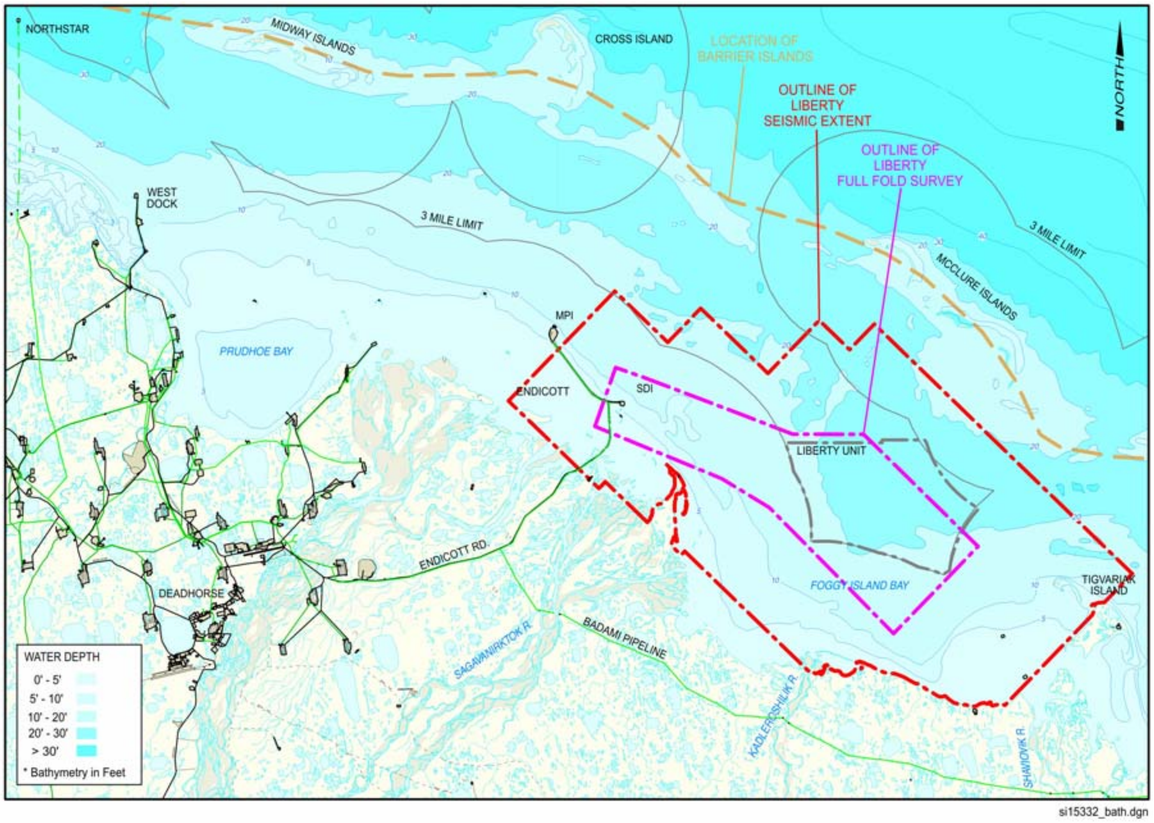

FIGURE 2. LIBERTY SEISMIC SURVEY AREA. THE PINK LINE REPRESENTS THE AREA WERE DATA NEEDS TO BE FULLY IMAGED AND THE RED DASHED LINE SHOWS THE OUTLINE OF THE LIBERTY SEISMIC EXTENT, WHICH IS THE AREA COVERED BY THE RECEIVER AND SOURCE LINES.

2.3 Seismic source

To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the *M/V Peregrine* and *M/V Maxime* owned by Peregrine Marine. The sources used for seismic data acquisition will be sleeve airgun arrays with a total discharge volume of 880 in^3 divided over two arrays. Each source vessel will have two 440 in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. More details of the sound specifications of the 8-airgun arrays are summarized in Table 1.

TABLE 1. AIRGUN ARRAY SPECIFICATION

Item	Specification
Energy Source	Eight 2000 psi Sleeve airguns; four of 70 in^3 and four of 150 in^3.
Source output (downward)	0-peak is 6.6 bar-m (236.4 dB re µPa @ 1m 0-pk) Peak-peak is 13.9 bar-m (242.9 dB re µPa @ 1 m pk-pk)
Towing depth of energy source	Between 1-4 m
Air discharge volume	880 in^3
Dominant frequency components	5-135 Hz

The arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths varying from 1-4 m (3-13 ft), depending on the water depth. The vessel will travel along pre-determined lines at ~1 to 5 knots, depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4-second shot intervals with two operating source vessels. The seismic data acquisition will occur over a 24-hr/day schedule.

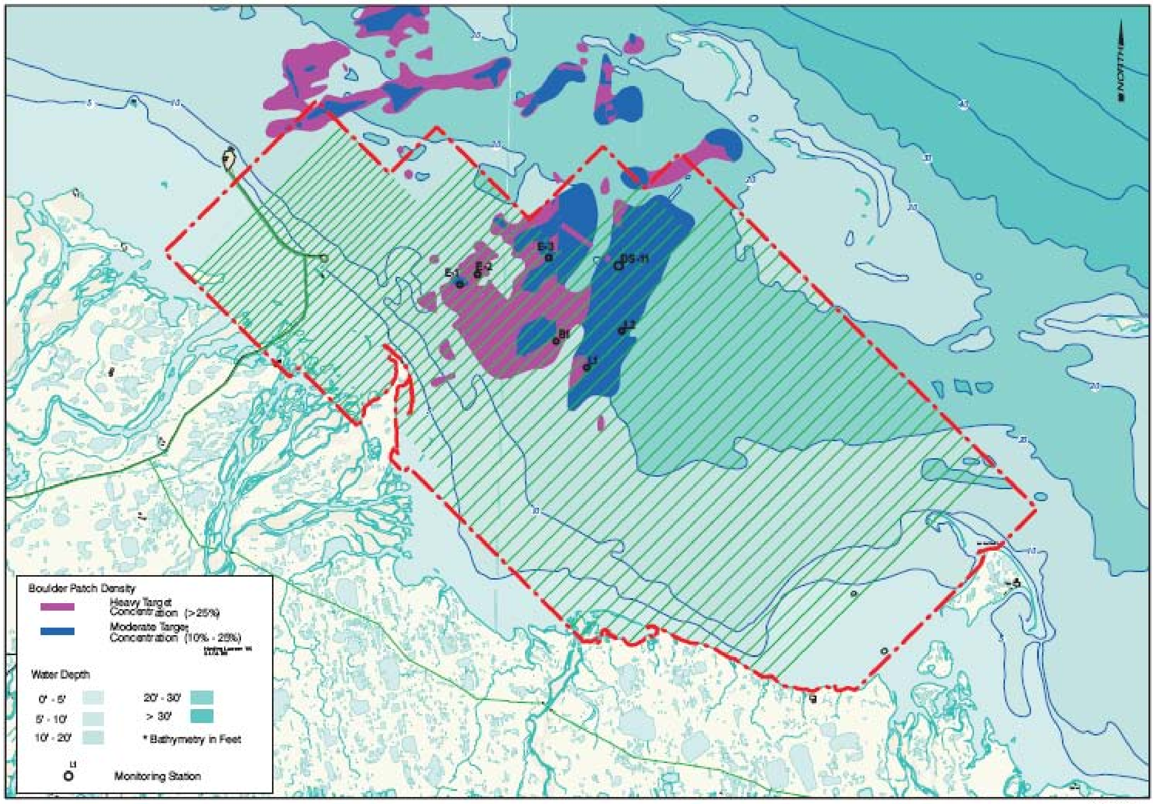

Figure 3. The Stefansson Sound Boulder Patch area as situated within the Liberty seismic survey area. The receiver line locations as planned are marked in green. Note that these lines are not drawn in scale (in reality they are ~ 1 inch in width) and that only a maximum of ~9 lines will be present on the seafloor at any given time. The black dots are sites from an ongoing long term monitoring program.

2.4 Cable deployment and retrieval

The *M/V Peregrine*, *M/V Maxime* and 4 bow pickers (*Canvasback*, *Cape Fear*, *Rumplemimz and Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels will be powered with twin jet diesels and are rigged with hydraulically driven deployment and retrieval systems ("Squirters"). The *M/V Peregrine* and *M/V Maxime* function both as source and cable vessel and will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are extremely small (width of ~0.5 inch) while still allowing a pull of 800 pounds. The smaller bow picker cable vessels will also carry 120 hydrophone stations and are capable of beach landings. All cable vessels will maintain 24-hr operations.

Data will be acquired using the patch technique, composed of 22 patches with 3 receiver lines per patch, starting at the Endicott causeway and moving east from there. Approximately 30 to 33 source lines will be acquired perpendicular to the receiver lines for each patch, with an average duration of 2 days. This allows recording on one patch, laying the next patch and holding a third patch on deck as backup. Each cable patch will remain on the seafloor for about 7 days; deployment on the seafloor ~1 day before data acquisition and retrieval ~1-2 days after data acquisition. The maximum total length of receiver cable that will be on the seafloor at any time is about 83 miles (134 km).

Some receiver cables will be deployed on mudflats to record reflected source signals and allow for full imaging of the data in the area of interest, i.e. well path (pink line in figure 2). The deployment of these receiver cables will be conducted with equipment that can operate in shallow waters and marshy conditions (i.e., swamp buggies, Jon boats).

The position of each receiver needs to be established. Due to the variable bathymetry in the survey area, receiver positioning may require more than one technique. A combination of Ocean Bottom Receiver Location (OBRL), GPS, and acoustic pingers will be used. For OBRL, the source vessel will fire a precisely positioned single gun multiple times along either side of the receiver cables. Multiple gun locations are then calculated at a given receiver to triangulate an accurate position for the receiver. In addition, Dyne acoustical pingers will be located at predetermined intervals at the receiver lines. The pinger locations can be determined using a transponder and allow for interpolation of the receiver locations between the acoustical pingers and as calibration/verification of the OBRL method. The sonar Dyne pingers operate at 19-36 kHz and have a source level of 188-193 dB re μPa at 1m. Because OBRL methods are not accurate in shallow water (< 15 ft), the receiver locations at these depths will be recorded as "as laid" positions, which will be the GPS location where the receivers are deployed.

2.5 Recording

A Sercel 428 FDU (Field Digitizer Unit) will be located at each hydrophone (Figure 4). This system is lightweight and robust and rated to 14 m (45 ft) of water depth, which will allow it to operate well in the water depths for this survey. For approximately each 30 recorder-hydrophone units one or two battery pack(s) will be deployed at the sea bottom. Battery packs will be equipped with a surface buoy or acoustic release, to ensure that the battery packs can be located and retrieved when needed. The intention is to retrieve all equipment that will be deployed at the seafloor.

The data received at each FDU will be transmitted through the cables to a recorder for further processing. This recorder will be installed on a pin-together boat barge combination and positioned close to the area where data are being acquired. While recording, the pin-together boat barge is stationary and is expected to utilize a four point anchoring system.

FIGURE 4. SERCEL 428 FIELD DIGITIZER UNIT (FDU).

2.6 Crew housing and transfer

The *M/V Peregrine* is able to house 10 crew including MMOs. The *M/V Maxime* can accommodate 6 people, including the MMOs. These source vessels will maintain 24-hr operations; crew transfers will take place by crew boats and/or hovercraft. The four bow pickers will be too small to house their crew and these crews will be accommodated onshore at Endicott (MPI) camp or other Deadhorse facility or offshore on the *M/V Arctic Wolf*. The seismic activity will be a 24-hr operation to allow for efficient data acquisition in the short summer season, so crew change vessels will transfer crews approximately every 12 hours. Shifts for crews on the source vessels and cable vessels will be staggered to maximize transport efficiency. Two vessels will be used for these crew transfers, a crew boat (*M/V Qayaq Spirit*) and, if available, the Northstar hovercraft (*Arctic Hawk*).

In addition to housing crew at Endicott facilities, there will be a mother ship mobilized, the *M/V Arctic Wolf*. This vessel will house up to 30 crew and store cable parts and fuel for the other vessels. The *M/V Arctic Wolf* is a propeller driven vessel. Because of its size, the vessel cannot be transported by truck to Prudhoe Bay and will mobilize from either Homer or Anchorage and sail around Barrow to the survey area when ice conditions allow and in consultation with beluga whale hunters in the Chukchi Sea. Two marine mammal observers will conduct observations off of this vessel during the transits from and to Anchorage/Homer (see Section 13.1). Crew will be housed in other camps in Deadhorse or other operating areas if the *M/V Arctic Wolf* arrives after seismic acquisition begins.

The recorder barge/boat (*M/V Alaganik* and *Hook Point*) can currently accommodate 4 people on the boat portion. The barge portion is dedicated to recording and staging of cables, hydrophones and batteries and cannot be used to create additional housing due US Coast Guard restrictions.

Refueling of vessels at sea will be conducted from the vessel *M/V Arctic Wolf*, following applicable U.S. Coast Guard and other regulatory requirements. Refuel of the boat storage on the *Arctic Wolf* will take place at West Dock, Endicott dock or by delivery from an approved Crowley vessel.

3 Description of Boulder Patch Community

Stefansson Sound is a large barrier island lagoon system off the Sagavanirktok River. In the early 1970s, researchers from the U.S. Geological Survey discovered areas within Stefansson Sound in the Beaufort Sea, Alaska where the characteristic mud bottom is covered by patches of rock (Reimnitz & Toimil 1976). The area of Stefansson Sound containing rocky substrate was charted and designated as the "Boulder Patch" by the U.S. Board of Geographic Names. Although boulders up to 2 m across and 1 m high are sometimes encountered, most of the rock cover occurs in the pebble to cobble size range (pebble is ~0.2 to 2.5 inch and cobbles 2.5 to 10 inch) (Figure 5).

Figure 5. Example of Boulder Patch cobble that functions as hard substrate for Arctic Kelp and other organisms (photo: Bill Streever)

The Boulder Patch is thought to be composed of rocks of Flaxman formation origin that were ice rafted to the area and incorporated in the Gubik formation at an earlier time (Dunton et al., 1982). Scattered rocks of the same origin can be seen above the low water line along nearby beaches.

Isolated patches of marine life occur in areas where rocks are widely scattered (10-25 % rock cover). However, in areas with denser rock cover (> 25 % bottom cover) the rocks harbor a rich flora and fauna relative to benthos communities in the Beaufort Sea, including extensive beds of the kelp *Laminaria solidungula*. The estimated area of the Boulder Patch with rock cover between 10-25% is 33km^2 and 36 km^2 is estimated to have a rock cover of more than 25% (Gallaway et al. 1999) (Figure 6).

3.1 Kelp community

While kelp communities are common in arctic waters outside of Alaska, the community in the Boulder Patch is hundreds of kilometers separated from the main range (Canadian Arctic). Although other kelp species occur on the Boulder Patch, the arctic kelp *Laminaria solidungula* is the predominant member of the Boulder Patch kelp community and serves both as food and shelter for a diverse assemblage of marine invertebrate fauna (Dunton et al. 1992). *L. solidungula* has been found to thrive at low-light levels and is thus well adapted to the Arctic.

There are few quantitative estimates of kelp biomass in the Boulder Patch. Recorded biomass of kelp shows that in areas of >25% rock cover the kelp biomass is about 4 times higher than in areas with 10-25% rock cover (262 g/m^2 vs. 67 g/m^2) (Dunton et al. 1982).Water transparency is a very important factor influencing kelp growth as it influences the amount of photosynthetic active radiation that can reach the plants (Aumack et al. 2007). Periods of decreased water transparency in summer and large patches of turbid ice in winter can cause low or undetectable levels of photosynthetic active radiation (Dunton et al. 1992) and hence limit kelp growth (Aumack et al. 2007). Polar marine plants have a variety of adaptive responses that help compensate for lower irradiances at higher latitudes. *L. solidungula* is very well adapted to the low-light environment of the Arctic (Hooper 1984, Dunton and Jodwalis 1988).

During the summer open-water period, when light is available, the photosynthetic production is usually sufficient to compensate for respiratory demands and allow accumulation of carbon storage compounds, necessary for growth, reproduction, and metabolism. Little linear growth occurs during this period due to insufficient concentrations of inorganic nitrogen that is needed for synthesis of new tissue. The products of photosynthesis are stored and used during the winter, when inorganic nitrogen concentrations have increased to levels enabling growth of new blades (Dunton and Schell 1986). Consequently, *L. solidungula* often completes nearly 90% of its annual linear growth (mean 23 cm, range 22-25 cm) in darkness (Dunton et al. 1982, Aumack et al. 2007). When the ice canopy is clear, light reaches the plants during spring and annual growth increases significantly (Dunton 1984).

In the Boulder Patch, turbidity is the major factor influencing water transparency and is potentially greatest during late summer and early fall when 1 to 5 mm of sediment accumulate on the seafloor and covers the biota (Dunton et al. 1982). Although the Sagavanirktok River Delta discharges about 6 miles (10 km) southwest of the Boulder Patch, the boulders do not appear to have been buried by riverine sediments. The predominantly easterly wind-driven currents result in a net westward drift in summer, moving the riverine sediments away from the Boulder Patch (Barnes et al. 1977, Matthews 1981).

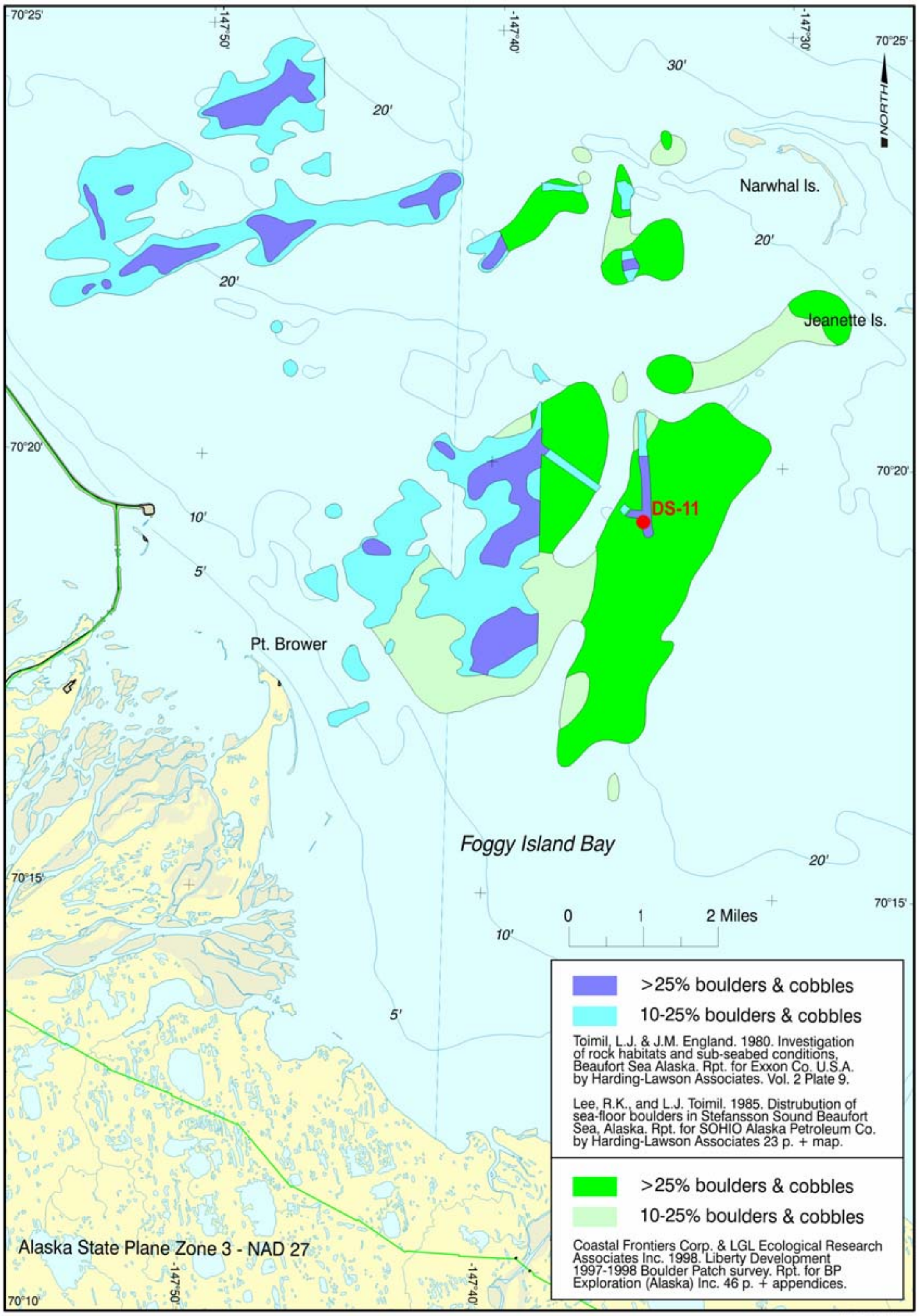

FIGURE 6. THE STEFANSSON SOUND BOULDER PATCH AREA. NOTE THAT THE AREAS ARE APPROXIMATIONS OF THE ACTUAL BOULDER PATCH.

The changes in water transparency are predominantly attributed to storms and associated shifts in wind-induced currents during the open water period. When these conditions prevail, benthic sediments are lifted from the Boulder Patch and re-suspended into the water column, preventing burial of the rich biological community. The fine sediments remain suspended for long periods and the majority of these sediments are incorporated in the ice canopy during freeze-up in October (Reimnitz and Dunton 1979, Barnes and Fox 1982, Dunton et al. 1982), blocking light transmission in the water column even during the 24-hour daylight in spring. The water transparency is measured by the amount of total suspended solids in the water column. These suspended solids include clay, silt, sand, decaying vegetation and animals or any inanimate particulate matter (Kirk 1983) and originate from erosion, natural discharge, run-off and flocculations. As these suspended particulates move through the water column, they reflect and adsorb sunlight, thereby reducing light availability for macroalgal photosynthesis and biomass production. Ultimately, reduced kelp production means less food and habitat for organisms dependent on the kelp. Total suspended solids in the Boulder Patch ranged from 4.2 to 14.3 mg/l (average 6.8 mg/l), this is four times lower than the values measured closer to shore along Endicott Island (23.0 to 24.2 mg/l) but higher than those measured at more seaward locations (e.g. Narhwal Island 2.6 to 2.8 mg/l) (Aumack, 2003).

The contribution of kelp can account to 50 to 75% of the total productivity of the Boulder Patch system (Dunton et al. 1982), which is considerable. This energy is passed on to other trophic levels either directly as food or indirectly through bacterial transformation of particulate detritus. There is direct evidence that several animals shifted their diet to an increased dependence on kelp carbon during the dark winter period when phytoplankton is absent. For example, up to 50% of the body carbon of mysid crustaceans, which are key prey species for birds, fish and marine mammals, was composed of carbon derived from kelp detritus during the ice covered season (Dunton and Shell 1986, 1987).

3.2 Boulder Patch Fauna

The kelp canopy serves as a habitat for a variety of animals. The major faunal groups in the Boulder Patch (by weight) are fishes, sponges, mollusks, crustaceans, cnidarians and bryozoans, many of which are suspension and filter feeders that are sensitive to high levels of turbidity and siltation (Dunton and Schonberg 2000). Only a few species graze directly on the kelp plants, such as the chiton *Amicula vestita*, which constitutes the greatest percentage of molluskan biomass. Several species of bottom dwelling fish are present in the Boulder Patch such as fourhorn sculpin, great sculpin, snailfish, prickleback, eelpout and arctic flounder. Artic cod and crustaceans such as amphipods, isopods and mysids are common in the water column adjacent to the Boulder Patch community (Dunton et al., 1982).

The rich infauna, animals that live within the bottom substratum rather than on its surface, depends on the refuges provided by the rocks and on detrital material that accumulates under the rocks in the Boulder Patch. The restriction of the fauna to the upper 5 cm of the sediment exposes this community to naturally occurring physical perturbations, including ice gouging and frazil ice formation in the sediments (Dunton and Schonberg 2000).

3.3 Reconolization of Boulder Patch communities

Recovery of the benthic communities on the Boulder Patch area was studied by completely removing all flora and fauna from selected boulders and cobbles (Dunton et al. 1982; Konar 2007). The results showed that the re-development of the benthic communities is a slow process in the Arctic. The factors influencing the recovery on the denuded boulders include the stability of the substratum, temporal variability in the composition and abundance of larvae and spores, biological interactions such as predation, herbivory and competition for space. In the Boulder

Patch most of the first colonizers appeared in early winter, which may be due to the lack of sedimentation covering the plots in that period. Sedimentation cover was substantial on the denuded boulders during summer and fall, and if small organisms were present they could not be seen. It is also likely that the naturally occurring periodic inundation by sediment in the Boulder Patch adversely affects the process of recolonization by effectively blocking larvae or spores from reaching the rock surface, or by smothering epilithic biota with a stature less than 1 or 3 mm.

4 POTENTIAL IMPACTS ON BOULDER PATCH FROM PROPOSED SEISMIC SURVEY

The proposed OBC seismic survey is planned during the open water season in the months July and August of 2008, with a possible extension into September/October. The seismic survey area includes the known Boulder Patch area, where receiver cables will be deployed onto the seafloor and recovered after data acquisition (Figure 3). The main potential impacts that could be expected from the proposed seismic survey and associated activities are:

- Damage to Arctic kelp beds and other biota from the deployment and retrieval of cables;
- Decrease of Arctic kelp growth due to an increase of re-suspended sediments in the water column;
- Mortality/injury to invertebrate and fish species from airgun sounds

The sessile species are especially susceptible to damage as they cannot avoid the area, in contrast with the more mobile invertebrate species and fish. The potential impacts from the seismic survey are assessed in more detail in the sections below.

4.1 Damage to Arctic kelp beds and other biota

The Boulder Patch is located in relatively shallow water depths and forms a unique habitat in the Beaufort Sea, with a rich biotic flora and fauna. The Arctic kelp is a major component of the Boulder Patch community and contributes greatly to the productivity of the system. The majority of the Boulder Patch fauna consists of sessile species, such as the sponges, cnidarians and bryozoans or of organisms with only a limited ability to move, such as mollusks. These organisms can be impacted by the deployment and retrieval of receiver cables with associated equipment like batteries, hydrophones and the field digitizing units. The actual deployment of this equipment onto the seafloor and the potential dragging of the cables and equipment over the seafloor during cable deployment and retrieval, storms or due to presence of ice bergs with deep keels have the potential to damage the kelp and other biota.

4.1.1 Deployment and retrieval of receiver cables

Of the total 490 miles of cable line, 57 miles (or 12%) will be laid in the Boulder Patch area. To assess the damage that can occur due to the deployment of these receiver cables and associated equipment, the footprint onto the seafloor was calculated. This calculation included the following parameters:

- The width of the cable line, including the lead line is 1 inch (2.54 cm).
- The cable will contain a hydrophone (~16 $inch^2$ or 103 cm^2) including a 6 ft long chain attached to the hydrophone cable to avoid movements over the seafloor. Data recorders or field digitizing unit (FDU) of ~12 $inch^2$ (77 cm^2) are placed on the cable with each

hydrophone at 110 ft intervals. The combined footprint of the hydrophone and FDU recorder is 136 $inch^2$ (877 cm^2).

- Two batteries are deployed for each 30 hydrophone-recorder unit. The battery has a footprint of ~135 $inch^2$ (871 cm^2).

To assess the potential damage to the Boulder Patch communities, the footprint of the receiver cable and associated equipment was calculated for Boulder Patch areas with 10-25% and >25% rock cover and for the total Boulder Patch area. Total Boulder Patch in this case refers to the area inside the seismic survey area as this part of the Boulder Patch contains the highest kelp densities. More detailed information on the equipment that will be deployed and the results of the footprint calculations are provided in Table 2.

TABLE 2. INFORMATION ON DEPLOYMENT OF EQUIPMENT IN THE BOULDER PATCH AREA. NOTE THAT THE NUMBERS PROVIDED ARE ESTIMATES THAT REFLECT THE ACTUAL SITUATION AS CLOSE AS POSSIBLE. THE TOTAL FOOTPRINT IS CALCULATED BY ADDING THE FOOTPRINT FROM THE RECEIVER LINE, BATTERIES AND HYDROPHONE-RECORDERS.

Parameter	10-25% rock cover	>25% rock cover	> 10% rock cover
Boulder Patch area in mi^2 (km^2)	13 (34)	14 (37)	27 (71)
Receiver line length in mi (km)	29 (47)	28 (45)	57 (92)
Number of Batteries	~42-85	~42-85	~84-170
Number of Hydrophone-recorders	~1380	~1340	~2720
Total footprint in mi^2 (km^2)	$0.5*10^{-3}$ ($1.2*10^{-3}$)	$0.5*10^{-3}$ ($1.2*10^{-3}$)	$1.0*10^{-3}$ ($2.4*10^{-3}$)
% of Boulder Patch area	**0.005**	**0.006**	**0.012**

The footprint of the receiver cables and associated equipment to be deployed on the sea floor is very small relative to the entire Boulder Patch area (0.012%). In addition, the damage to the biota from actual contact with the cable, batteries, hydrophone and recorder or during retrieval of the equipment will be localized and in small patches. This type of damage is not comparable with the complete removal of all organisms resulting in bare rock as was done for the recolonization experiments (Konar 2007, Dunton et al. 1982). Any potential damage is not comparable with complete removal of the organisms and is not expected to have a long term impact on the Boulder Patch communities.

4.1.2 Movement of receiver cables over the sea floor

A factor that could increase the potential damage to the Boulder Patch communities from the presence of receiver cables and associated equipment is its movement over the sea floor, especially during stormy weather conditions that result in high wave action or due to the presence of icebergs with deep keels.

The Boulder Patch within the seismic survey area occurs at water depths between 10 and 30 ft (3 and 9 m). As described in section 2.4, it is important to know the exact location of the hydrophones during data acquisition and to prevent any displacements. For this reason the cables will be paired with leaded ropes and each hydrophone will have a chain attached to the cable with tape. The batteries deployed for each 30 hydrophones are relatively heavy and also contribute to limited movements of cable and hydrophone. Dragging of cables over the sea floor requires substantial waves or swells, and even in these circumstances the movement of the cable will be restricted by the equipment that is attached to it. Seismic operations will be shutdown at sea states of >6 ft. Under these conditions, no new cables will be deployed and cables already on the sea floor cannot be retrieved. During the open-water season, wave heights are limited by the shallow waters adjacent to the coast and the shelter provided by the barrier islands. Wave measurements obtained in the vicinity of the Foggy Island Bay during the summer periods of 1980 to 1983 (LGL and Northern Technical Services 1983, OSI 1984) showed that wave heights varied from year to year, with a maximum measured wave height of 5.6 ft (1.7 m) and the majority of waves less than 2 ft (0.6 m) in height. Similarly, only icebergs with keels deep enough to reach the sea floor would have the potential to drag the cables. The seismic survey requires open-water conditions, defined as water with less than ~10% ice cover. During the summer ice invasions may occur but these are not likely to contain large and deep keeled ice floes and such invasions generally do not exceed 10% ice cover (Vaudrey 1997). The presence of large and deep keeled icebergs that have the potential to drag the cable will also scour on the seafloor and cause natural damage to the communities.

Surface buoys are the most susceptible to being captured and dragged to wave action and ice bergs even by smaller waves or ice floes. During the proposed survey the receiver lines that will be deployed in the Boulder Patch area will not be equipped with a surface buoy and relocation will entirely depend on the acoustic release buoys. Based on the information provided above and the absence of buoys, impacts on the Boulder Patch biota due to dragging of equipment over the sea floor is not expected to result in significant or permanent damage.

4.2 Decrease of kelp growth

As described earlier, the growth of kelp is highly dependent on the turbidity of the water column and availability of sunlight. In the Boulder Patch, sedimentation is potentially greatest during late summer and early fall when 1 to 5 mm can accumulate on the seafloor and cover the biota. The deployment and retrieval of the cables and associated equipment can result in the re-suspension of sediment into the water column and increase turbidity. However, it is unlikely that this will result in a substantial decrease in light availability and hence kelp growth as the amount of re-suspension is very small, mainly involving sediments already existing on the seafloor and not distinguishable from naturally occurring sediment movement from wave action, currents, and river outflow. No impacts from re-suspended sediments on the Boulder Patch are expected during the cable deployment and retrieval.

4.3 Mortality/injury to invertebrate and fish species

Invertebrate species

Little information is available on the potential impacts from seismic sounds on invertebrate species, because these species do not have hearing structures, although some can detect pressure waves. Furthermore, unlike vertebrates, the bodies of marine invertebrates are generally the same density as the surrounding water and therefore, theoretically, a sudden change in pressure, such as that caused by loud sounds is unlikely to result in physical damage. A study designed to assess the impact of seismic sounds on shrimp resources measured bottom trawl yields of a nonselective commercial shrimp fishery comprising the Southern white shrimp (*Litopenaeus schmitti*), the Southern brown shrimp (*Farfantepenaeus subtilis*) and the Atlantic Seabob (*Xyphopenaeus kroyeri*), before and after exposure to an airgun array of 635 in^3 total discharge volume and a peak pressure of 196 dB re 1 µPa at 1 m (Andriguetto-Filho et al. 2005). The results did not detect significant deleterious impact of seismic sounds on the studied species, suggesting that shrimp stocks are resilient to the disturbance by air-guns under the study conditions. Similarly, exposure of male and female snow crabs to airgun sounds of a received level of maximum 224 dB re 1 $\mu Pa_{0\text{-}p}$ did not indicate any chronic or long term effect of a variety of hematological[2] indices at 2 to 4 m from the source (Christian et al. 2004). Additionally, various life stages of Dungeness crabs did not show any effects from a maximum exposure of 230 dB re 1 μPa_p at 1 m (Pearson et al. 1994). Received sound level exposures of 227 and 202 dB re 1 μPa_p to lobsters did not result in any detectable impacts, but there was some indication of a non-lethal response weeks and months after exposure that could be related to "organ stress", although conclusions from this pilot study should be made with care (Payne et al. 2007). Based on the currently available knowledge, there is no indication that the proposed seismic airgun sounds cause injury or mortality to invertebrate species even at very close range. If the impact would be more subtle, it would be very localized and likely not much distinguishable from natural population dynamics of these species.

Fish species

Despite the growing number of literature on the potential impacts from fish exposed to airgun sounds, there are still many uncertainties related to the interpretation of the existing data. Some of the main reasons for this are:

- The current knowledge of hearing systems of different fish species and the effects of exposure to sound on such different auditory systems remains limited
- Only a limited number of fish species has been studied and caution is needed when interpreting the results to other fish species and/or circumstances;
- Most data on potential fish mortality, injury or changes in behavior is acquired using caged fishes. Due to the restrictions of these cages, the measured impacts (if any) might not necessarily be related to the sound source only, or represent natural behavior. In addition to this, potential impact from the handling of fish is mostly not taken into account;
- The available data lacks information on sound measurements, i.e. what is measured and how (appropriate use of units and references, pressure and/or particle velocity, distance from the sound source, water depth, received levels) [3].

Information on the impact to fish associated with hard substratum communities is even more limited. One of these studies exposed caged reef fishes at distances from 1 to 7 m from an airgun array that generated sound peak pressure of 196 dB (re 1 μPa_p at 1 m) at a depth of 5 m (Boeger et al. 2006). These exposures did not result in mortality or obvious external damage in any experimental configuration. The majority of air gun shots resulted in a startle response in the form of a temporary increase in swimming velocity and/or a lateral shift in swimming direction, returning to normal swimming velocities shortly thereafter. Also, repeated exposure to air guns seemed to result in increasingly less obvious startle responses, indicating possible habituation to the disturbance. These results were consistent with another experiment where (non-caged) reef fish were exposed to pressure levels between 210 and 218 dB re 1 μPa_{-} at 1 m (Wardle et al. 2001). No significant effect on the behavior of resident reef fish was detected. Based on the very limited information available it seems not very likely that the proposed seismic survey will have an impact on the fish species inhabiting the Boulder Patch.

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[2] Hematology is the branch of biology that is concerned with the study of blood, the blood-forming organs, and blood diseases.

[3] For more information on sound types, see: Richardson, W.J., C.R. Greene, C.I. Malme and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego. 576 p.

4.4 Summary

The proposed seismic survey is not expected to have any significant impacts on the Boulder Patch communities. The main operation during the proposed seismic survey that has the potential to damage the Boulder Patch biota is the deployment and retrieval of the receiver cables and associated equipment. However, the footprint of this equipment is very small relative to the entire Boulder Patch area and permanent damage to the ecosystem from the proposed seismic survey is very likely not substantial and probably not distinguishable from factors that cause natural disturbances.

TABLE 3. SUMMARY OF POTENTIAL IMPACTS TO THE BOULDER PATCH BIOTA FROM PROPOSED OBC SEISMIC SURVEY IN THE LIBERTY AREA

Section	Potential Impact	Source	Description of potential impact
4.1	Damage to kelp beds and other biota	Cable deployment and retrieval	The total footprint of the cable and associated equipment on the Boulder Patch is very low (0.0024 km^2 or 0.012% of Boulder Patch area) and any damage will be localized and patchy and is not expected to have a significant impact on the biota.
		Cable movement due to storm and presence of icebergs	The potential for movements of cables over the seafloor is not likely to occur and any potential damage to the Boulder Patch biota is not expected to result in a significant and permanent damage.
4.2	Decrease of kelp growth	Re-suspension of sediments due to cable deployment, retrieval and movements	No impacts from re-suspended sediments on the Boulder Patch are expected as the amount of re-suspension is very insignificant, mainly involving sediments already existing on the seafloor and not within natural variations.
4.3	Injury to invertebrate and fish species	Airgun sounds	There is no indication that airgun sounds, even at very close range, cause severe injury or mortality to invertebrate or fish species.

5 MITIGATION MEASURES AND MONITORING

The 3D OBC seismic survey in the Liberty area, in particular the deployment and retrieval of the receiver cables onto the seafloor, has the potential to damage the flora and fauna on the Boulder Patch. The magnitude of the impact, however, is not distinguishable from natural factors that can cause disturbance to the Boulder Patch community and unlikely to have a significant permanent impact.

Nevertheless, BP plans to adopt several mitigation measures that will further reduce any potential damage of the Boulder Patch communities and intends to implement some monitoring activities to document damage in case it occurs. More details on the mitigation measures, the monitoring effort and reporting are provided below.

5.1 Mitigation measures implemented during survey planning and design

- The receiver cables that will be used during the proposed seismic survey are smaller than the ones that have been used in previous OBC surveys;
- The field digitizing unit is among the lightest and smallest recording equipment available;
- The chain that will be attached to the hydrophone to prevent movements will be entirely taped to the hydrophone pigtail and as such form an integrated part of the hydrophone. This will prevent entanglement of plants.

5.2 Mitigation measures during survey

- BPXA will report to MMS if damage to the Boulder Patch occurs as a result of their operations (see Section 5.3 Monitoring). Additionally, BPXA shall notify MMS if they detect any fragile biocenoses otherwise not documented in their permit application.
- Vessels will not anchor within any documented Boulder Patch areas, unless an emergency situation involving human safety specifically exists and there are no other feasible sites to anchor at the time.
- No refueling of vessels will occur in the Boulder Patch area.
- In coordination with the researchers, the deployment of cables or batteries will be avoided on the long term monitoring sites of the Boulder Patch. Navigators will be supplied with the coordinates of an exclusion zone around these sites.
- All possible options will be investigated to avoid or minimize the use of surface buoys on the batteries that will be deployed on the Boulder Patch.
- Caution with cable deployment and retrieval is an important factor for data quality and as such part of the operational procedures. However, captains of the vessels involved in the retrieval of receiver cables will receive extra instructions to operate their vessels in a manner that will minimize the chance of dragging cables when operating in the Boulder Patch. A specific speed will not be dictated since vessel control in varying weather conditions must be left to the captain's discretion.
- A Boulder Patch awareness orientation will be provided to all crew members. This orientation will include watching a Boulder Patch awareness video and instructions on the implementation of the above measures. This orientation session will be documented with an attendance list.
- A toolbox meeting will be held among the crew prior to the start of the operations within the Boulder Patch ares to remind them of the Boulder Patch mitigation requirements.

5.3 Monitoring

Two earlier ocean bottom cable seismic surveys have occurred in the Boulder Patch area in 1996 and 1997. In response to the concerns of the National Marine Fisheries Service (NMFS) and the U.S. Environmental Protection Agency (EPA), BPXA committed to conduct a general reconnaissance in several Boulder Patch areas where cables were deployed and retrieved in 1996 and 1997. The purpose of this reconnaissance was to obtain visual documentation of the impacts, if any, from the cables within the Boulder Patch areas.

Methods used to obtain visual information were divers, with a video camera and a remotely operated vehicle (ROV) equipped with a video. The images obtained during these monitoring activities were of insufficient quality to be used for potential damage assessments, mainly due to the low visibility of the water column. Also, BPXA's current safety regulations do not allow scuba diving operations.

For the proposed 2008 OBC seismic survey, BPXA intends to conduct a different type of monitoring. During the deployment and retrieval of the cables on the known Boulder Patch areas, the crew of the cable vessels will document if kelp plants are entangled in the receiver cable lines, hydrophones or batteries when they are retrieved and will bag the samples. The number of plants, approximate coordinates on the Boulder Patch, water depth and a short description of the plant (e.g. length, signs of damage) will be recorded and reported to MMS after seismic data acquisition on the Boulder Patch is completed.

6 CUMULATIVE IMPACTS ON BOULDER PATCH

The cumulative effects described in this section relate to potential effects to the Boulder Patch communities that may result from State or private actions reasonably certain to occur within or near the Liberty project area. These actions relate primarily to future oil & gas developments.

In the cumulative sense, benthos could be buried by construction of offshore pipelines and islands. The reasonably foreseeable developments with offshore facilities would be Sandpiper, Flaxman, Stinson, and Hammerhead/Kuvlum, outside of the barrier islands, and none of them are near the Boulder Patch. The only development inside the barrier islands close to the Boulder Patch is the Liberty development. However, this development does not include the construction of new pipelines and islands but will use uERD from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. The development and, therefore, the cumulative risk to these future developments would be similar to the Liberty development-specific risk. Another cumulative aspect is the scientific long term monitoring program on the Boulder Patch, funded by MMS. These activities include anchoring on the Boulder site at monitoring stations, sampling of kelp and other species as required and conducting experiments. The potential impacts from these activities are not distinguishable from natural disturbances to the Boulder Patch. The proposed OBC seismic survey is not expected to result in significant impacts to the Boulder Patch communities and as such does not add to the cumulative risk.

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REQUEST FOR AN INCIDENTAL HARASSMENT AUTHORIZATION PURSUANT TO SECTION 101 (A) (5) OF THE MARINE MAMMAL PROTECTION ACT

Covering

Incidental Harassment of Marine Mammals during an OBC Seismic survey in the Liberty Prospect, Beaufort Sea, Alaska in 2008

Submitted by

BP EXPLORATION (ALASKA) INC.

Department of Health, Safety, and Environment

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November 2007

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REQUEST BY BP TO ALLOW THE INCIDENTAL HARASSMENT OF MARINE MAMMALS DURING AN OBC SEISMIC SURVEY IN THE LIBERTY PROSPECT, BEAUFORT SEA, ALASKA, 2008

Summary

BP Exploration Alaska Inc. (BPXA) plans to conduct a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea in 2008. This survey will use a towed airgun array consisting of 8 operating airguns with a maximum discharge volume of 880 cubic inch (in^3) and will take place in shallow waters of maximum 30 ft deep inside the barrier islands. BPXA request that it be issued an Incidental Harassment Authorization (IHA) allowing non-lethal harassment of marine mammals, incidental to the planned seismic surveys. This request is submitted pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA), 16 U.S.C. § 1371 (a)(5).

A total of three cetacean species and four species of pinnipeds are known to occur or may occur in the proposed survey area. Of these species, only the bowhead whale is listed as "Endangered" under the ESA. Five additional cetacean species – narwhal, killer whale, harbor porpoise, minke whale and fin whale – could occur in the Beaufort Sea, but each of these species is rare or extralimital and unlikely to be encountered in the Liberty area. BPXA is proposing a marine mammal monitoring and mitigation program to minimize potential impacts of the proposed activity on marine mammals and to document the nature and extent of any of such effects.

The items required to be addressed pursuant to 50 C.F.R. § 216.104, "Submission of Requests" are set forth below. This includes a description of the specific operations to be conducted, the marine mammals occurring in the survey area, proposed measures to mitigate against any potential injurious effects and a plan to monitor any behavioral effects on those marine mammals from the proposed operations.

1 DETAILED OVERVIEW OF OPERATIONS TO BE CONDUCTED

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

BP Exploration Alaska Inc. (BPXA) plans to conduct a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea during ~40-60 survey days in July/August 2008, with an "as needed" extension into September/October (in compliance with the CAA). Section 2 provides more details on survey period, duration and factors that can influence those.

The Liberty field contains one of the largest undeveloped light-oil reservoirs near North Slope infrastructure, and the development of this field could recover an estimated 105 million barrels of oil. The field is located in Federal waters of the Beaufort Sea about 5.5 miles offshore in 20 ft of water and approximately 5 to 8 miles east of the existing Endicott Satellite Drilling Island (SDI) (Figure 1). The Liberty development project design and scope has been changed from an offshore stand-alone development (manmade production/drilling island and subsea pipeline) to the use of ultra-extended-reach drilling from the existing Endicott infrastructure involving an expansion of the SDI and use of existing processing facilities. As a result of this change in scope, BPXA believes that Liberty can be developed with a substantially reduced environmental footprint and impact than the originally proposed offshore stand-alone development. The currently available seismic data focused primarily on deeper targets and hence does not image the shallow overburden sections of the well bore optimally.

1.1 Purpose of the proposed OBC seismic survey

The acquisition of additional marine 3D seismic survey data increases the probability of successful implementation of the proposed ultra-extended-reach drilling techniques by providing higher resolution data to assist in imaging for well planning and drilling operations.

The dataset obtained with the proposed seismic survey will replace and augment the data from the Endicott 3D vibroseis survey (1983) and NW Badami (Liberty) 3D vibroseis survey (1995). Various seismic acquisition methods and sound source reduction technologies have been identified and assessed on their technical and environmental performance. The 3D OBC seismic survey method being proposed is the most appropriate for the specific survey goal and objectives of the current Liberty seismic survey.

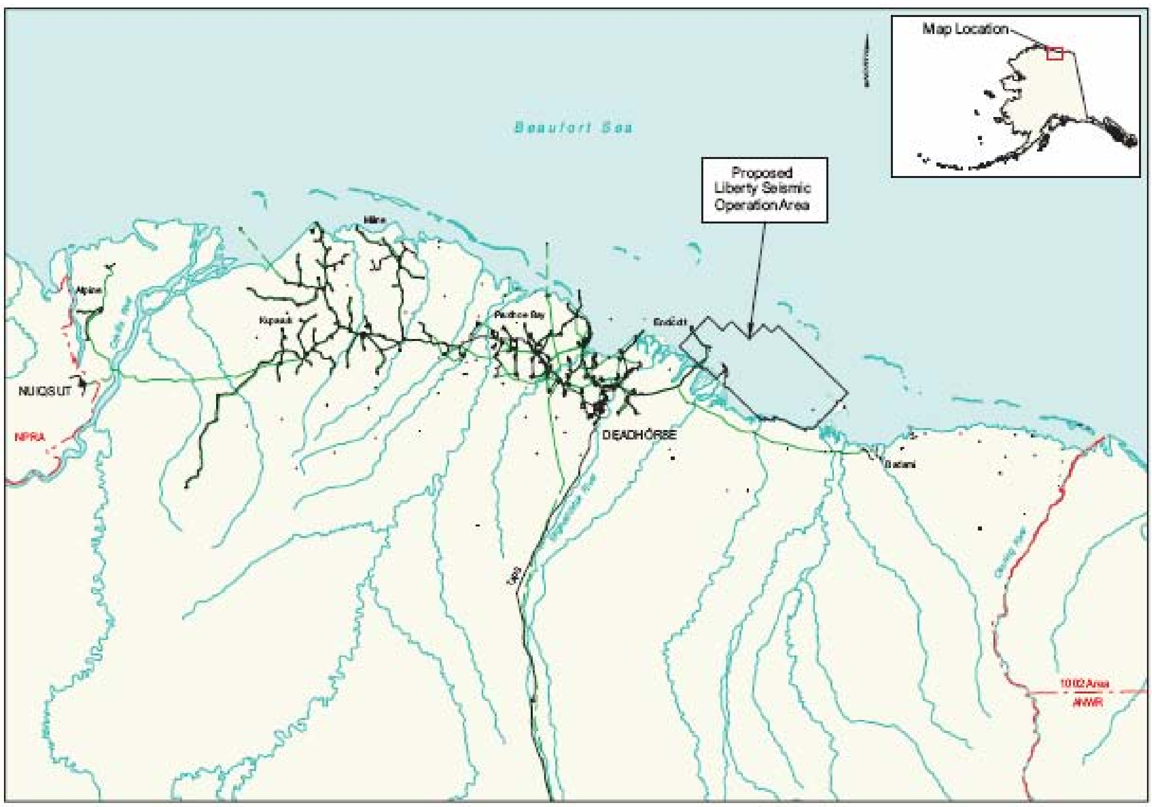

Figure 1. Overview of Liberty area.

1.2 Details of the proposed OBC seismic survey

OBC seismic surveys are used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. This type of seismic survey requires the use of multiple vessels for cable deployment/recovery, recording, shooting, and utility boats. The planned 3D OBC seismic survey in the Liberty area will be conducted by

CGGVeritas. A detailed overview of the activities of this survey is provided below, with focus on the mobilization procedure, seismic and other sound sources, the deployment and retrieval of the receiver cables, and the recording procedure.

Mobilization

The proposed survey will take place in the Liberty prospect area located in Foggy Island Bay in the Beaufort Sea east of Prudhoe Bay (Figure 1). The vessel fleet involved in the seismic survey activities will consist of approximately eleven vessels as listed below. Details of these vessels (or equivalent vessels if availability changes) are provided in Appendix A.

- Two source vessels, the *M/V Peregrine* (90 x 24 ft) and the *M/V Maxime* (46 x 16 ft).
- One recorder boat/barge, with *M/V Alaganik* barge (80 x 24 ft) and *Hook Point* boat (32 x 15 ft).
- Four small bow picker vessels to deploy and retrieve the receiver cables; these are the *F/V Canvas Back* (32 x 14 ft), *F/V Cape Fear* (32 x 12 ft), *F/V Rumplemimz* (32 x 14 ft) and *F/V Sleep Robber* (32 x 14 ft). These vessels can operate in very shallow waters up to ~18 inch (0.5 m) water depth.
- HSE vessel *Weather or Knot* (38 x 15 ft).
- Crew transport vessel *M/V Qayak Spirit* (42 x 14 ft) and (Northstar's) hovercraft *M/V Arctic Hawk* (42 x 20 ft).
- Crew housing and fuel vessel *M/V Arctic Wolf* (135 x 38 ft).

To deploy and retrieve cables in water depths less than those accessible by the bow pickers, equipment such as swamp buggies and/or Jon boats will be used.

Most vessels will be transported by trucks to the North Slope in late May/early June, where they will be prepared at West Dock. The *Arctic Wolf* will sail around Barrow when ice conditions allow and the hovercraft will travel from West Dock. Vessel preparation will include assembly of navigation and source equipment, cable deployment and retrieval systems and safety equipment. The preparation process will require about 35 days to complete with most activities occurring at West Dock. Once assembled, the deployment, retrieval, navigation and source systems will be tested prior to departure to the project site.

Preparation of the cables ("cable dressing") will be conducted and completed at the CGGVeritas shop in Anchorage. Cable dressing includes attaching lead line and weighting systems to hydrophones to reduce any chance for movement on the sea floor. After completion of the final quality control check, the cables will be transported together with the vessels to West Dock where they will be loaded onto the vessels prior to departure to the project site. Some equipment might be staged at the Endicott facilities.

Seismic survey area details

The well path is the area of primary interest that needs to be fully covered by the seismic data. The size of this zone has been reduced to an absolute minimum of 35.6 mi^2 (92.1 km^2). To obtain full data coverage in this area of interest a larger zone needs to be surveyed to account for accurate migration of acoustic reflections. The total seismic survey extent is 135.8 mi^2 (351.8 km^2) and covers also some mudflat/ areas (Figure 2).

Receiver cable lines consist of a hydrophone and a Field Digitizing Unit (FDU) placed on the cables at 110 ft intervals and placed on the seafloor according to a predefined configuration to record the reflected source signals from the airguns. The cables that will be deployed on mudflats and in very shallow water will consist of marsh phones and are placed in a similar configuration as those deployed at the seabottom. The receiver cables will be oriented in a NE-SW direction. A total of approximately 66 NE-SW oriented receiver lines will be deployed with increasing line spacing from west to east of ~880 ft to ~2,000 ft. Total receiver line length will be ~490 miles (~788 km) of which ~10 miles (16 km) will be laid on mudflats. The source vessels will travel perpendicular over these receiver cables along lines which will have a NW to SE orientation and a varying total length of minimum 2 and maximum 3.5 miles (= 3.2 to 5.6 km). The total source line length is ~2000 miles (~3220 km) in water depths varying from 3 to 30 ft (1 to 9.1 m). The Liberty seismic survey design is planned such that the most critical data along the well path can be acquired as highest priority, before time becomes limited.

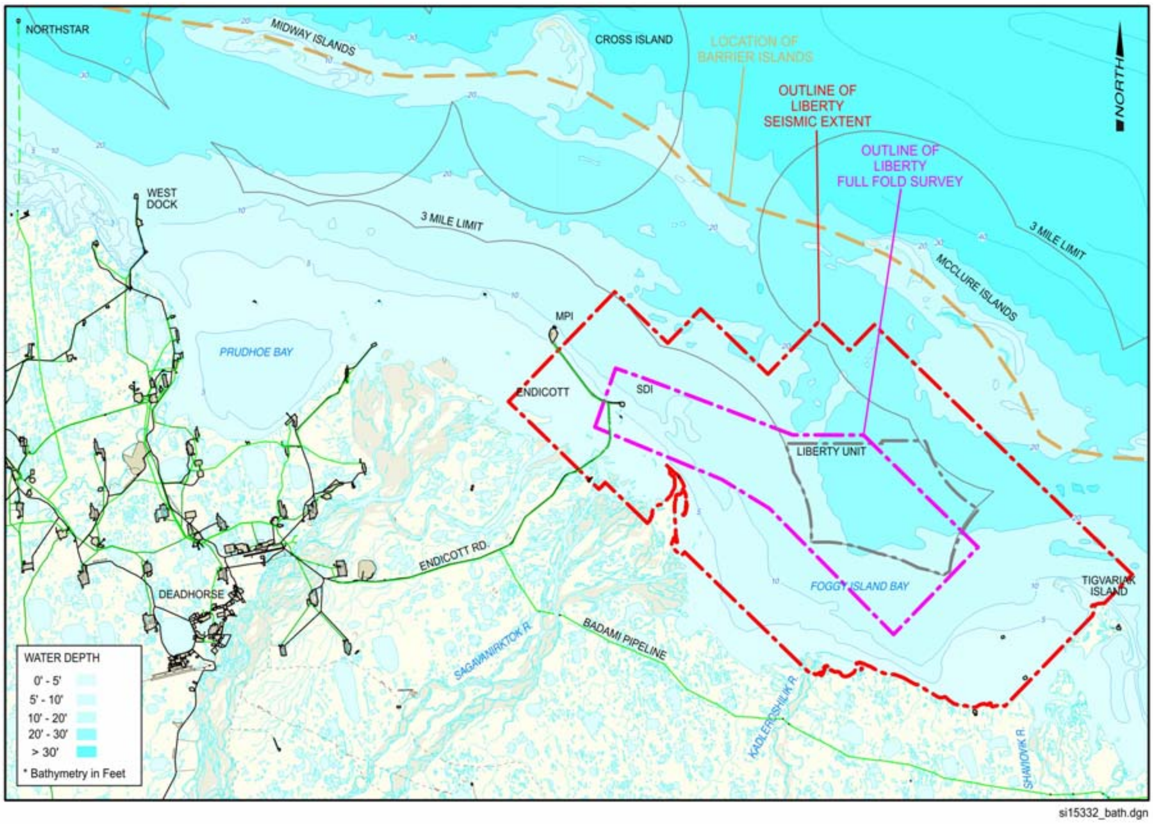

FIGURE 2. Liberty seismic survey area. The pink line represents the area were data needs to be acquired and the red dashed line shows the outline of the Liberty seismic extent, which is the area covered by the receiver and source lines.

Seismic source

To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the *M/V Peregrine* and *M/V Maxime* owned by Peregrine Marine. The sources used for seismic data acquisition will be sleeve airgun arrays with a total discharge volume of 880 cubic inch (in^3) divided over two arrays. Each source vessel will have two 440 in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. The 880 in^3 array has an estimated source level of ~250 dB re 1 µPa.

The arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths varying from 1-4 m (3-13 ft), depending on the water depth. The vessel will travel along pre-determined lines at ~1 to 5 knots, mainly depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4 second shot intervals with two operating source vessels. The seismic data acquisition will occur over a 24 hr/day schedule.

A summary of the 8-airgun array specification (see Annex B for more details):

Energy Source	Eight 2000 psi Sleeve airguns of 70 in^3 and 150 in^3.
Source output (downward)	0-peak is 6.6 bar-m (236.4 dB re µPa @ 1m 0-pk) Peak-peak is 13.9 bar-m (242.9 dB re µPa @ 1 m pk-pk)
Towing depth of energy source	Between 1-4 m
Air discharge volume	880 in^3.
Dominant frequency components	5-135 Hz

Cable deployment and retrieval

The *M/V Peregrine*, *M/V Maxime* and 4 bow pickers (*Canvas Back*, *Cape Fear*, *Rumplemimz and Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels will be powered with twin jet diesels and are rigged with hydraulically driven deployment and retrieval systems ("Squirters"). The *M/V Peregrine* and *M/V Maxime* function both as source and cable vessel and will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are extremely small while still allowing a pull of 800 pounds. The smaller bow picker cable vessels will also carry 120 hydrophone stations and are capable of beach landings.   All cable vessels will maintain 24-hr operations.

Part of the receiver cables will be deployed on mudflats to pick up reflected source signals and allow for full interpretation of the data in the area of interest, i.e. well path (pink line in figure 2). The deployment of these receiver cables will be conducted by other equipment that can operate in shallow waters and marshy conditions (such as swamp buggies, Jon boats).

The positions of each receiver need to be established. Due to the variable bathymetry in the survey area, receiver positioning may require more than one technique. A combination of Ocean Bottom Receiver Location (OBRL), GPS and acoustic pingers will be used. For OBRL, the source vessel fires a precisely positioned single gun multiple times along either side of the receiver cables. Multiple gun locations are then calculated at a given receiver to triangulate an accurate position for the receiver. In addition, Dyne acoustical pingers will be located at predetermined intervals at the receiver lines. The pinger locations can be determined using a transponder and allow for interpolation of the receiver locations between the acoustical pingers and as calibration/verification of the OBRL method. The sonar Dyne pingers operate at 19-36 kHz and have a source level of 188-193 dB re µPa at 1m. Because OBRL methods are not accurate in shallow water (< 15 ft), the receiver locations at these depths will be recorded as “as laid” positions, which is the GPS location where the receivers are deployed.

Recording

A Sercel 428 FDU (Field Digitizer Unit) will be located at each hydrophone. This system is lightweight and robust and rated to 14 m (45 ft) of water depth, which will allow it to operate well in the water depths for this survey. For approximately each 30 recorder-hydrophone units one or two battery pack(s) will be deployed at the sea bottom. This battery pack will be equipped with a buoy (or acoustic release) and a pinger, to ensure that the battery packs can be located and retrieved when needed.

The data received at each FDU will be transmitted through the cables to a recorder for further processing. This recorder will be installed on a pin-together boat barge combination and positioned close to the area where data are being acquired. While recording, the pin-together boat barge is stationary and is expected to utilize a four point anchoring system.

Crew housing and transfer

The *M/V Peregrine* is partially self contained and able to house 10 crew including the MMOs. The *M/V Maxime* can accommodate 6 people, including the MMOs. These source vessels will maintain 24-hr operations; crew transfers will take place by crew boats and/or hovercraft. The four bow pickers are too small to house their crew and they will be accommodated at Endicott (MPI). The seismic activity is a 24-hr operation to allow for efficient data acquisition in the short time window available, so crew change vessels will transfer crews approximately every 12 hours. Shifts for crews on the source vessels and cable vessels will be staggered to maximize transport efficiency. Two vessels will be used for these crew transfers, a crew boat (*M/V Qayaq Spirit*) and, if available, the Northstar hovercraft (*Arctic Hawk*).

In addition to housing crew at Endicott facilities, there will be a mother ship mobilized, the *M/V Arctic Wolf*. This vessel will house up to 30 crew, store cable parts and fuel for the other vessels. The *M/V Arctic Wolf* is a propeller driven vessel. Because of its size, the vessel can not be transported by truck to Prudhoe Bay and will mobilize from either Homer or Anchorage and sail around Barrow to the survey area when ice conditions allow and in consultation with beluga whale hunters. Two marine mammal observers will conduct observations off of this vessel during the transits from and to Anchorage/Homer (see Section 13.1). Crew will be housed in other camps in Deadhorse or other operating areas if the *M/V Arctic Wolf* arrives after seismic acquisition begins.

The recorder barge/boat (*M/V Alaganik* and *Hook Point*) can currently accommodate 4 people on the boat portion, which could be increased slightly with 6 additional bunks to a total of 10. The barge portion is dedicated to recording and staging of cables, hydrophones and batteries and can not be used to create additional housing due US Coast Guard restrictions.

Refueling of vessels at sea will be conducted following approved US Coast Guard procedures. Refuel of the boat storage will take place at West Dock, Endicott dock or by delivery from an approved Crowley vessel.

2 DATES, DURATION AND REGION OF ACTIVITY

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

BP seeks incidental harassment authorization for a period of 60 days in the period July/ August 2008, with an "as needed" extension of additional days after the whaling season (in accordance with the CAA), given the uncertainties in ice conditions and other factors that can influence the survey. Transportation of vessels to West Dock will occur in late May/early June where they will be prepared. The M/V Arctic Wolf will transit from Homer or Anchorage to the site when ice conditions allow and in consideration of the spring beluga hunt in the Chukchi Sea. Seismic data acquisition is planned to start on 1 July depending on the presence of ice. Open water seismic operations can only start when the project area is ice free (i.e. < 10% ice coverage), which in this area normally occurs around 20 July (+/- 14 days). Limited layout of receiver cables might be possible on the mudflats in the Sagavanirktok River delta areas before the ice has cleared.

The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay, Beaufort Sea of which 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft, 43% in water depths of 10-20 ft, and 25% in water depths of 20-30 ft (Figure 2). The approximate boundaries of the total surface area are between 70^{o}11'N and 70^{o}23'N and between 147^{o}10'W and 148^{o}02'W (Figure 2).

Data acquisition will be prioritized. The acquisition order will be defined based on starting date of the survey and weather conditions.

3 SPECIES AND NUMBERS OF MARINE MAMMALS IN AREA

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

The marine mammal species that occur in the proposed survey area can be classified according to the taxonomic groups shown in Figure 3.

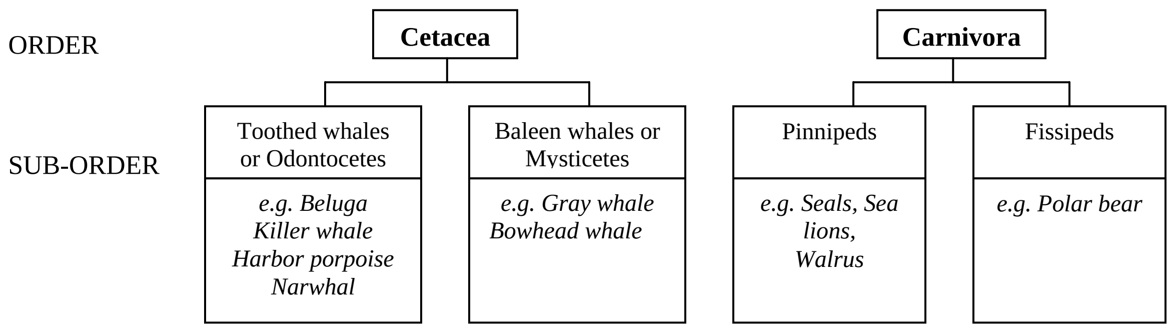

Figure 3. Taxonomic classification of marine mammals that occur in the Beaufort Sea.

Cetaceans and pinnipeds (except walrus) are the subject of this IHA Request to NMFS. In the U.S., the walrus and polar bear are managed by the U.S. Fish & Wildlife Service (USFWS). A separate Letter of Authorization (LOA) Request (under Title 50, Part 18 Subpart J, Non-lethal taking of marine mammals incidental to oil and gas exploration activities in the Beaufort Sea) for this survey will be submitted to USFWS specific to walruses and polar bears.

A total of three cetacean species, four species of pinnipeds, and one marine fissiped (polar bear) are known to occur or may occur in the Beaufort Sea in or near the Liberty area (Table 1). Of these species, only the bowhead whale is listed as "Endangered" under the ESA. Five additional cetacean species – narwhal, killer whale, harbor porpoise, minke whale and fin whale – could occur in the Beaufort Sea, but each of these species is rare or extralimital and unlikely to be encountered in the Liberty area. They are included in the table in light gray and their distribution is briefly discussed in Section 4.5.

To avoid duplication, more details on the number of each marine mammal species occurring in the area is provided in Section 4.

Table 1. Habitat, abundance and conservation status of marine mammals occurring in the Beaufort Sea. Species that are rare and extralimital for the Beaufort Sea and not likely to be encountered in the Liberty area are included in light gray.

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
ODONTOCETES					
Beluga whale *(Delphinapterus leucas)*	Offshore, Coastal, Ice edges	50,000[4] 39,258[5]	Not listed	VU	II
Narwhal *(Monodon monoceros)*	Offshore, Ice edge	Rare[6]	Not listed	DD	II
Killer whale *(Orcinus orca)*	Widely distributed	Rare	Not listed	LR-cd	II
Harbor Porpoise *(Phocoena phocoena)*	Coastal, inland waters	Extralimital	Not listed	VU	II
MYSTICETES					
Bowhead whale *(Balaena mysticetus)*	Pack ice & coastal	10,545[7]	Endangered	LR-cd	I
Gray whale (eastern Pacific population) *(Eschrichtius robustus)*	Coastal, lagoons	488[8] 18,178[9]	Not listed	LR-cd	I
Minke whale *(Balaenoptera acutorostrata)*	Shelf, coastal	0	Not listed	LR-cd	I
Fin whale *(Balaenoptera physalus)*	Slope, mostly pelagic	0	Endangered	EN	I
PINNIPEDS					
Walrus *(Odobenus rosmarus)*	Coastal haul outs, pack ice, ice and water	201,039[10]	Not listed	–	II
Bearded seal *(Erignathus barbatus)*	Pack ice and water	300,000-450,000[11] 4863[12]	Not listed	–	–
Spotted seal *(Phoca largha)*	Pack ice and water	1,000[11] 59,214[13]	Not listed	–	–
Ringed seal *(Pusa hispida)*	Shore-fast ice, pack ice and water	Up to 3.6 million [15] 245,048[16] 326,500[17]	Not listed	–	–
CARNIVORA					
Polar bear *(Ursus maritimus)*	Coastal, ice	>2500[18] 15,000[19]	Not listed	LR-cd	–

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]

1. U.S. Endangered Species Act.
2. IUCN Red List of Threatened Species (2003). Codes for IUCN classifications: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; LR = Lower Risk (-cd = Conservation Dependent; -nt = Near Threatened; -lc = Least Concern); DD = Data Deficient.
3. Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004). Numbers I and II refer to the Cites Appendices, with Appendix I listing species that are threatened with extinction and for which trade is closely controlled and Appendix II species are not necessarily now threatened with extinction but may become so unless trade is closely controlled.
4. Total Western Alaska population, including Beaufort Sea animals that occur there during migration and in winter (Small and DeMaster 1995).
5. Beaufort Sea population (Angliss and Outlaw 2007).
6. Population in Baffin Bay and the Canadian arctic archipelago is ~60,000 (DFO 2004); very few enter the Beaufort Sea.
7. Abundance of bowheads surveyed near Barrow, as of 2001 (George et al. 2004); revised to 10,545 by Zeh and Punt (2005), with annual population growth of 3.4%.
8. Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002).
9. North Pacific gray whale population in 2001/02 (Rugh et al. 2005).
10. Pacific walrus population (Gilbert et al. 1992, referenced in Angliss and Outlaw 2007).
11. Alaska population (USDOI/MMS 1996).
12. Eastern Chukchi Sea population (NMML, unpublished data).
13. 1,000 is estimate of Alaska Beaufort Sea population (USDOI/MMS 1996). 59,214 is total Alaskan population estimate as in Angliss and Outlaw (2005), based on 1992/'93 aerial survey counts (Rugh et al. 1997) with correction factor applied (Lowry et al. 1998).
14. Bering Sea population (Burns 1981), no reliable estimate for the size of the Alaska ribbon seal stock is available (Angliss and Outlaw, 2005).
15. Alaska estimate (Frost et al. 1988 in Angliss and Lodge 2004).
16. Bering/Chukchi Sea population (Bengston et al. 2000).
17. Alaskan Beaufort Sea population estimate (Amstrup 1995).
18. Amstrup et al (2001).
19. NWT Wildlife and Fisheries, http://www.nwtwildlife.rwed.gov.nt.ca/Publications/speciesatriskweb/polarbear.htm

4 STATUS AND (SEASONAL) DISTRIBUTION OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS

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

This Section contains information on the population status of the marine mammal species that occur in the Beaufort Sea and that might be affected by the seismic survey in the Liberty area. It also provides more details on the temporal and spatial distribution and abundance taking into account the most recent data available. Bowhead whale (*Balaena mysticetus*) is the only marine mammal species listed as threatened or endangered under the ESA that is likely to occur in the project area.

The marine mammal species expected to be encountered most frequently throughout the seismic survey in the Liberty area is the ringed seal. The bearded and spotted seal can also be observed but to a far lesser extent than the ringed seal. Due to its distribution, encounters with the walrus are possible but not expected. However, anecdotal reports suggest that walrus may be occurring somewhat more frequently in the project area than they have in the past. Presence of beluga, bowhead and gray whales in the shallow water environment within the barrier islands is possible but expected to be very limited. More detailed information for each species is provided below.

4.1 Odontocetes

4.1.1 Beluga (Delphinapterus leucas)

Distribution

The beluga whale is an arctic and subarctic species with a circumpolar distribution in the Northern Hemisphere and occurs between 50º and 80ºN (Reeves et al. 2002). In Alaska, beluga whales comprise five distinct stocks: Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea, Bristol Bay, and Cook Inlet (O'Corry-Crowe et al. 1997). For the proposed project, only individuals from the Beaufort Sea and possibly the eastern Chukchi Sea stocks may be encountered.

Beluga whales of the Beaufort stock winter in the Bering Sea, summer in the eastern Beaufort Sea, and migrate in offshore waters of western and northern Alaska (Angliss and Lodge 2007). The majority of belugas in the Beaufort stock migrate into the Beaufort Sea in April or May, although some whales may pass Point Barrow as early as late March and as late as July (Braham et al. 1984; Ljungblad et al. 1984; Richardson et al. 1995). The spring-migration routes through ice leads are similar to those of the bowhead whale. Much of the Beaufort Sea seasonal population enters the Mackenzie River estuary for a short period from July through August to molt their epidermis, but they spend most of the summer in offshore waters of the eastern Beaufort Sea, Amundsen Gulf and more northerly areas (Davis and Evans 1982; Harwood et al. 1996; Richard et al. 2001). Belugas are rarely seen in the central Alaskan Beaufort Sea during the early summer. During late summer and autumn, most belugas migrate westward far offshore near the pack ice (Frost et al. 1988; Hazard 1988; Clarke et al. 1993; Miller et al. 1999), with the main fall migration corridor ~100+ mi (~160+ km) north of the coast. Satellite-linked telemetry data show that some belugas of this population migrate west considerably farther offshore, as far north as 76º to 78ºN latitude (Richard et al. 1997, 2001). Small numbers of belugas have also been observed well south of the southern edge of the pack-ice, but always seaward of the barrier islands Johnson (1979).

Beluga whales from the eastern Chukchi stock are assumed to winter in the Bering Sea (Angliss and Lodge 2004). They are known to congregate in Kasegaluk Lagoon during summer; however, evidence from a small number of satellite-tagged animals suggests that some of these whales may subsequently range into the Arctic Ocean north of the Beaufort Sea. Suydam et al. (2005) put satellite tags on 23 beluga whales captured in Kasegaluk Lagoon in late June and early July from 1998 to 2002. Five of these whales moved far into the Arctic Ocean and into the pack ice to 79/80°N. These and other whales moved to areas as far as 680 miles (1,100 km) offshore between Barrow and the Mackenzie River delta spending time in water with 90% ice coverage. These results suggest possible overlap of the Chukchi and Beaufort Sea beluga whale populations.

In summary, most beluga whales migrate well offshore away from the proposed project area, although there is a possibility that they could occur near the project area.

Population status

The Beaufort Sea beluga whale population is estimated to contain 39,258 individuals with a minimum estimation for this stock at 32,453 (Angliss and Outlaw 2007). This estimate is based on the application of a sightability correction factor of 2× to the 1992 uncorrected census of 19,629 individuals made by Harwood et al. (1996). This estimate was obtained from a partial survey of the known range of the Beaufort Sea population and may be an underestimate of the true population size. The current population trend of the Beaufort Sea stock of beluga whales is unknown, but this population is not considered to be a strategic stock by NMFS (Angliss and Outlaw 2007).

The eastern Chukchi Sea population is estimated at 3,710 animals (Angliss and Outlaw 2007). This estimate is based on surveys conducted from 1989 to 1991 (Frost et al. 1993). Although other aerial survey counts have been conducted in 1998 and 2002 (DeMaster et al. 1998, Lowry and Frost 2002, cited in Angliss and Outlaw 2007), the abundance estimate from the 1989 to 1991 surveys is still considered to be the most reliable for the eastern Chukchi Sea beluga whale stock. Survey effort was concentrated on the 105 mile (170 km) long Kasegaluk Lagoon where belugas are known to occur during the open-water season. The actual number of beluga whales recorded during the surveys was much lower (1,200). Correction factors to account for animals that were underwater (2.62 x) and for the proportion of newborns and yearlings that were not observed due to their small size and dark coloration (1.18 x) were used to calculate the estimate. The estimate is considered to be a minimum population estimate for the eastern Chukchi stock because the surveys on which it was based did not include offshore areas where belugas are also likely to occur. This population is considered to be stable.

Subsistence hunt

Beluga whales are an important subsistence resource of Inuit Natives in Canada and are also important locally to Inupiat Natives in Alaska. The mean annual harvest of beluga whales by Alaska Natives in the Beaufort Sea was 53 whales between 1999 and 2003 (Angliss and Outlaw 2007 and references therein). The mean annual take of Beaufort Sea beluga whales in Canadian waters was 99 whales during the same time period. The Beaufort Sea beluga-whale stock is not considered to be "depleted" under the Marine Mammal Protection Act, or "threatened" or "endangered" under the ESA.

Beluga whales from the eastern Chukchi Sea stock are an important subsistence resource for residents of the village of Point Lay, adjacent to Kasegaluk Lagoon, and other villages in northwest Alaska. Each year, hunters from Point Lay drive belugas into the lagoon to a traditional hunting location. The belugas have been predictably sighted near the lagoon from late June through mid- to late July (Suydam et al. 2001). The annual subsistence take of eastern Chukchi Sea beluga whales by Alaska Natives averaged 65 during the period from 1999 to 2003. In August 2007 a total of 70 belugas were caught in Kotzebue. Hundreds of large male belugas suddenly appeared near the beach, two months early and in numbers not seen since 1996 (from Anchorage Daily news, 13 August 2007).

4.2 Mysticetes

4.2.1 Bowhead Whale (Balaena mysticetus)

Distribution

Bowhead whales only occur at high latitudes in the northern hemisphere and have a disjunct circumpolar distribution (Reeves 1980). They are one of only three whale species that spend their entire lives in the Arctic. Five stocks are recognized for management purposes (IWC 1992). The smallest of these stocks occur in Baffin Bay, Davis Strait, Hudson Bay (Canadian Arctic and West Greenland), Okhotsk Sea (Eastern Russia) and Northeast Atlantic from Spitzbergen westward to eastern Greenland. The largest stock is the western Arctic or Bering–Chukchi–Beaufort (BCB) stock, which occurs in or near the project area.

Whales from the western Arctic stock winter in the Bering Sea and migrate through the Bering Strait, Chukchi Sea and Alaskan Beaufort Sea to the Canadian Beaufort Sea, where they feed during the summer (Moore and Reeves 1993). Spring migration through the Chukchi and the western Beaufort Sea occurs through offshore ice leads, generally from March through mid-June

(Braham et al. 1984; Moore and Reeves 1993). Some bowheads arrive in coastal areas of the eastern Canadian Beaufort Sea and Amundsen Gulf in late May and June, but most remain among the offshore pack ice of the Beaufort Sea until mid summer. Bowheads generally start their westward migration towards the Bering Sea late August through mid- or late October. Fall migration period through Alaskan waters primarily occurs during September and October. However, in recent years a small number of bowheads have been seen or heard offshore from the Prudhoe Bay region during the last week of August (Treacy 1993; LGL and Greeneridge 1996; Greene 1997; Greene et al. 1999; Blackwell et al. 2004). Consistent with this, Nuiqsut whalers have stated that the earliest arriving bowheads have apparently reached the Cross Island area earlier in recent years than formerly (T. Napageak, pers. comm.). Westbound bowheads typically reach the Barrow area in mid-September, and remain in that area until late October (e.g., Brower 1996). However, over the years, local residents reported small numbers of bowhead whales feeding off Barrow during the summer. Bowhead whales of the western Arctic stock may also occur in small numbers in the Bering and Chukchi seas during the summer (Rugh et al. 2000 in Angliss and Lodge 2004).

The migration routes of bowheads appear to be correlated with ice coverage, with a shift farther offshore during years with higher-than-average ice coverage (Moore 2000; Treacy et al. 2006). During fall migration, most bowheads migrate west in water ranging from 15 to 200 m deep (Miller et al. 2002 in Richardson and Thomson 2002). Some individuals enter shallower water, particularly in light ice years, but few whales are ever seen shoreward of the barrier islands in the Alaskan Beaufort Sea.

Because the Liberty seismic survey will take place shoreward of the barrier islands in very shallow waters from 3 to 30 ft (1 to 9.1 m), few bowhead whales are likely to occur in the project area. Bowhead whales would be most likely to occur in or near the project area during fall migration in September and October.

Population status

The pre-exploitation population of bowhead whales in the Bering, Chukchi, and Beaufort seas is estimated to have been 10,400-23,000 whales in 1848 – compared to an estimate between 1,000 and 3,000 animals in 1914 near the end of the commercial whaling period (Woodby and Botkin 1993). Up to the early 1990s, the population size was believed to be increasing at a rate of about 3.2% per year (Zeh et al. 1996; Angliss and Lodge 2002) despite annual subsistence harvests of 14–74 bowheads from 1973 to 1997 (Suydam et al. 1995). The latest estimate from an additional census in 2001 suggests an annual population growth rate of 3.4% (95% CI 1.7–5%) from 1978 to 2001 and a population size (in 2001) of ~10,470 animals (George et al. 2004), recently revised to 10,545 by Zeh and Punt (2005). Assuming a continuing annual population net growth of 3.4%, the 2008 bowhead population may number around 13,330 animals. The large increases in population estimates that occurred from the late 1970s to the early 1990s were partly a result of actual population growth, but were also partly attributable to improved census techniques (Zeh et al. 1993).

The Western Arctic bowhead whale stock has been increasing in recent years; the current estimate of 10,545 is between 19% and 105% of the pre-exploitation abundance (estimates ranging roughly from 10,000 to 55,000) and this stock may now be approaching its carrying capacity (Brandon and Wade 2004, cited in Angliss and Outlaw 2007). However, the stock remains classified as a strategic stock because the bowhead whale is listed as "endangered" under the ESA and therefore also designated as "depleted" under the MMPA. For the next 5-year evaluation of stock status the criteria for recovery of large whales in general (Angliss et al. 2002) and bowhead whales in particular (Shelden et al. 2001) will be used to determine whether the western Arctic bowhead whale stock can be delisted. In a recent publication the evaluation of extinction risk for the western Arctic bowhead whale stock suggested that this population should be considered for reclassification under the ESA (Gerber et al. 2007).

Subsistence hunt

The spring and fall bowhead whale migrations are subject to important subsistence hunts by the local Inupiat people. The spring subsistence hunt occurs from March to June, with participation by people from villages located from St. Lawrence Island to Barrow. In autumn, westward-migrating bowhead whales reach the Kaktovik and Cross Island (Nuiqsut) areas in early September, and that is when the subsistence hunts for bowheads in these areas typically begin (Kaleak 1996; Long 1996; Galginaitis and Koski 2002; Galginaitis and Funk 2004, 2005; Koski et al. 2005). The hunt at those two locations continues until the end of September, depending on weather conditions and when/if the quota is reached. Autumn whaling near Barrow normally begins in mid-September, but may begin as early as August if whales are observed and ice conditions are favorable (USDOI/BLM 2005). Whaling near Barrow can continue into October, depending on the quota and conditions.

4.2.2 Gray Whale (Eschrichtius robustus)

Distribution

Gray whales originally inhabited both the North Atlantic and North Pacific oceans. The Atlantic populations are believed to have become extinct by the early 1700s. The North Pacific gray whales are divided into two populations, the western and eastern north Pacific gray whales that are treated as separate management units. Eastern Pacific gray whales breed and calve in the protected waters along the west coast of Baja California and the east coast of the Gulf of California from January to April (Swartz and Jones 1981; Jones and Swartz 1984). At the end of the breeding and calving season, most of these gray whales migrate about 8,000 km, generally in shallow waters along the west coast of North America, to the main summer feeding grounds in the northern Bering and Chukchi seas (Tomilin 1957; Rice and Wolman 1971; Braham 1984; Nerini 1984).

Most summering eastern Pacific gray whales have historically congregated in the northern Bering Sea, particularly off St. Lawrence Island in the Chirikov Basin (Moore et al. 2000a), and in the southern Chukchi Sea. It is believed that changing oceanographic conditions, resulting in a decline of the benthic prey base for gray whales in the Chirikov Basin, moved feeding gray whales to areas north of the Bering Strait (Moore et al. 2003). A satellite tagging study conducted in 2005 revealed that a majority of the whales spent most of their time in the Chukchi Sea, and primarily in Russian waters. The most favored feeding area was NNW of the Bering Strait in the Chukchi Sea, where three whales spent August through mid-November. One of these whales traversed the Chukchi west to Wrangell Island, where it spent the month of August, with its route taking it to 72ºN (Mate, 2006). In recent years gray whale sightings have increased at Point Barrow. Moore et al. (2000b) reported that during the summer feeding season, gray whales in the Chukchi Sea were clustered along the shore primarily between Cape Lisburne and Point Barrow and were associated with shallow, coastal shoal habitat. Gray whales were also observed clustered in near shore waters at Point Hope, southwest of Point Hope and between Icy Cape and Point Barrow, as well as in offshore waters northwest of Point Barrow at Hanna Shoal. In July 2005 tagged whales were observed to use the areas between Pt. Barrow and Icy Cape (Mate, 2006). In the spring of 2003 and 2004, a few tens of gray whales were seen near Barrow by early-to-mid June (LGL Ltd and NSB-DWM, unpubl. data). No gray whales were sighted during vessel observations north of Barrow in 2002 or 2005 (Harwood et al. 2005; Haley and Ireland 2006).

Historically only a small number of gray whales have been sighted in the Beaufort Sea east of Point Barrow. Hunters at Cross Island (near Prudhoe Bay) took a single gray whale in 1933 (Maher 1960). During the extensive aerial survey programs funded by MMS and industry, only one gray whale was sighted in the central Alaskan Beaufort Sea from 1979 to 1997. Small numbers of gray whales were sighted on several occasions in the central Alaskan Beaufort, mainly in the Harrison Bay area (Miller et al. 1999; Treacy 2000). One single sighting of a gray whale was made on 1 August 2001 near the Northstar production island (Williams and Coltrane 2002). Several single gray whales have been seen farther east in the Canadian Beaufort Sea (Rugh and Fraker 1981; LGL Ltd., unpubl. data), indicating that small numbers must travel through the Alaskan Beaufort during some summers. Given the infrequent occurrence of gray whales in the Beaufort Sea east of Point Barrow, it is possible but unlikely that gray whales will be encountered near the planned seismic activities in the Liberty area.

Population status

The larger eastern Pacific gray whale population recovered significantly from commercial whaling during its protection under the ESA and was delisted in 1994. In 1998 the population size was estimated to be 26,635 (Rugh et al. 1999; Angliss and Lodge 2002; NMFS 2002). However, abundance estimates since 1998 indicate a consistent decline, and Rugh (2003 in Keller and Gerber 2004; see also Rugh et al. 2005) estimated the population to be 17,500 in 2002. The lower population estimates were thought to be an indication that the abundance was responding to environmental limitations as the population approaches the carrying capacity of its environment, but there is still an ongoing debate around the cause of the decreasing gray whale population trend. The eastern Pacific stock is not considered by NMFS to be endangered or to be a strategic stock.

Subsistence hunt

Subsistence hunters in Alaska and Russia have traditionally harvested whales from the eastern Pacific gray whale population. The U.S. and Russia have agreed that the quota will be shared with an average annual harvest of 120 whales by the Russians in Chukotka and 4 whales by the Makah Indian Tribe. Inupiat subsistence hunters have permits to hunt bowhead whales but not gray whales. The only reported takes by subsistence hunters in Alaska during this decade occurred in 1995, and the Makah Tribe harvested one whale in 1999 (IWC 2001) and one (illegally) in 2007.

4.3 Pinnipeds

4.3.1 Pacific Walrus (Odobenus rosmarus divergens)

Although the walrus is managed by U.S. Fish & Wildlife Service and is not a subject of this IHA Request to NMFS, the following account is included for completeness. BP will submit a walrus and polar bear LoA request to USFWS for the proposed seismic survey in the Liberty area.

Distribution

There are two recognized subspecies of walrus: (1) the Pacific and (2) the Atlantic walrus. Walruses are migratory, moving south with the advancing ice in autumn and north as the ice recedes in spring (Fay 1981). The Pacific walrus spends the winter in the Bering Sea. Spring migration usually begins in April, and most of the walruses move north through the Bering Strait by late June. Females with calves comprise most of the early spring migrants and nearly all the adult females with dependent young migrate into the Chukchi Sea during the summer, while a substantial number of adult males remain in the Bering Sea. Although most of the population of Pacific walrus moves to the Chukchi Sea during summer, several thousands aggregate in the Gulf of Anadyr and in Bristol Bay (Angliss and Outlaw 2007). Two large arctic areas are occupied — from the Bering Strait west to Wrangell Island and along the northwest coast of Alaska from about Point Hope to north of Point Barrow. Although a few walruses may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open-water season, the majority of the Pacific population occurs west of 155° W, with the highest seasonal abundance along the pack-ice front (Sease and Chapman 1988). With the southern advance of the pack ice in the Chukchi Sea during the fall (October-December), most of the walrus population migrates south through the Bering Strait. Solitary animals occasionally may overwinter in the Chukchi Sea and in the eastern Beaufort Sea.

Population status

The size of the Pacific walrus population has never been known with certainty and is believed to have fluctuated markedly in response to varying levels of human exploitation (Fay et al. 1989). The North Pacific walrus population was estimated at about 201,039 animals in 1990 (Gilbert et al., 1992 referenced in Angliss and Outlaw 2007), comprising about 80% of the world population. After 1990, aerial survey efforts to estimate population size were suspended due to unresolved problems with survey methods. Participants of the USFWS and U.S. Geological Survey workshop in 2000 on walrus survey methods recommended investing in research on walrus distribution and haul out patterns and exploring new survey tools, including remote sensing systems.

Subsistence hunt

Walruses are hunted primarily from June through mid-August in Chukchi waters to the west of Point Barrow and southwest to Peard Bay. Walruses rarely occur in the Beaufort Sea north and east of Barrow although there were some sightings of walrus hauling out at Northstar and Endicott. The harvest effort peaks in July and August and is often conducted simultaneously with the bearded seal hunt. The annual walrus harvest by Barrow residents ranged from 7 to 206 animals from 1990 to 2002, and ranged from 0 to 4 and 0 to 153 animals for Point Lay and Wainwright communities, respectively (Fuller and George 1997; Schliebe 2002 in USDOI/BLM 2005; USDOI/BLM 2003).

4.3.2 Bearded Seal (Erignathus barbatus)

Distribution

Bearded seals are associated with sea ice and have a circumpolar distribution (Burns 1981). During the open-water period, bearded seals prefer mainly relatively shallow areas no deeper than 200 m (e.g., Harwood et al. 2005), because they are predominantly benthic feeders (Burns 1981).

The bearded seal is the largest of the northern phocids. Bearded seals have occasionally been reported to maintain breathing holes in sea ice and broken areas within the pack ice, particularly if the water depth is <200 m. Bearded seals apparently also feed on ice-associated organisms when they are present, and this allows a few bearded seals to live in areas considerably more than 200 m deep.

Seasonal movements of bearded seals are directly related to the advance and retreat of sea ice and to water depth (Kelly 1988). During winter, most bearded seals in Alaskan waters are found in the Bering Sea. In the Chukchi and Beaufort seas, favorable conditions are more limited, and consequently, bearded seals are less abundant there during winter. From mid-April to June, as the ice recedes, some of the bearded seals that overwinter in the Bering Sea migrate northward through the Bering Strait. During the summer they are found near the widely fragmented margin of multi-year ice covering the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea. Bearded seal densities in the pack ice of the northern Chukchi Sea appear to be low as only three bearded seals were observed during a survey that passed through the proposed seismic survey area in early August of 2005 (Haley and Ireland 2006). Suitable habitat is more limited in the Beaufort Sea where the continental shelf is narrower and the pack ice edge frequently occurs seaward of the shelf and over water too deep for benthic feeding. The preferred habitat in the western and central Beaufort Sea during the open water period is the continental shelf seaward of the scour zone. Marine mammal observations conducted during seismic surveys in nearshore waters in the Alaskan Beaufort Sea from 1996 to 2001 identified 454 seals during the periods that no seismic guns were active. Of these seal species 4.4% were bearded seals (Moulton and Lawson 2002).

Population status

Early estimates of the Alaska stock of bearded seals range from about 300,000 to 450,000 individuals (MMS 1996). Surveys flown in the Eastern Chukchi Sea during May-June 1999 and 2000 indicated densities of 0.07 seals/km^2 and 0.14 seals/km^2, respectively, with consistently high densities along the coast to the south of Kivalina (Bengtson et al. 2005, referenced in Angliss and Outlaw 2007). Because no correction factor is available, these densities cannot be used to develop an abundance estimate and hence no reliable population estimate for the Alaska stock of bearded seals exists. The Alaska stock of bearded seals is not classified by NMFS as endangered or a strategic stock.

Subsistence hunt

Seals in general, and also bearded seals, are an important species for Alaskan subsistence hunters. As of August 2000, the subsistence harvest database indicated that the estimated number of bearded seals harvested for subsistence use per year in Alaska is 6,788.

4.3.3 Spotted Seal (Phoca largha)

Distribution

Spotted seals (also known as largha seals) occur in the Beaufort, Chukchi, Bering and Okhotsk seas, and south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). Spotted seals overwinter in the Bering Sea and inhabit the southern margin of the ice during spring (Shaughnessy and Fay 1977).

During spring when pupping, breeding, and molting occur, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering seas (Quakenbush 1988; Rugh et al. 1997). In late April and early May, adult spotted seals are often seen on the ice in female-pup, male-female pairs, or in male-female-pup triads. Subadults may be seen in larger groups of up to two hundred animals. During the summer, spotted seals are found in Alaska from Bristol Bay through western Alaska to the Chukchi and Beaufort seas. They are primarily present in the Bering and Chukchi seas, and some range into the Beaufort Sea from July until September (Rugh et al. 1997; Lowry et al. 1998). At this time of year, spotted seals haul out on land part of the time, but also spend extended periods at sea. The seals are commonly seen in bays, lagoons and estuaries, but also range far offshore as far north as 69–72ºN. In summer, they are rarely seen on the pack ice, except when the ice is very near to shore. As the ice cover thickens with the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry et al. 1998).

Relatively low numbers are present in the Beaufort Sea. A small number of spotted seal haul outs are (or were) located in the central Beaufort Sea in the deltas of the Colville River and, previously, the Sagavanirktok River. Historically, these sites supported as many as 400–600 spotted seals, but in recent times <20 seals have been seen at any one site (Johnson et al. 1999). In total, there are probably no more than a few tens of spotted seals along the coast of the central

Alaska Beaufort Sea during summer and early fall. A total of 12 spotted seals were positively identified near the source vessel during open-water seismic programs in the central Alaskan Beaufort Sea during 6 years from 1996 to 2001 (Moulton and Lawson 2002, p. 317). Numbers seen per year ranged from zero (in 1998 and 2000) to four (in 1999).

Population status

Early estimates of the world population of spotted seals range from 370,000 to 420,000 (Burns 1973 cited in Angliss and Outlaw 2007), and the size of the Bering Sea population, including animals in Russian waters, was estimated to be 200,000–250,000 animals (Bigg 1981). Based on aerial survey counts conducted in 1992 over the Bering Sea pack ice in spring and in 1993 along known haul out sites on the western Alaska coast during summer, the population is estimated to be most likely between several thousand and several tens of thousands (Rugh et al. 1997).

A reliable estimation of the spotted seal populations in Alaskan waters is not available. When a preliminary correction factor is applied to the counts of the 1992/'93 aerial survey data, the Alaskan spotted seal population can be estimated at 59,214 animals (Angliss and Outlaw 2007). This correction factor is derived from a movement and behavior study of spotted seals in Kakegaluk Lagoon, where results from satellite transmitters on 4 spotted seals showed that seals spend 6.8% of their time at haul outs (Lowry et al., 1998). The Alaska stock of spotted seals is not classified as endangered or as a strategic stock by NMFS (Hill and DeMaster 1998).

Subsistence hunt

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions. As of August 2000, the subsistence harvest database indicated that the estimated number of spotted seals harvested for subsistence use per year is 5,265 (Angliss and Outlaw 2007).

4.3.4 Ringed Seal (Pusa hispida)

Distribution

Ringed seals have a circumpolar distribution and occur in all seas of the Arctic Ocean (King 1983). They are closely associated with ice, and in the summer they often occur along the receding ice edges or farther north in the pack ice. In the North Pacific, they occur in the southern Bering Sea and range south to the seas of Okhotsk and Japan. They are found throughout the Beaufort, Chukchi, and Bering seas (Angliss and Lodge 2004).

Ringed seals are year-round residents in the northern Chukchi and Beaufort Seas and, in years of extensive ice coverage, they can occur as far south as Bristol Bay (Angliss and Outlaw 2007). The ringed seal is the most frequently encountered seal species in the area. During winter, ringed seals occupy landfast (but not grounded) ice and offshore pack ice of the Bering, Chukchi and Beaufort seas preferably on large floes (i.e., > 48 m in diameter) (Simpkins et al. 2003). In winter and spring, the highest densities of ringed seals are found on stable landfast ice. However, in areas where there is limited fast ice but wide expanses of pack ice, including the Beaufort Sea, Chukchi Sea and Baffin Bay, total numbers of ringed seals on pack ice may exceed those on shorefast ice (Burns 1970; Stirling et al. 1982; Finley et al. 1983). Simpkins et al. (2003) observed that ringed seals are often found in the interior ice pack where the sea ice coverage is greater than 90%. Ringed seals maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). They give birth in lairs from mid-March through April, nurse their pups in the lairs for 5–8 weeks, and mate in late April and May (Smith 1973; Hammill et al. 1991; Lydersen and Hammill 1993). Ringed seals will likely be the most commonly observed marine mammal species in the area of the Liberty seismic survey.

Population size

No reliable estimate for the size of the Alaska ringed seal stock is currently available (Angliss and Outlaw 2007). During aerial surveys flown in the Alaskan Beaufort Sea between Barrow and Kaktovik in 1996-1999 observed seal densities ranged from 0.81-1.17/km2 (Frost et al. 2002, 2004) over an area of approximate 18,000 km^2. In combination with the average abundance estimate of 230,673 for the eastern Chukchi Sea (Bengtson et al. 2005), this results in a total of approximately 250,000 seals. This number should be considered as a minimum because it does not include the entire geographic range of the stock and the estimate for the Alaska Beaufort Sea has not been corrected for the number of ringed seals not hauled out at the time of the surveys. The Alaska stock of ringed seals is not endangered, and is not classified as a strategic stock by NMFS.

Subsistence hunt

Ringed seals are an important species for Alaska Native subsistence hunters. A recent report on ice seal subsistence harvest in three Alaskan communities indicated that the number and species of ice seals harvested in a particular village may vary considerably between years (Coffing et al. 1999). These interannual differences are likely due to differences in ice and wind conditions that change the hunters' access to different ice habitats frequented by different types of seals. As of August 2000, the subsistence harvest database indicated that the estimated number of ringed seals harvested for subsistence use per year is 9,567 (Angliss and Outlaw 2007).

4.4 Carnivora

4.4.1 Polar Bear (Ursus maritimus)

Although the polar bear is managed by the USFWS and is not a subject of this IHA Request to NMFS, the following account is included for completeness. BP will submit a LOA request for this species in the Liberty area, Beaufort Sea.

Distribution

Polar bears have a circumpolar distribution throughout the northern hemisphere (Amstrup et al. 1986) and occur in relatively low densities throughout most ice-covered areas (DeMaster and Stirling 1981). They are common in the Chukchi and Beaufort seas north of Alaska throughout the year, including the late summer period (Harwood et al. 2005). They also occur throughout the East Siberian, Laptev, and Kara Seas of Russia and the Barents Sea of northern Europe. They are found in the northern part of the Greenland Sea, and are common in Baffin Bay, which separates Canada and Greenland, as well as through most of the Canadian Arctic Archipelago. Polar bears typically range as far north as 88°N (Ray 1971; Durner and Amstrup 1995) above which their population thins dramatically. However, polar bears have been observed across the Arctic, including close to the North Pole (van Meurs and Splettstoesser 2003). Stirling (1990) reported that of 181 sightings of bears, only three were above 82°N. Three polar bears were observed from the Healy in the northern Chukchi Sea during a survey through this area in August of 2005 (Haley and Ireland 2006). These three sightings occurred along 2,401 km of observed trackline over 14 days between 70°N and 81°N.

Polar bears are divided into six major populations and many sub-populations based on mark-and-recapture studies (Lentfer 1983), radio telemetry studies (Amstrup and Gardner 1994), and morpho-metrics (Manning 1971; Wilson 1976). The Southern Beaufort Sea population ranges from the Baillie Islands, Canada, in the east to Point Hope, Alaska, in the west. The Bering/Chukchi Sea population ranges from Point Barrow, Alaska, in the east to the Eastern Siberian Sea in the west. These two populations overlap between Point Hope and Point Barrow, Alaska, centered near Point Lay (Amstrup 1995).

The Bering/Chukchi and Southern Beaufort populations have been extensively studied by tracking the movement of tagged females (Garner et al. 1990). Radio-tracking studies indicate significant movement within populations and occasional movement between populations (Garner et al. 1990; Amstrup 1995). For example, a female polar bear within sight of the Prudhoe Bay oilfields was captured, fitted with a satellite-tracking collar, and her movements monitored for 576 days. She traveled north and then south to Greenland, traversing ~7162 km in 576 days (Durner and Amstrup 1995).

Polar bears usually forage in areas where there are high concentrations of ringed and bearded seals (Larsen 1985; Stirling and McEwan 1975). This includes areas of land-fast ice, as well as moving pack ice. Polar bears are opportunistic feeders and feed on a variety of foods including not only seals but also beluga whales, arctic cod, geese and their eggs, walruses, bowhead whales, and reindeer (Smith 1985; Jefferson et al. 1993; Smith and Hill 1996; Derocher et al. 2000).

Females give birth to 1 to 3 cubs at an average interval of every 3.6 years (Jefferson et al. 1993; Lentfer et al. 1980). Cubs remain with their mothers for 1.4 to 3.4 years (Derocher et al. 1993; Ramsay and Stirling 1988). Mating occurs from April to June followed by a delayed implantation which occurs during September to December. Females give birth usually the following December or January (Harington 1968; Jefferson et al. 1993). In general, females 6 years of age or older successfully wean more cubs than younger bears; however, females as young as 4 years old can produce offspring (Ramsay and Stirling 1988). An examination of reproductive rates of polar bears indicated that 5% of four-year-old females had cubs, whereas 50% of five year-old females had cubs (Ramsay and Stirling 1988). The maximum reproductive age reported for Alaskan polar bears is 18 years (Amstrup and DeMaster 1988).

Population size

The total number of polar bears worldwide is estimated to be 20,000-25,000. Polar bears are not evenly distributed throughout the Arctic, nor do they comprise a single nomadic cosmopolitan population, but rather occur in 19 relatively discrete populations (Schliebe et al. 2006b). Amstrup (1995) estimated the minimum population of polar bears for the south Beaufort Sea subpopulation to be ~1500–1800 individuals, with an average density of about one bear per 38.6 to 77.2 mi^2 (100–200 km^2). The field work for an intensive capture-recapture effort in the SB region, coordinated between the U.S. and Canada, was completed in spring 2006 and a final population analysis and report will be expected in 2007. There are no reliable data on the population status of polar bears in the Bering/Chukchi Sea (Schliebe et al. 2006b).

Currently, polar bear populations are protected under the MMPA, as well as by the International Agreement on the Conservation of Polar Bears, ratified in 1976. Countries participating in the latter treaty include Canada, Denmark, Norway, Russia (former USSR), and the USA. The polar bear has been listed as "vulnerable" on the IUCN red list since 2005, based on the likelihood of an overall decline in the size of the total population of more than 30% within the next 35 to 50 years. Currently, USFWS proposes to list the polar bear as threatened under the Endangered Species Act (ESA) (Federal Register / Vol. 72, No. 5 / Tuesday, January 9, 2007 / Proposed Rules).

Based on polar bear sightings in previous years and also in 2007, polar bears could be present along the shore of the main land or the barrier islands during the Liberty seismic survey.

Subsistence hunt

The harvest quota for the southern Beaufort Sea population is 80 animals, 40 for Alaska and 40 for Northwest Territories (NWT). A joint users-group agreement sets harvest quotas and includes provisions to protect bears in dens and females with cubs. In 2004/2005, the harvest in

Alaska was 27 bears. The northern Beaufort Sea sub-population is harvested by hunters from Nunavut and NWT. The harvest quota is 6 bears for Nunavut and 65 for NWT of which Nunavut harvested 4 bears in 2004-2005 (Schliebe et al. 2006a).

4.5 Rare or extralimital species in Beaufort Sea

4.5.1 Narwhal (Monodon monoceros)

Narwhals have a discontinuous arctic distribution (Hay and Mansfield 1989; Reeves et al. 2002). A large population inhabits Baffin Bay, West Greenland, and the eastern part of the Canadian Arctic archipelago, and much smaller numbers inhabit the Northeast Atlantic/East Greenland area. Population estimates for the narwhal are scarce, and the IUCN-World Conservation Union lists the species as Data Deficient (IUCN Red List of Threatened Species 2003). The species is rarely seen in Alaskan waters or the Beaufort Sea generally and if they would be observed it would most likely be far offshore. Thus it is very unlikely that individuals will be encountered in the shallow waters of the Liberty seismic survey area.

4.5.2 Killer Whale (Orcinus orca)

Killer whales are cosmopolitan and globally fairly abundant. The killer whale is very common in temperate waters, but it also frequents the tropics and waters at high latitudes. Killer whales are known to inhabit almost all coastal waters of Alaska, extending from southeast Alaska through the Aleutian Islands to the Bering and Chukchi seas (Angliss and Lodge 2004). Killer whales probably do not occur regularly in the Beaufort Sea although sightings have been reported (Leatherwood et al. 1986; Lowry et al. 1987; George et al. 1994) of which one possible sighting at Endicott in 2006. Killer whales are, however, more common southwest of Barrow in the Southern Chukchi Sea and Bering Sea and it is very unlikely that they will be encountered in the Liberty area.

4.5.3 Harbor Porpoise (Phocoena phocoena)

The harbor porpoise is a small toothed whale that inhabits shallow, coastal waters—temperate, subarctic, and arctic—in the Northern Hemisphere (Read 1999). Harbor porpoises occur mainly in shelf areas where they can dive to depths of at least 220 m and stay submerged for more than 5 minutes (Harwood and Wilson 2001) feeding on small schooling fish (Read 1999). Harbor porpoises typically occur in small groups of only a few individuals and tend to avoid vessels (Richardson et al. 1995). The subspecies *P. phocoena vomerina* ranges from the Chukchi Sea, Pribilof Islands, Unimak Island, and the south-eastern shore of Bristol Bay south to San Luis Obispo, California. Point Barrow, Alaska, is the approximate northeastern extent of their regular ranges (Suydam and George 1992), though there are some extralimital records east to the mouth of the Mackenzie River in the Northwest Territories, Canada.

4.5.4 Minke Whale (Balaenoptera acutorostrata)

Minke whales have a cosmopolitan distribution at ice-free latitudes (Stewart and Leatherwood 1985), and also occur in some marginal ice areas. Angliss and Outlaw (2005) recognize 2 minke whale stocks in U.S. waters: (1) the Alaska stock, and (2) the California/Oregon/Washington stock. Minke whales from the Alaska stock are relatively common in the Bering and Chukchi Seas (Leatherwood et al. 1982) and are not considered to range into the Beaufort Sea.

4.5.5 *Fin Whale (Balaenoptera physalus)*

Fin whales are widely distributed in all the world's oceans (Gambell 1985), but typically occur in temperate and polar regions. Three stocks of fin whales are currently recognized in U.S. waters (Angliss and Outlaw 2007): (1) Alaska (Northeast Pacific), (2) California/Washington/Oregon, and (3) Hawaii. The North Pacific population summers from the Chukchi Sea to California (Gambell 1985), and there is no indication that fin whales inhabit the Alaskan Beaufort Sea or waters of the northern Chukchi Sea. The fin whale is listed as "Endangered" under the ESA and is classified as a strategic stock by NMFS.

5 INCIDENTAL HARASSMENT AUTHORIZATION REQUESTED

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

BP requests authorization for incidental (Level B) harassment of marine mammals pursuant to Section 101(a)(5)(D) of the MMPA during its planned seismic survey in the Liberty area, Beaufort Sea in July/August 2008, with an "as needed" extension into September/October (in compliance with the CAA).

Response of marine mammals to the activities described in Section 1 can occur due to:

- Exposure to pulsed sounds from an 8-gun 880 in^3 sleeve airgun array (estimated source level ~250 dB re µPa at 1m);
- Exposure to pulsed sounds from the Dyne pinger sonar (19-36 kHz, source level of 188-193 dB re µPa at 1m), Benthos acoustic releases (7-15 kHz, source level of ~192 dB re µPa at 1m) and vessel bathymetry sonar systems;
- Exposure to non-pulsed, continuous sounds from vessels (seismic survey and support/crew vessels);
- Physical presence of vessels in the area (collision risk between marine mammals and vessels).

The response of marine mammals to these activities depends on the species of cetacean or pinnipeds, the behavior of the animal at the time of reception of the stimulus, as well as the distance to and received level of the sound (see Section 7 and Appendix C). Disturbance reactions, such as avoidance, are very likely to occur amongst marine mammals in the vicinity of the source vessel. No serious injury to marine mammals is anticipated, for example due to collisions with vessels, given the nature of the activity in combination with the planned mitigation measures (see Section 11 for mitigation measures). No lethal injuries are expected.

This request focuses on the potential impact to marine mammals from pulsed sounds generated by the seismic airguns. The continuous sounds generated by routine vessel operations are not likely to have an additional impact on the marine mammals, as is the case for the use of vessel sonar system and the acoustic pingers given the considerations discussed in section 1 and 7, i.e., relatively high operating frequency, short pulse duration, and low duty cycle, and brief (if any) behavioral response.

6 NUMBERS OF MARINE MAMMALS THAT MAY BE HARASSED

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of Incidental Take Authorization (ITA) request described in Section 5, and the number of times such takings for each type of ITA are likely to occur.

The anticipated harassments from the activities described in Section 1 involve temporary changes in behavior. There is no evidence that the planned activities could result in injury, such as damage to the hearing apparatus. Section 7 provides a summary of potential impacts from sounds on marine mammals (with more general background information in Appendix C). In any case, the mitigation measures to be implemented during this survey are based on level B harassment criteria using 160 dB and 170 dB re 1µPa rms, and will as such minimize any potential risk to injury.

This Section describes the methods used to estimate the numbers of marine mammals that might be affected during the proposed OBC seismic survey in the Liberty area, Beaufort Sea. The estimates are based on expected marine mammal density and anticipated area ensonified by levels of ≥170 and ≥160 dB re 1µPa.

Expected density of marine mammals in the survey area of operation and area of influence are based on best available data. Density data derived from studies conducted in or near the proposed survey area are used for calculations, where available. When estimates were derived from data collected in regions, habitats, or seasons that differ from the proposed seismic survey, adjustments to reported population or density estimates were made to account for these differences insofar as possible (Section 6.1).

The anticipated area to be ensonified by levels of ≥160 and ≥170 dB re 1µPa is a combination of the area covered by the ~3,219 km survey lines and the estimated safety radii. The close spacing of neighboring vessel tracklines within the planned seismic survey area results in a limited area exposed to sounds of ≥160 dB, while much of that area is exposed repeatedly. Section 6.2 describes in more detail the method used to calculate the safety radii and the area ensonified and potential numbers of marine mammals potentially affected is described in Section 6.3.

6.1 Marine mammal density estimates

Numbers of marine mammals that might be present and potentially disturbed are estimated, based on available data about mammal distribution and densities at different locations and times of the year. The proposed survey covers a small area in the nearshore shallow waters of the western Beaufort Sea within Barrier islands in the summer season (July/August 2008), with an "as needed" extension of additional days after the whaling season (in accordance with the CAA), given the uncertainties in ice conditions and other factors that can influence the survey.

The duration of the seismic data acquisition in the Liberty area is estimated to be ~40 days, based on a continuous 24-hr operation. This can extend to a maximum of 60 days taking into account unpredictable delays. It is expected that the data acquisition can be completed during the months July and August. However, if further data acquisition is required after August, the seismic activities may resume in September and/or October after completion of the whaling season and in accordance with the CAA. Therefore, the nearshore marine mammal densities for the summer period have been applied to 95% of the total trackline kilometers. The fall densities have been applied to the remaining 5% of tracklines.

Most marine mammals in the Alaskan Beaufort Sea are migratory, occupying different habitats and/or locations during the year. The densities can therefore vary greatly within seasons and for different locations. For the purpose of this IHA, different densities have been derived for the summer (late July through August) and the fall (September through early October). In addition to seasonal variation in densities, spatial differentiation is also an important factor for marine mammal densities, both in latitudinal and longitudinal gradient. Taking into account the size and location of the proposed seismic survey area and the associated area of influence, only the nearshore zone (defined as the area between the shoreline and the 50 m line of bathymetry) in the western part of the Beaufort Sea (defined as the area west of 141^{o}W) is relevant for the calculation of densities. If the best available density data cover other zones than the nearshore zone or areas outside the western part of the Beaufort Sea, densities were derived based on expert judgment.

Ideally, when calculating densities from marine mammal distribution survey data, two correction factors need to be taken into account: (1) detectability bias [f(0)], and (2) availability bias [g(0)]. The detectability bias is associated with the diminishing sightability when the distance between the observation point and marine mammal increases. The availability bias refers to the fact that marine mammals may be present in the area but are not available to the observer to be sighted (i.e. beneath the water surface). The uncorrected number of marine mammals observed is therefore always lower than the actual numbers present. Unfortunately, for most density data not enough information is available of the survey specifics or of marine mammal behavior and movement patterns to calculate these two correction factors. The density estimates provided in this IHA request are based on uncorrected data, except for the beluga and bowhead whale densities. Correction factors were applied to the data from Moore et al. (2000b) and Miller et al. (2002) derived from Harwood et al 1996.

Because the available density data is not always representative for the area of interest, and correction factors were not always known, there is some uncertainty in the data and assumptions used in the density calculations. To provide allowance for these uncertainties, maximum estimates of the numbers potentially affected have been provided in addition to average densities. The marine mammal densities presented are believed to be close to, and in most cases higher than the densities that are expected to be encountered during the survey. Walruses and polar bears will be the subject of a separate request to USFWS for an LOA to be submitted by BP.

6.1.1 Density of Cetaceans in the Beaufort Sea

The densities of beluga and bowhead whales present in the Beaufort Sea are expected to vary by season and location. During the early and mid-summer, most belugas and bowheads are found in the Canadian Beaufort Sea or adjacent areas. During fall, both species migrate through the Alaskan Beaufort Sea, sometimes interrupting their migration to feed.

Beluga whales

Beluga density estimates for the Alaskan Beaufort Sea are derived from aerial survey data obtained by Moore et al. (2000b). The overall beluga whale density (i.e. total sightings from all depth regimes) was calculated with these data and this density was assumed to represent the average offshore density for the summer season in the eastern Beaufort Sea. During the summer season beluga whales are far more abundant in the offshore area, and so the densities for the nearshore area were (conservatively) estimated to be 10% of the offshore densities.

During the summer season, very few beluga whales are expected to be encountered in the western part of the Beaufort Sea, especially in the inshore waters of the Barrier islands. The average density of beluga whales for the proposed survey was therefore estimated to be 10% of the density of the eastern Beaufort Sea (Table 2).

In fall, during the westward migration, the offshore density is expected to be roughly equal across the eastern and western regions of the Alaskan Beaufort Sea. Also the depth distribution of migrating beluga whales is expected to be more equally distributed. For the autumn period, the density of beluga whales in the western Beaufort Sea was estimated to be 10% of the highest fall density calculated from Moore et al. (2000b) (Table 2).

The maximum density estimates of beluga whales were calculated as 4x the average estimates.

Bowhead whales

Bowhead sightings in the Alaskan Beaufort become more common as the whales start their westward migration in August. Peak sighting rates occur near Kaktovik (east of the Liberty area) in September. The density data used in this IHA request are derived from Miller et al. (2002) who calculated the seasonal distribution and numbers of bowheads observed in the eastern Alaskan Beaufort Sea and adjacent Canadian waters from aerial surveys conducted by various researchers during the late summer and autumn of 1979–2000. Correction factors (Thomas et al. 2002) were applied to these density estimates.

Bowheads in the eastern Alaskan Beaufort Sea and Canada occur in offshore habitats in summer. From late August-early September shallower habitats are selected during years with moderate and light ice-cover and deeper waters in years with heavy ice-cover. In the western Beaufort Sea during the period July-August very few bowhead whales are expected to be present in the nearshore zone. The densities calculated from 14 surveys in August in water depths of >50m in the eastern Alaskan and Canadian Beaufort Sea, were used as the basis for the summer density calculations in this IHA request. Because bowheads mainly occur in offshore waters during the summer season with decreasing abundance from east to west, density estimates for the proposed survey were estimated to be 10% of the reported densities by Miller et al. (2002)(Table 2).

Many of the bowhead whales will be migrating westward during the fall period, mostly in the nearshore and continental habitat zones. So, the fall densities of bowhead whales provided for the eastern Alaskan and Canadian Beaufort Sea are considered to be similar as those for the western Beaufort Sea. Average and maximum densities for the autumn period were based on calculated densities of 79 surveys conducted in the period September–October for the combined nearshore and continental zones (Miller et al. 2002). Because the whale density during the fall migration is in general higher in the nearshore area (<50m), the estimates provided were multiplied by two to obtain nearshore fall densities (Table 2). For the proposed survey 10% of these estimates were used.

Both the summer and autumn densities are assumed to be conservative given that the proposed survey takes place entirely inside the barrier islands.

Other cetacean species

For other cetacean species that may be encountered in the Beaufort Sea, densities are likely to vary somewhat by season, but differences are not expected to be great enough to estimate separate densities for the two seasons. Based on their known distribution Narwhal, harbor porpoise and gray whales are not likely to be encountered in the Liberty area. No densities have been provided, however, arbitrary numbers for harassment authorization were used, loosely based on historic opportunistic sightings in the region (Table 6).

6.1.2 Density of Pinnipeds in the Beaufort Sea

Pinnipeds in the polar regions are mostly associated with sea ice and most census methods count pinnipeds when they are hauled out on the ice. To account for the proportion of animals present but not hauled out (availability bias) or seals present on the ice but missed (detection bias), a correction factor should be applied to the “raw” counts. This correction factor is very dependent on the behavior of each species. To estimate the proportion of ringed seals visible resting on the ice surface, radio tags were placed on seals during the spring months during 1999-2003 (Kelly et al. 2006). Applying the probability that seals were visible to the data from past aerial surveys indicated that the fraction of seals visible varied from less than 0.40 to more than 0.75 between survey years. The environmental factors that are important in explaining the availability of seals to be counted were found to be time of day, date, wind speed, air temperature, and days from snow melt (Kelly et al. 2006). No correction factors have been applied to the seal densities reported here. The seismic activities covered by the present IHA request will occur during the open water season. Seal density during this period is generally lower than during spring when animals are hauled out on the ice. No distinction is made in density of pinnipeds between summer and autumn season.

Ringed seals

Seal counts through springtime aerial surveys, conducted in the period 1997-2002 in Prudhoe Bay and Foggy Island Bay area, reported (uncorrected) ringed seal densities ranging from 0.43 to 0.83 seals per km^2 in water over 3 m in depth (Moulton et al. 2002). Similar surveys in the Prudhoe Bay area conducted during the years 1997, 1998 and 1999 estimated consistent higher densities of seals (0.73 versus 0.43 seals/km^2 in 1997; 0.64 vs 0.39 seals/km^2 in 1998 and 0.87 vs 0.63 seals/km^2 in 1999) (Frost et al. (2002, 2004). It is not clear why such different results were obtained from similar surveys with considerable overlap in timing and methods. For this IHA request the average density was calculated from the combined 1997-2002 ringed seal densities from Moulton et al. (2003) and Frost et al. (2003). The highest observed density for the Prudhoe Bay and Liberty area was used as the maximum. Because these density estimates were calculated from spring data and the numbers of seals is expected to be much lower during the open water season, the densities used for the proposed survey were (conservatively) estimated to be 50% of the spring densities (Table 2). Due to the lack of open water seal density data, this number is considered to be realistic.

Bearded seals

During the 2002 spring aerial seal survey in the Prudhoe Bay area, a total of nine single bearded seal sightings were recorded. Four sightings were in the pack ice north of the ice edge and five were on the landfast ice. Of the bearded seals observed in the landfast ice, two were sighted south of the barrier islands. Several bearded seals were seen in 1999-2001, but none during 1997-1998. Density calculations were not conducted because of the small number of bearded seals recorded (Moulton et al. 2002). During a vessel based marine mammal survey for an OBC survey near and west of the Liberty area all three seal species were observed, with 92% ringed seals, 7% bearded seals and 1% spotted seals (Harris et al. 1997). The densities for bearded seals were therefore calculated as 7% of the ringed seal densities.

Spotted seals

Spotted seals have seldom been observed in the survey area. During a vessel based marine mammal survey for an OBC survey near and west of the Liberty area all three seal species were observed, with 92% ringed seals, 7% bearded seals and 1% spotted seals (Harris et al. 1997). The densities for spotted seals were therefore calculated as 1% of the ringed seal densities.

Table 2. Expected densities (average and maximum) of cetaceans and pinnipeds for the nearshore zone in the Liberty area for the summer and autumn season. Densities are provided per km^2.

Species	Summer densities (#/km^2)		Autumn densities (#/km^2)	
	Average	Maximum	Average	Maximum
Cetaceans				
Beluga whale	0.0003	0.0011	0.0027	0.0108
Bowhead whale*	0.0001	0.0003	0.0043	0.0240
Pinnipeds				
Ringed seal	0.3050	0.4350	0.3050	0.4350
Bearded seal	0.0214	0.0305	0.0214	0.0305
Spotted seal	0.0031	0.0044	0.0031	0.0044

* *endangered species*

6.2 Safety radii

As outlined in Section 5, impacts on marine mammals from the planned seismic survey focus on the sound sources of the seismic airguns. This Section describes the methodology used to estimate the safety radii for received levels of 190, 180, 170 and 160 dB re 1µPa for pulsed sounds emitted by the airgun array with a total discharge volume of 880 in^3 and the assumptions underlying these calculations (more specifications of this airgun array are included in Appendix B). The distances to reach received sound levels of 170 and 160 dB re 1 µPa (rms) will be used to calculate the potential numbers of marine mammals exposed to these sound levels (Section 6.3). The distances to received levels of 180 and 190 dB re 1 µPa (rms) are mainly relevant as safety radii for mitigation purposes (see Section 11).

Greeneridge estimated radii to specific received sound pressure levels from the airgun arrays that will be operated at BP's Liberty Site (in Foggy Island Bay) during the open water season in 2008. The results from transmission loss experiments conducted in 1997 (Greene 1998) during the open-water season at the Liberty prospect in Foggy Island Bay were used to calculate the estimated distances of received levels of the proposed airgun source. The following facts and assumptions have been used for this computation:

1 The received sound levels from a 56 in^3 4-gun array of sleeve guns were measured during operation at Liberty in water depths of ~21 ft (~6.4 m) in 1997 (Greene 1998). The array depth was 1 m, the array volume was 56 in^3 and the internal pressure of the sleeve guns was 2000 psi. The airguns in the current array are also sleeve guns which make them comparable.

2 For distances from ~110 to 10,000 m, the measured equation for received SPL in 1997 was RL = 238.2 – 26.04log(R) -0.0018R. The constant term changes for different sources, but the coefficients of log(R) and R are dependent on the sound propagation at a site, not the source. Thus, those coefficients are retained in determining the distance estimates of received levels.

3 For estimation purposes, the sound pressures in the far field (>10x the array extent) from an airgun array increase with the number of airguns and with the cube root of the total volume. These two proportionalities are confounded (more guns generally increase the volume) but to be conservative they are used independently in the calculations. Changes

in pressure dependency from clusters of airguns were also (conservatively) ignored in the computations.

4 The array depth in 1997 was 1 m and the water depth 6.4 m. The operating array depths expected for the proposed Liberty survey will be from 1 to 4 m in water depths ranging from 3 to 30 ft (1 to 9.1 m). Generally, the transmission of sound into the water will improve with increasing array depth, leading to higher received levels of sound pressure at specific distances from the source. This is especially the case for low-frequency sources such as airgun arrays. For estimation purposes, array depths of both 1 m and 4 m were used.

The results of these computations are shown in Table 3. The sources used for seismic data acquisition are sleeve airgun arrays with a total discharge volume of 880 cubic inch (in^3) divided over two arrays. Each source vessel will have two 440 in^3 arrays each comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. The use of 2 separate arrays allows operations in shallow water depth. The safety radii are calculated for both the total discharge volume of 880 in^3 (8 guns) and for one 440 in^3 array (4 guns).

For the full 880 in^3 array, the volume change from the 1997 array is 880/56 = 15.71, the cube root of which is 2.5. The increase in pressure levels expected from the volume increase is 20log(2.5) = 8 dB. The number of guns for the full array is a factor of 2 higher than in 1997. The increase in pressure expected from doubling the number of guns is 20log(2) = 6 dB. Combining these two calculated changes in pressure level yields a total increase of 14 dB compared to the 1997 source, which is likely more than might actually be measured. So, with an estimated, extrapolated effective source level of ~252.2 dB re 1 µPa @ 1 m, the received levels for the 8-gun array at depth 1 m may be estimated from the equation:

(i) RL8 (dB re 1 µPa) = 252.2 – 26.04log(R) – 0.0018R (for R in meters).

For the smaller 440 in^3 array, the volume change from the 1997 array is 440/56 = 7.857, the cube root of which is almost 2, and the increase in pressure levels expected from the volume increase is 20log(2) = 6 dB. The number of guns is equal for both sources, so no additional pressure increase is expected due to the number of guns. Thus, the increase in pressure level compared to 1997 is 6 dB. So, with an estimated, extrapolated effective source level of ~244.2 dB re 1 µPa @ 1 m, the received level for the 4-gun array at depth 1 m may be estimated from the equation:

(ii) RL4 (dB re 1 µPa) = 244.2 – 26.04 log(R) – 0.0018R (for R in meters).

For source depth 4 m (4 times 1 m), the effective source level could increase by as much as 12 dB, but because of the shallow water environment only a 6 dB increase is assumed to occur. With the effective source level increase of 6 dB included into formula *(i)* and *(ii)* above, the estimated distances increase accordingly (see Table 3).

The estimated distances are based on transmission loss profiles within the barrier islands. It is expected that these islands will function as a sound barrier beyond which sound will not propagate much, although most propagation is expected through the channels between the islands. The estimated distances for 120 dB and maybe 160 dB (especially for the source lines closest to the islands) may be overestimations.

Table 3. Estimated distances for specified received levels from airgun arrays with a total discharge volume of 440 in^3 and 880 in^3. Note that the array depth is an important factor for sound propagation loss.

Received levels (dB re 1 µPa rms) [a]	Distance in meters[b] (array depth 1 m)		Distance in meters[b] (array depth 4 m)	
	440 in^3	880 in^3	440 in^3	880 in^3
190	~120	~235	~200	~390
180	~280	~545	~462	~880
170	~640	~1,190	~1,030	~1,830
160	~1,380	~2,380	~2,090	~3,430
120	~10,800	~13,700	~12,900	~16,000

[a] The distance in meters for each received level was calculated using the radius calculator available to the public at www.greeneridge.com (courtesy of W.C. Burgess, Ph.D.)

[b] Received levels of airgun sounds are expressed in dB re 1 µPa (rms, averaged over pulse duration).

The rms (root mean square) received sound pressure levels that are used as impact criteria for marine mammals are not directly comparable to the peak or peak-to-peak values normally used by geophysicists to characterize source levels of airguns (Appendix B). The measurement units used to describe airgun sources, peak or peak-to-peak dB, are always higher than the rms dB referred to in much of the biological literature and in the NMFS criteria. A measured broadband received level of 160 dB re 1 µPa (rms) in the far field would typically correspond to a peak measurement of about 170 to 172 dB re 1 µPa and to a peak-to-peak measurement of about 176 to 178 dB re 1 µPa, as measured for the same pulse received at the same location (Greene 1997; McCauley et al. 1998, 2000). The precise difference between rms and peak or peak-to-peak values for a given pulse depends on the frequency content and duration of the pulse, among other factors. However, the rms level is always lower than the peak or peak-to-peak level for an airgun-type source. Additional discussion of the characteristics of airgun pulses is included in Appendix C.

The distances from the source to specific received sound levels as summarized in Table 3 are estimates used for the purpose of this IHA request. These estimated distances will be verified with field measurements at the start of the survey (see Section 13).

6.3 Number of marine mammals potentially affected

The radii associated with received sound levels of 160 and/or 170 dB re 1 µPa (rms) or higher are used to calculate the number of potential marine mammal "exposures" to sounds that have the potential to impact their behavior. The 160 dB criterion is applied for all species and for pinnipeds additional calculations were made for the 170 dB criterion. Based on evidence summarized in Section 7 and Appendix C, these criteria are considered appropriate for those two groups.

The potential number of each species that might be exposed to received levels of ≥160 and ≥170 dB re 1 µPa (rms) is calculated by multiplying:

- The expected species density as provided in Table 2 of Section 6.1;
- The anticipated area to be ensonified to that level during airgun operations.

The area expected to be ensonified was determined by entering the seismic survey lines into a MapInfo Geographic Information System (GIS). GIS was than used to identify the relevant areas by "drawing" the applicable 160-dB buffer from Table 3 around each seismic source line and than to calculate the total area within the buffers. This method avoids the large overlap of buffer zones from each seismic source line, and hence an overestimation of the potential number of marine mammals exposed.

Some of the animals, particularly migrating bowhead whales, might show avoidance reactions before being exposed to sound levels of 160 dB re 1 µPa (rms) or higher. During autumn some migrating bowheads have been found to react to a noise threshold closer to 130 dB re 1 µPa (rms; Miller et al. 1999; Richardson et al. 1999). The numbers potentially impacted at thresholds ≥160 and ≥170 dB re 1 µPa (rms), however, are calculated as if no avoidance behavior takes place (Table 4).

6.3.1 Number of Cetaceans Potentially Exposed to ≥160 dB

The estimates show that one endangered cetacean species (the bowhead whale) is expected to be exposed to sound levels of ≥160 dB unless bowheads avoid the survey vessel before this received level is reached. Migrating bowheads are likely to do so, though many of the summering bowheads probably will not. Our respective average and maximum estimated numbers of exposed bowhead whales, as rounded numbers, are shown the two right-hand columns in Table 4. Note that 95 % of the survey coverage is expected in July and August, before the bowhead fall migration and only 5 % during fall migration when most bowheads are passing the area, offshore of the barrier islands.

Table 4. Number of bowhead and beluga whales potentially exposed to received sound levels of ≥160 dB. The numbers were calculated for a 880 in^3 array towed at 1 m and 4 m depth. Note that not all animals will change their behavior when exposed to these sound levels, and some might alter their behavior somewhat when levels are lower (see text).

Species	Summer		Autumn		Total	
	Average	Maximum	Average	Maximum	Average	Maximum
Array depth 1 m						
Beluga whale	0.1	0.5	1.3	5.1	1	6
Bowhead whale*	0.0	0.1	2.0	11.3	2	11
Array depth 4 m						
Beluga whale	0.1	0.5	1.3	5.2	1	6
Bowhead whale	0.0	0.1	2.1	11.6	2	12

* *endangered species*

Average and maximum estimates of the number of beluga whales potentially exposed are also summarized in Table 4. Species such as gray whale, narwhal, killer whale and harbor porpoise are not expected to be encountered but might be present in very low numbers; the maximum expected numbers exposed for these species are provided in Table 6 and are based on arbitrary estimates.

6.3.2 Number of Pinnipeds Potentially Exposed to ≥170 dB

Pinnipeds are not likely to react to seismic sounds unless the received levels are 170 dB re 1 µPa (rms), and many of those exposed to 170 dB will still not react overtly (Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005). The ringed seal is the most widespread and abundant pinniped in ice-covered arctic waters, and there is a great deal of annual variation in population size and distribution of these marine mammals.

Ringed seals account for the majority of marine mammals expected to be encountered, and hence exposed to airgun sounds with received levels of ≥160 dB and ≥170 dB re 1 μPa (rms) during the proposed seismic survey. The average (and maximum) estimates of the number of ringed seals exposed to these received levels are summarized in Table 5.

The other two species that could be encountered are the bearded seal and spotted seal. The likelihood of encounters, however, is much lower than for ringed seals with average and maximum numbers potentially exposed to ≥160 and ≥170 dB re 1 μPa (rms) as shown in Table 5.

Table 5. Number of pinnipeds potentially exposed to received sound levels of ≥160 dB and ≥170 dB. The numbers were calculated for 880 in^3 array towed at 1 m and 4 m depth. Note that not all animals will change their behavior when exposed to these sound levels.

Species	Numbers potentially exposed to ≥160 dB*		Numbers potentially exposed to ≥170 dB*	
	Average	Maximum	Average	Maximum
Array depth 1 m				
Ringed seal	151	215	129	184
Bearded seal	11	15	9	13
Spotted seal	2	2	1	2
Array depth 4 m				
Ringed seal	156	222	141	201
Bearded seal	11	16	10	14
Spotted seal	2	2	1	2

* *no distinction in summer or autumn densities has been made*

6.4 Conclusions

Impacts of seismic sounds on cetaceans are generally expected to be restricted to avoidance of a limited area around the seismic operation and short-term changes in behavior, falling within the MMPA definition of "Level B harassment". The requested "harassment authorization" for each species is based on the estimated maximum numbers exposed to ≥160 dB re 1μPa (rms) from an airgun array operating at 4 m depth (Table 6). This is the highest number of the various estimates.

Table 6. Summary of the number of marine mammals potentially exposed to received sound levels of ≥160 dB and ≥170 dB (for pinnipeds only) during BP's proposed seismic survey in the Liberty area, based on radii for 880 in^3 array and 4 m array depth. The two far right columns show the numbers of potentially affected marine mammals for which authorization is requested and the % of the population that these numbers constitute. Note that not all marine mammals will change their behavior when exposed to these sound levels, and some might alter their behavior somewhat when levels are lower (see text).

Species	Exposures to ≥160 dB		Exposures to ≥170 dB		Requested Authorization	Estimated % of population
	Average	Maximum	Average	Maximum		
Cetaceans						
Beluga whale	1	6	Not applicable		6 (50)*	0.02 (0.13)*
Bowhead whale	2	12			12	0.09
Gray whale					3	0.02
Narwhal		Not applicable			1	-
Killer whale					3	-
Harbor porpoise					3	-
Pinnipeds						
Ringed seal	156	222	141	201	225	0.07
Bearded seal	11	16	10	14	20	0.01
Spotted seal	2	2	1	2	5	0.01

* belugas are know to show aggregate behavior and can occur in large numbers in nearshore zones. For the unlikely event that a group of belugas appears in the Liberty area during the seismic survey this number is added to the requested authorization.

The estimated numbers of cetaceans and pinnipeds potentially exposed to sound levels sufficient to cause behavioral disturbance are very low percentages of the population sizes in the Bering–Chukchi-Beaufort seas. For the bowhead whale, a species listed as "Endangered" under the ESA, our estimates include ~12 bowheads. This is ~0.1% of the estimated 2008 Bering-Chukchi-Beaufort population of 13,330 (based on a population size of 10,545 in 2001 and an annual population growth of 3.4%, cf Table 1). The beluga whale is not expected to occur in or near the Liberty area, however some individuals might be observed. Beluga's also show aggregate behavior and so there is the unlikely event that if belugas will appear in this area it might be in a larger group. In both circumstances these numbers constitute very low percentages of the estimated population size (Table 6).

The many reported cases of apparent tolerance by cetaceans of seismic operations, vessel traffic, and some other human activities show that co-existence is possible. Mitigation measures such as controlled speed, look outs, non-pursuit, shut downs or power downs when marine mammals are seen within defined ranges, and avoiding migration pathways when animals are likely most sensitive to noise will further reduce short-term reactions, and minimize any effects on hearing sensitivity. In all cases, the effects are expected to be short-term, with no lasting biological consequence. Subsistence issues are addressed below in Section 8.

From the few pinniped species likely to be encountered in the study area, the ringed seal is by far the most abundant marine mammal that can be encountered. The estimated number of ringed seals potentially exposed to airgun sounds at received levels of ≥160 dB re 1 µPa (rms) during the seismic survey represent <0.1% of the Bering-Chukchi-Beaufort population, and these are even smaller portions for the bearded seal and spotted seal (Table 6). It is probable that at this received level, only a small percentage of these seals would actually be disturbed. As for cetaceans, the short-term exposures of pinnipeds to airgun sounds are not expected to result in any long-term negative consequences for the individuals or their populations.

7 ANTICIPATED IMPACT ON SPECIES OR STOCKS

The anticipated impact of the activity on the species or stocks of marine mammals.

This section summarizes the potential impacts on marine mammals of airgun operations and pinger systems. Note that for the completeness, examples or information is sometimes included for species that are not directly sometimes provided from species that are not

7.1 Summary of potential effects of airgun sounds

The effects of sounds from airguns might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and at least in theory, temporary or permanent hearing impairment, or non-auditory physical effects (Richardson et al. 1995). *In theory* is added because it is unlikely that temporary or especially permanent hearing impairment and non-auditory physical effects would occur.

Tolerance

Numerous studies have shown that pulsed sounds from airguns are often readily detectable in the water at distances of many kilometers. For a summary of the characteristics of airgun pulses, see Appendix C. Numerous studies have shown that marine mammals at distances more than a few kilometers from operating seismic 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, small odontocetes, and sea otters seem to be more tolerant of exposure to airgun pulses than are baleen whales.

Masking

Masking effects of pulsed sounds (even from large arrays of airguns) on marine mammal calls and other natural sounds are expected to be limited, although there are very few specific data of relevance. Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Although there has been one report that sperm whales cease calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994), a more recent study reports that sperm whales off northern Norway continued calling in the presence of seismic pulses (Madsen et al. 2002). That has also been shown during recent work in the Gulf of Mexico (Tyack et al. 2003). Bowhead whale calls are frequently detected in the presence of seismic pulses, although the number of calls detected may sometimes be reduced in the presence of airgun pulses (Richardson et al. 1986; Greene et al. 1999). Masking effects of seismic pulses are expected to be negligible given the low number of cetaceans expected to be exposed, the intermittent nature of seismic pulses and the fact that ringed seals (most probably to be present in the area) are not vocal during this period. Masking effects, in general, are discussed further in Appendix C.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Based on NMFS (2001, p. 9293), we assume that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or "taking". By potentially significant, we mean "in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations".

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react briefly to an underwater sound by changing its behavior or moving a small distance, the impacts of the change are unlikely to be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be significant. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound. That likely overestimates the numbers of marine mammals that are affected in some biologically-important manner.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically-important degree by a seismic program are based on behavioral observations during studies of several species. However, information is lacking for many species. Detailed studies have been done on humpback, gray, and bowhead whales, and on ringed seals. Less detailed data are available for some other species of baleen whales, sperm whales, small toothed whales, and sea otters.

Baleen Whales — Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to pulses from large arrays of airguns at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, as reviewed in Appendix C, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. In the case of the migrating gray and bowhead whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals. They simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 µPa rms range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed. In many areas, seismic pulses from large arrays of airguns diminish to those levels at distances ranging from 4.5 to 14.5 km from the source. For the much smaller airgun array of this seismic survey distances to received levels in the 160–170 dB re 1 µPa rms range are 1.2 – 3.5 km (Table 3). Baleen whales within those distances may show avoidance or other strong disturbance reactions to the airgun array, however in the Liberty seismic survey area a limited number of baleen whales are expected to occur. Subtle behavioral changes sometimes become evident at somewhat lower received levels, and recent studies reviewed in Appendix C have shown that some species of baleen whales, notably bowhead and humpback whales, at times show strong avoidance at received levels lower than 160–170 dB re 1 µPa rms. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn, in particular, are unusually responsive, with avoidance occurring out to distances of 20–30 km from a medium-sized airgun source (Miller et al. 1999; Richardson et al. 1999). However, more recent research on bowhead whales (Miller et al. 2005) corroborates earlier evidence that, during the summer feeding season, bowheads are not as sensitive to seismic sources. In summer, bowheads typically begin to show avoidance reactions at a received level of about 160–170 dB re 1 µPa rms (Richardson et al. 1986; Ljungblad et al. 1988; Miller et al. 1999). The Liberty seismic project will be conducted in the summer and might occur partly in autumn, when the bowheads are commonly involved in migration. However, because the survey will be located nearshore of the barrier islands in shallow water and with seismic airguns of relatively small discharge volumes, the distance of received levels that might elicit avoidance behavior will likely not (or barely) reach the main migration corridor.

Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 µPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Those findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast, and on observations of the distribution of feeding Western Pacific gray whales off Sakhalin Island, Russia during a seismic survey (Yazvenko et al. 2007).

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration and much ship traffic in that area for decades (Appendix A in Malme et al. 1984). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson et al. 1987). Populations of both gray whales and bowhead whales grew substantially during this time. In any event, the brief exposures to sound pulses from the proposed airgun source are highly unlikely to result in prolonged effects.

Toothed Whales — Few systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above and (in more detail) in Appendix C have been reported for toothed whales. However, systematic work on sperm whales is underway (Tyack et al. 2003), and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone 2003; Smultea et al. 2004; Moulton and Miller 2005).

Seismic operators and marine mammal observers sometimes see dolphins and other small toothed whales near operating airgun arrays, but in general there seems to be a tendency for most delphinids to show some limited avoidance of seismic vessels operating large airgun systems. However, some dolphins seem to be attracted to the seismic vessel and floats, and some ride the bow wave of the seismic vessel even when large arrays of airguns are firing. Nonetheless, there have been indications that small toothed whales sometimes move away, or maintain a somewhat greater distance from the vessel, when a large array of airguns is operating than when it is silent (e.g., Goold 1996a,b,c; Calambokidis and Osmek 1998; Stone 2003). The beluga may be a species that (at least at times) shows long-distance avoidance of seismic vessels. Aerial surveys during seismic operations in the southeastern Beaufort Sea recorded much lower sighting rates of beluga whales within 10–20 km of an active seismic vessel. These results were consistent with the low number of beluga sightings reported by observers aboard the seismic vessel, suggesting that some belugas might be avoiding the seismic operations at distances of 10–20 km (Miller et al. 2005).

Captive bottlenose dolphins and (of more relevance in this project) beluga whales exhibit changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2002, 2005). However, the animals tolerated high received levels of sound (pk–pk level >200 dB re 1 μPa) before exhibiting aversive behaviors. With the presently-planned source, such levels would be limited to distances less than 200 m of the 8-airgun array in shallow water and encounters with beluga whales are not likely to occur within these distances.

Reactions of toothed whales to large arrays of airguns are variable and, at least for delphinids, seem to be confined to a smaller radius than has been observed for mysticetes (Appendix C). A ≥170 dB disturbance criterion (rather than ≥160 dB) is considered appropriate for delphinids (and pinnipeds), which tend to be less responsive than other cetaceans. However, based on the limited existing evidence, belugas should not be grouped with delphinids in the "less responsive" category.

Pinnipeds — Pinnipeds are not likely to show a strong avoidance reaction to the airgun sources that will be used. Visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior—see Appendix C. Ringed seals frequently do not avoid the area within a few hundred meters of operating airgun arrays (Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005). However, initial telemetry work suggests that avoidance and other behavioral reactions by two other species of seals to small airgun sources may at times be stronger than evident to date from visual studies of pinniped reactions to airguns (Thompson et al. 1998). Even if reactions of the species occurring in the present study area are as strong as those evident in the telemetry study, reactions are expected to be confined to relatively small distances and durations, with no long-term effects on pinniped individuals or populations. As for delphinids, a ≥170 dB disturbance criterion is considered appropriate for pinnipeds, which tend to be less responsive than many cetaceans.

Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds, but there has been no specific documentation of this for marine mammals exposed to sequences of airgun pulses. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds ≥180 and ≥190 dB re 1 μPa (rms), respectively (NMFS 2000). Those criteria have been used in defining the safety (shut down) radii planned for the proposed seismic survey. However, those criteria were established before there were any data on the minimum received levels of sounds necessary to cause temporary auditory impairment in marine mammals. As discussed in Appendix C and summarized here:

- The 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid temporary threshold shift (TTS), let alone permanent auditory injury, at least for belugas and delphinids.
- The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS.
- The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

NMFS is presently developing new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS and other relevant factors in marine and terrestrial mammals (NMFS 2005; D. Wieting in http://mmc.gov/sound/plenary2/pdf/plenary2summaryfinal.pdf). New science-based noise exposure criteria are also proposed by a group of experts in this field, based on an extensive review and syntheses of available data on the effect of noise on marine mammals (Southall et al., in press) and this review seems to confirm that the current 180 dB and 190 dB are conservative.

Several aspects of the planned monitoring and mitigation measures for this project are designed to detect marine mammals occurring near the airguns to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment. In addition, many cetaceans are likely to show some avoidance of the area with high received levels of airgun sound (see above). In those cases, the avoidance responses of the animals themselves will reduce or (most likely) avoid any possibility of hearing impairment.

Non-auditory physical effects might also 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. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds. However, as discussed below, 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 present study area. It is unlikely that any effects of these types would occur during the present project given the brief duration of exposure of any given mammal, and the planned monitoring and mitigation measures (see below). The following subsections discuss in somewhat more detail the possibilities of TTS, permanent threshold shift (PTS), and non-auditory physical effects.

Temporary Threshold Shift (TTS) — TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. At least in terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the noise ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound.

For toothed whales exposed to single short pulses, the TTS threshold appears to be, to a first approximation, a function of the energy content of the pulse (Finneran et al. 2002, 2005). Given the available data, the received level of a single seismic pulse might need to be ~210 dB re 1 µPa rms (~221–226 dB pk–pk) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200–205 dB (rms) might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Seismic pulses with received levels of 200–205 dB or more are usually restricted to a radius of no more than 200 m around a seismic vessel operating a large array of airguns. For the smaller airgun array used in the proposed survey this radius will be no more than 100 m.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. However, no cases of TTS are expected given the moderate size of the source, and the strong likelihood that baleen whales (especially migrating bowheads) 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; cf. Au et al. 2000). In the harbor seal, which is closely related to the ringed seal, TTS onset apparently occurs at somewhat lower received energy levels than for odontocetes (see Appendix C).

A marine mammal within a radius of ~60 m (~197 ft) around the proposed airgun array might be exposed to a few seismic pulses with levels of ≥205 dB, and possibly more pulses if the mammal moved with the seismic vessel. (As noted above, most cetacean species tend to avoid operating airguns, although not all individuals do so.) However, several of the considerations that are relevant in assessing the impact of typical seismic surveys with arrays of airguns are not directly applicable here:

- "Ramping up" (soft start) is standard operational protocol during startup of large airgun arrays in many jurisdictions. Ramping up involves starting the airguns in sequence, usually commencing with a single airgun and gradually adding additional airguns. This practice will be employed when either airgun array is operated.
- It is unlikely that cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative small airgun array and the movement of both the vessel and the marine mammal. In this project, most of the planned seismic survey will be in very shallow water nearshore of the barrier islands. The propagation of the sounds generated is expected to be very limited offshore of the islands, where most of the baleen whales are expected to occur.
- With a large array of airguns, TTS would be most likely in any odontocetes that bow-ride or in any odontocetes or pinnipeds that linger near the airguns. In the present project, BP anticipates the 190 and 180 dB distances to be 390 m and 880 m, respectively, for the 8-gun array (Table 3). Only seals could be expected to be potentially close to the airguns and no species that occur within the project area are expected to bow-ride.
- There is a possibility that a small number of seals (which often show little or no avoidance of approaching seismic vessels) could occur close to the airguns and that they might incur slight TTS if no mitigation action (shutdown) were taken.

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 180 and 190 dB distances for the airguns operated by BP may be found to vary with array depth, however, conservative estimates have been used (390 m and 880 m, respectively; see Table 3) until results from field measurements are available (see Section 13.2). Furthermore, established 190 and 180 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., in press). Since no bow-riding species occur in the study area, it is unlikely such exposures will occur.

Permanent Threshold Shift (PTS) — When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. 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. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to the strong sound pulses with very rapid rise time—see Appendix C.

It is highly unlikely that marine mammals could receive sounds strong enough (and over a sufficient duration) to cause permanent hearing impairment during a project employing the airgun sources planned here. In the proposed project, marine mammals are unlikely to be exposed to received levels of seismic pulses strong enough to cause more than slight TTS. Given the higher level of sound necessary to cause PTS, it is even less likely that PTS could occur. In fact, even the levels immediately adjacent to the airgun may not be sufficient to induce PTS, especially because a mammal would not be exposed to more than one strong pulse unless it swam immediately alongside the airgun for a period longer than the inter-pulse interval. Baleen whales, and apparently belugas as well, generally avoid the immediate area around operating seismic vessels. The planned monitoring and mitigation measures, including visual monitoring, power downs, and shut downs of the airguns when mammals are seen within the "safety radii", will minimize the already-minimal probability of exposure of marine mammals to sounds strong enough to induce PTS.

Non-auditory Physiological Effects — Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, and other types of organ or tissue damage. However, studies examining such effects are very limited. If any such effects do occur, they probably would be limited to unusual situations when animals might be exposed at close range for unusually long periods. It is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop. That is especially so in the case of the proposed project where the airgun configuration focuses most energy downward and the source vessels are moving at 4–5 knots.

In general, little is known about the potential for seismic survey sounds to cause auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to short distances and probably to projects involving large arrays of airguns. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. 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 auditory impairment or other physical effects. Also, the planned monitoring and mitigation measures include shut downs of the airguns, which will reduce any such effects that might otherwise occur.

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 have slower rise times, and there is no proof that they can cause serious injury, death, or stranding even in the case of large airgun arrays. However, the association of mass strandings of beaked whales with naval exercises and, in one case, a seismic survey, has raised the possibility that beaked whales exposed to strong pulsed sounds may be especially susceptible to injury and/or behavioral reactions that can lead to stranding (more details are provided in Appendix C). However, no beaked whales are found within this project area. The shallow water environment, small airgun arrays and planned monitoring and mitigation measures of the proposed survey are not expected to result in mortality of other marine mammal species.

7.2 Summary of potential effects of pinger signals

A pinger system (Dyne Acoustical Pingers) and acoustic releases/transponders (Benthos) will be used during seismic operations to position the receivers and locate and retrieve the batteries. Sounds from these pingers are very short pulses. The Dyne pinger has a source level ranging from ~188-193 dB re 1 μPa at 1 m in a frequency range of 19-36 kHz and the benthos has source levels ~192 dB re 1 μPa at 1 m in a frequency range of 7-15 kHz. Pulses are emitted on command from the operator aboard the source vessel.

Masking

The pinger produces sounds within the frequency range that could be detected by some seals and baleen whales, as they can hear sounds at frequencies up to 36 kHz. However, marine mammal communications will not be masked appreciably by the pinger signals. This is a consequence of the relatively low power output, low duty cycle, and brief period when an individual mammal is likely to be within the area of potential effects.

Behavioral Responses

Marine mammal behavioral reactions to other pulsed sound sources are discussed above, and responses to the pinger are likely to be similar to those for other pulsed sources if received at the same levels. However, the pulsed signals from the pinger are much weaker than those from the airgun. Therefore, behavioral responses are not expected unless marine mammals are very close to the source. The maximum reaction that might be expected would be a startle reaction or other short-term response. NMFS (2001) has concluded that momentary behavioral reactions "do not rise to the level of taking".

Hearing Impairment and Other Physical Effects

Source levels of the pinger are much lower than those of the airguns, which are discussed above. It is unlikely that the pinger produces pulse levels strong enough to cause temporary hearing impairment or (especially) physical injuries even in an animal that is (briefly) in a position near the source.

8 ANTICIPATED IMPACT ON SUBSISTENCE

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

Subsistence remains the basis for Alaska Native culture and community. Marine mammals are legally hunted in Alaskan waters by coastal Alaska Natives. In rural Alaska, subsistence activities are often central to many aspects of human existence, including patterns of family life, artistic expression, and community religious and celebratory activities. The main species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses and polar bears[1]. The importance of each of these species varies among the communities and is largely based on availability.

In the Beaufort Sea, bowhead and beluga whales are the marine mammal species primarily harvested during the open water season, when the proposed seismic survey is planned. Bowhead whale hunting is the key activity in the subsistence economies of Barrow and two smaller communities, Nuiqsut and Kaktovik. The whale harvests have a great influence on social relations by strengthening the sense of Inupiat culture and heritage in addition to reinforcing family and community ties. Barrow residents focus hunting efforts on bowhead whales during the spring; however, can also conduct bowhead whale hunts in the fall. The communities of Nuiqsut and Kaktovik participate only in the fall bowhead harvest. Few belugas are present or harvested from Nuiqsut or Kaktovik.

Subsistence bowhead whale hunt

The Nuiqsut subsistence hunt has the potential to be impacted by the proposed seismic survey due to its proximity to Cross Island. Around late August the hunters from Nuiqsut establish camps on Cross Island from where they undertake the fall bowhead whale hunt. The hunting period starts normally in early September and lasts until around mid-October depending mainly on ice and weather conditions and the success of the hunt. Most of the hunt occurs offshore in waters east, north and northwest of Cross Island where bowheads migrate and not inside the barrier islands (Galginaitis 2007). Hunters prefer to take bowheads close to shore to avoid a long tow, but Braund and Moorehead (1995) report that crews may (rarely) pursue whales as far as 80 km offshore. The proposed seismic survey takes place within the barrier islands in very shallow water (<10 m) and has the potential to interfere with the hunt in two ways:

1 Deflection of whales further offshore from sounds generated by seismic airguns. Due to the relatively small airgun array in combination with the shallow water environment of the survey and presence of barrier islands, most low frequency sounds are not expected to propagate into the main bowhead migration corridor.

2 Interference with the hunt due to the presence of vessels near Cross Island.

Both concerns will be discussed with the native communities, and the survey will be conducted in compliance with the mitigation measures outlined in the CAA as a result of these communications.

Subsistence seal hunt

Ringed seals are hunted mainly from October through June. Hunting for these smaller mammals is concentrated during the ice season because of larger availability of seals on the ice. In winter, leads and cracks in the ice off points of land and along the barrier islands are used for hunting ringed seals. Although ringed seals are available year-round, the seismic survey will not occur during the primary period when these seals are typically harvested.

The more limited seal harvest that takes place during the open water season starts around the second week of June. Hunters take boats on routes in the Colville River and much of Harrison Bay. The main seal hunt occurs in areas far west from the Liberty area so impacts on the subsistence seal hunt are not expected. The potential for impacts on the seal hunt will however be discussed with the Nuiqsut community and specific provisions will be integrated in the survey in compliance with the CAA where applicable.

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[1] The subsistence hunt of walrus and polar bear and the anticipated impact of the proposed seismic survey activity on subsistence hunting is subject of the polar bear and walrus LOA request to USFWS.

9 ANTICIPATED IMPACT ON HABITAT

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

The proposed seismic survey will not result in any permanent impact on habitats used by marine mammals, or to the food sources they utilize. The proposed activities will be of short duration in any particular area at any given time; thus any effects would be localized and short-term. The main impact issue associated with the proposed activity will be temporarily elevated sound levels and the associated direct effects on marine mammals, as discussed in Section 6 and 7 above.

10 ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

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

The proposed airgun operations will not result in any permanent impact on habitats used by marine mammals, or to the food sources they use. The main impact issue associated with the proposed activities will be temporarily elevated sound levels and the associated direct effects on marine mammals, as discussed above.

During the seismic study only a small fraction of the available habitat would be ensonified at any given time. Disturbance to fish species would be short-term and fish would return to their pre-disturbance behavior once the seismic activity ceases. Thus, the proposed survey would have little, if any, impact on the abilities of marine mammals to feed in the area where seismic work is planned.

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 [eds.] 2002; Lowry et al. 2004). 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, if any would occur at all. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding mysticetes. More importantly, bowhead whales are not expected to occur of feed in the shallow area covered by the seismic survey.

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.

11 MITIGATION MEASURES

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

The introduction of pulsed sounds generated by seismic airguns is the main source of potential impacts on marine mammal species and the focus of this request. The response of the animal depends on various factors, but short term behavioral responses are the most likely to occur. No serious and lethal injuries are expected. Implementation of the mitigation measures as described below will reduce the potential impacts to marine mammals. This section describes the measures that have been implemented in the survey design and those that will be implemented during the survey.

11.1 Mitigation measures within the survey design

Mitigation measures to reduce any potential impact on marine mammal species that have been considered and implemented in the planning and design phase are as follows:

- The area for which seismic data is required, i.e. the well path from SDI to the Liberty prospect, has been minimized by re-analyzing and re-interpreting existing data (to the extent available and usable). This has led to a reduction in size from ~85 mi^2 to ~35 mi^2. Note that this is not the total seismic area extent that includes the seismic source vessels and receiver lines, although they are related.
- The total airgun discharge volume has been reduced to the minimum volume needed to obtain the required data. The total volume for the proposed survey is 880 in^3 (consisting of two 4-gun arrays of 440 in^3).
- Two seismic source vessels will be used simultaneously (alternating their shots) to minimize the total survey period. This will allow the survey to be completed prior to the start of the whale fall migration and whaling season (weather depending).

11.2 Mitigation measures during operation

The seismic survey will take place inside the barrier islands in nearshore shallow waters. The survey period will be July-August, prior to the bowhead whale migration season, with some contingency to obtain data in September/October after the whaling season if necessary in compliance with the CAA. It is unlikely that whales will be present in the nearshore zone where the seismic survey is taking place and if they are present the numbers will be low. The main marine mammal species to be expected in the area is the ringed seal. With the proposed mitigation measures (see below), any effect on individuals are expected to be limited to short term behavioral disturbance with negligible impact on the species or stock.

The mitigation measures are an integral part of the survey in the form of specific procedures, such as: *i*) speed and course alterations; *ii*) power-down, ramp up and shutdown procedures; and *iii*) provisions for poor visibility conditions. For the implementation of these measures it is important to first establish and verify the distances of various received levels that function as safety zones and second to monitor these safety zones and implement mitigation measures where required.

Establishment and monitoring of safety zones

Greeneridge Sciences, Inc. estimated for BP the distances from the 880 in^3 seismic airgun array where sound levels 190, 180, 170, and 160 dB re 1 µPa (rms) would be received (Section 6.2 and Table 3). For these estimations, the results from transmission loss data obtained in the Liberty area in 1997 were used (Greene 1998). The calculations included distances for a reduced array of 440 in^3 and two different array depths (1 m and 4 m). These calculations form the basis for estimating the number of animals potentially affected.

Received sound levels will be measured as a function of distance from the array prior to the start of the survey. This will be done for: (a) two 440 in^3 arrays (880 in^3), (b) one 440 in^3 array, (c) one 70 in^3 airgun (smallest volume of array). BP will apply appropriate adjustments to the estimated safety zones (Table 3) based on measurements of the 880 in^3 (= two 440 in^3) array. Results from measurements of the 440 in^3 and 70 in^3 data will be used for the implementation of mitigation measures to power down the sound source and reduce the size of the safety zones when required (see section on power-down procedures below).

Marine mammal observers on board of the vessels play a key role in monitoring these safety zones and implementation of the mitigation measures. Their primary role is to monitor marine mammals near the seismic source vessel during all daylight airgun operations and during any nighttime start-up of the airguns. These observations will provide the real-time data needed to implement the key mitigation measures as described below. When marine mammals are observed within, or about to enter, designated safety zones airgun operations will be powered down (or shut down if necessary) immediately. These safety zones are defined as the distance from the source to a received level of 190 dB for pinnipeds and 180 dB for cetaceans. A specific dedicated vessel monitoring program to detect aggregations of baleen whales (12 or more) within the ≥160 dB zone or 4 or more bowhead whale cow-calf pairs within the ≥120 dB zone is not considered applicable here as none of these situations is expected for the proposed survey based on the estimated safety zones (Table 3). Monitoring options will be reconsidered if radii measured in the field are significantly larger than the estimated radii (and extend to areas where bowhead whales can be expected).

Speed and course alterations

If a marine mammal (in water) is detected outside the safety radius and, based on its position and the relative motion, is likely to enter the safety radius, the vessel's speed and/or direct course should be changed in a manner that does not compromise safety requirements. The marine mammal activities and movements relative to the seismic 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, i.e., either further course alterations or power-down or shut-down of the airgun(s).

Power-down, ramp-up and shut-down procedures

Power-down, ramp-up and shutdown procedures are implemented to prevent marine mammals from exposure to received levels of 190 dB (pinnipeds) and 180 dB (cetaceans). Dedicated marine mammal observers monitor these safety zones and have the authority to call for the implementation of these procedures when required by the situation. A summary of these situations is described below for each procedure. The criteria are consistent with guidelines listed for cetaceans and pinnipeds by NMFS (2000), and other guidance by NMFS.

Power-down procedure

A power-down involves decreasing the number of airguns in use such that the radii of the 190 dB and 180 dB zones are decreased to the extent that observed marine mammals are not in the applicable safety zone. Situations that would require a power down are listed below.

- When the vessel is changing from one source line to another, one airgun or a reduced number of airguns is operated. The continued operation of one airgun or a reduced airgun array is intended to (a) alert marine mammals to the presence of the seismic vessel in the area, and (b) retain the option of initiating a ramp up to full operations under poor visibility conditions.
- If a marine mammal is detected outside the safety radius but is likely to enter the safety radius, and if the vessel's speed and/or course cannot be changed to avoid the animal from entering the safety zone. As an alternative to a complete shut down, the airguns may be powered down before the animal is within the safety zone.
- If a marine mammal is already within the safety zone when first detected, the airguns may be powered down immediately if this is a reasonable alternative to a complete shut down. This decision will be made by the MMO and can be based on the results obtained from the acoustic measurements for the establishments of safety zones (see Section 11.2.1).

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, or
- has not been seen within the zone for 15 min in case of small odontocetes and pinnipeds, or
- has not been seen within the zone for 30 min in case of mysticetes (large odontocetes do not occur within the study area).

Shut-down Procedures

A shut-down procedure involves the complete turn off of all airguns. Ramp-up procedures will be followed during resumption of full seismic operations. The operating airgun(s) will be shut down completely during the following situations:

- If a marine mammal approaches or enters the applicable safety zone and a power down is not practical or adequate to reduce exposure to less than 190 or 180 dB (rms), as appropriate.
- If a marine mammal approaches or enters the estimated safety radius around the reduced source that will be used 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.

Ramp-up Procedures

A ramp-up procedure will be followed when the airgun array begins operating after a specified duration with no or reduced airgun operations. The specified duration depends on the speed of the source vessel, the size of the airgun array that is being used, and the size of the safety zone, but is often about 10 min.

NMFS normally requires that, once ramp-up commences, the rate of ramp-up be no more than 6 dB per 5 min period. Ramp up will likely begin with the smallest airgun, 70 in^3. The precise ramp-up procedure has yet to be determined, but BP intends to follow the ramp-up guideline of no more than 6 dB per 5 min period (unless otherwise required). A common procedure is to double the number of operating airguns at 5-min intervals. During the ramp-up, the safety zone for the full 8-gun array will be maintained. A ramp-up procedure can be applied only in the following situations:

- If, after a complete shut-down, the entire 180 dB safety zone has been visible for at least 30 min prior to the planned start of the ramp-up in either daylight or nighttime. If the entire safety zone is visible with vessel lights and/or night vision devices, then ramp-up of the airguns from a complete shut-down may occur at night.
- If one airgun has operated during a power-down period, ramp-up to full power will be permissible at night or in poor visibility, on the assumption that marine mammals will either be alerted by the sounds from the single airgun and could move away, or may be detected by visual observations.
- If no marine mammals have been sighted within or near the applicable safety zone during the previous 15 min in either daylight or nighttime, provided that the entire safety zone was visible for at least 30 min.

Poor visibility conditions

BP plans to conduct 24-hrs operations. Regarding night time observations, note that there will be no periods of total darkness until mid-August. Observers dedicated to marine mammal observations are proposed not to be on duty during ongoing seismic operations at night, given the very limited effectiveness of visual observation at night. At night, bridge personnel will watch for marine mammals (insofar as practical) and will call for the airguns to be shut down if marine mammals are observed in or about to enter the safety zones. If a ramp-up procedure needs to be conducted following a full shut-down during nighttime, two marine mammal observers need to be present to monitor marine mammals near the source vessel and to determine if the proper conditions are being met for a ramp-up. The proposed provisions associated with operations at night or in periods of poor visibility include the following:

- During any nighttime operations, if the entire 180 dB safety radius is visible using vessel lights and/or night vision devices, then start of a ramp-up procedure after a complete shut-down of the airgun array may occur following a 30 min period of observation without sighting marine mammals in the safety zone.
- If during foggy conditions or darkness (which may be encountered starting in late August), the full 180 dB (rms) safety zone is not visible, the airguns can not commence a ramp-up procedure from a full shut-down.
- If one or more airguns have been operational before nightfall or before the onset of foggy conditions, they can remain operational throughout the night or foggy conditions. In this case ramp-up procedures can be initiated, even though the entire safety radius may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

BP has considered the use of passive acoustic monitoring in conjunction with visual monitoring to allow detection of marine mammals during poor visibility conditions, such as fog. The use of PAM for this specific survey might not be very effective because the species most commonly present (ringed seal) is not vocal during this time period.

12 PLAN OF COOPERATION

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

BP has begun negotiating a “Plan of Cooperation” in the form of a Conflict Avoidance Agreement (CAA) with representatives of the community of Nuiqsut, the AEWC and NSB for the proposed 2008 Liberty seismic survey in Foggy Island Bay, Beaufort Sea. BP is working with the people of these communities and organizations to identify and avoid areas of potential conflict. Meetings that have taken place prior to the survey include:

October 25, 2007: Meeting with AEWC and NSB representatives during the AEWC convention;

October 29, 2007: Meeting with NSB Wildlife Group to provide updates of the survey and to obtain information on their opinions and views on mitigation and monitoring requirements.

April 2008: As in previous years, BP plans to participate in the “open water peer/stakeholder review meeting” to be convened by NMFS in Anchorage in mid-April 2008, where representatives of the Alaska Eskimo Whaling Commission and North Slope Borough are also expected to participate.

Subsequent meetings with whaling captains, other community representatives, the AEWC, NSB, and any other stakeholders will be held as necessary to negotiate the terms of the plan and to coordinate the planned seismic survey operation with subsistence hunting activity.

The CAA will cover the phases of BP’s seismic survey planned to occur in July and August and if required after the whaling season or as agreed in the CAA with the respective communities. The purpose of this plan will be to identify measures that will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses and to ensure good communication between BP (including the seismic team leads), native communities along the coast, and subsistence hunters at sea.

The proposed Plan of Cooperation may address the following:

- Operational agreement and communications procedures
- Where/when agreement becomes effective
- General communications scheme
- On-board Inupiat observer
- Conflict avoidance
- Seasonally sensitive areas
- Vessel navigation
- Marine mammal monitoring activities
- Measures to avoid impacts to marine mammals
- Measures to avoid conflicts in areas of active whaling
- Emergency assistance
- Dispute resolution process

13 MONITORING AND REPORTING PLAN

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

BP proposes to sponsor marine mammal monitoring during the Liberty seismic survey, in order to implement the proposed mitigation measures that require real-time monitoring, to satisfy the anticipated monitoring requirements of the USFWS LOA and NMFS IHA, and to meet any monitoring requirements agreed to as part of the Plan of Cooperation/Conflict Avoidance Agreement.

BP's proposed Monitoring Plan is described below. BP understands that this Monitoring Plan will be subject to review by NMFS and others, and that refinements may be required.

The monitoring work described here has been planned as a self-contained project independent of any other related monitoring projects that may be occurring simultaneously in the same region. Provided that an acceptable methodology and business relationship can be worked out in advance, BP is prepared to work with other energy companies in its efforts to manage, understand, and fully communicate information about environmental impacts related to its activities.

13.1 Vessel-based visual monitoring by marine mammal observers (MMO)

There will be three MMOs on each source vessel during the entire survey. These vessel-based MMOs will monitor marine mammals near the seismic source vessels during all daylight hours and during any ramp-up of airguns at night. In case the source vessels are not shooting but are involved in the deployment or retrieval of receiver cables, the MMOs will remain on the vessels and will continue their observations. The main purpose of the MMOs is to monitor the established safety zones and to implement the mitigation measures as described in Section 11.

Objectives

The main objectives of the visual based marine mammal monitoring from the seismic source vessels are as follows:

1. To form the basis for implementation of mitigation measures during the seismic operation (e.g. course alteration, airgun power-down, shut-down and ramp-up);
2. To obtain information needed to estimate the number of marine mammals potentially affected, which must be reported to NMFS within 90 days after the survey;
3. To compare the distance and distribution of marine mammals relative to the source vessel at times with and without seismic activity;
4. To obtain data on the behavior and movement patterns of marine mammals observed and compare those at times with and without seismic activity.

Note that potential to successfully achieve objectives 3 and 4 is subject to the number of animals observed during the survey period.

Two MMOs will also be placed on the mothership the *M/V Arctic Wolf* during its transit from Homer or Anchorage, via the Chukchi Sea and around Barrow to the survey area. Presence of MMOs on this vessel is to prevent any potential impact on beluga whales during the spring hunt, in addition to other measures that will be taken in close communication with the whale hunters of Point Lay and Kotzebue. It will be important that at least one Alaska native resident who speaks Inupiat will be placed on this vessel.

Marine mammal observer protocol

BP intends to work with experienced MMOs that have had previous experience working on seismic survey vessels, which will be especially important for the lead MMO. At least one Alaska native resident who speaks Inupiat and is knowledgeable about the marine mammals of the area is expected to be included as one of the team members aboard both source vessels and the mother ship.

At least one observer will monitor for marine mammals at any time during daylight hours and nighttime ramp-ups after a full shut down (and if safety zone is visible). Note that there will be no periods of total darkness until mid-August. Two MMOs will be on duty whenever feasible and practical, as the use of two simultaneous observers will increase the detectability of animals present near the source vessels. MMOs will be on duty in shifts of maximum 4 hours, but the exact shift regime will be established by the lead MMO in consultation with each MMO team member.

Before the start of the seismic survey the lead MMO will explain the function of the MMOs, their monitoring protocol and mitigation measures to be implemented to the crew of the seismic source vessels *M/V Peregrine* and *M/V Maxime*. Additional information will be provided to the crew by the lead MMO that will allow the crew to assist in the detection of marine mammals and (where possible and practical) in the implementation of mitigation measures.

Both the *M/V Peregrine* and *M/V Maxime* are relatively small vessels but form suitable platforms for marine mammal observations. Observations will be made from the bridges, which are respectively ~15 ft (~4.5 m) and ~12 ft (~3.7 m) above sea level and where MMOs have the best view around the vessel. During daytime, the MMO(s) will scan the area around the vessel systematically with reticle binoculars (e.g., 7×50 Fujinon) and with the naked eye. During any periods of darkness, night vision devices will be available (ITT F500 Series Generation 3 binocular-image intensifier or equivalent), if and when required. Laser rangefinding binoculars (Leica LRF 1200 laser rangefinder or equivalent) will be available to assist with distance estimation; these are useful in training observers to estimate distances visually, but are generally not useful in measuring distances to animals directly.

Communication procedures

When marine mammals in the water are detected within or about to enter the designated safety zones, the airgun(s) power-down or shut-down procedures need to be implemented immediately. To assure prompt implementation of power-downs and shut-downs, multiple channels of communication between the MMOs and the airgun technicians will be established. During the power-down and shut-down, the MMO(s) will continue to maintain watch to determine when the animal(s) are outside the safety radius. Airgun operations can be resumed with a ramp-up procedure (depending on the extent of the power down) if the observers have visually confirmed that the animal(s) moved outside the safety zone, or if the animal(s) were not observed within the safety zone for 15 min (pinnipeds) or for 30 min (cetaceans). Direct communication with the airgun operator will be maintained throughout these procedures.

Data recording

All marine mammal observations and any airgun power-down, shut-down and ramp-up will be recorded in a standardized format. Data will be entered into a custom database using a notebook computer. The accuracy of the data entry will be verified by computerized validity data checks as the data are entered and by subsequent manual checking of the database. These procedures will allow initial summaries of data to be prepared during and shortly after the field program, and will facilitate transfer of the data to statistical, graphical, or other programs for further processing and archiving.

13.2 Acoustic measurements and monitoring

Acoustic measurements and monitoring will be conducted for three different purposes:

1 To establish the distances of the safety zones;

2 To measure source levels (i.e. received levels referenced to 1 m from the sound source) of each vessel of the seismic fleet, to obtain knowledge on the sounds generated by the vessels;

3 To measure received levels offshore of the barrier islands from the seismic sound source.

Verification and establishment of safety zones

Prior to, or at the beginning of the seismic survey, acoustic measurements will be conducted to calculate received sound levels as a function of distance from the airgun sound source. These measurements will be conducted for different discharge volumes.

The results of these acoustic measurements will be used to re-define the safety zone distances for received levels of 190 dB, 180 dB and 160 dB. The 160 dB received level is monitored to avoid any behavioral disturbances of whales that may be in the area. The distances of the received levels as a function of the different sound sources (varying discharge volumes) will be used to guide power-down and ramp-up procedures. A preliminary report describing the methodology and results of the measurement for at least the 190 dB and 180 dB (rms) safety zones will be submitted to NMFS within 72-hrs of completion of the measurements.

Measurements of vessel sounds

BP intends to measure vessel sounds of each representative vessel. The exact scope of the source level measurements (back-calculated as received levels at 1 m from the source) should follow a pre-defined protocol to eliminate the complex interplay of factors that underlie these measurements, such as bathymetry, vessel activity, location, season, etc. Where possible and practical the monitoring protocol will be developed in alignment with other existing vessel source level measurements. BP would welcome a discussion with NMFS or other stakeholders to define a mutual beneficial objective.

Received sound levels offshore the barrier islands

The proposed seismic survey will take place inside the barrier islands and as such the sounds from the seismic survey activities are not expected to propagate much beyond the shallow areas formed by these barrier islands. However, because the survey might extend partly into September/October, when bowheads migrate past the area, and there are some slightly deeper water channels in between the barrier islands, BP intends to develop a simple acoustic monitoring plan to measure received sound levels outside the barrier islands during the seismic survey.

13.3 Aerial Surveys

During the July and August timeframe no bowhead whales are expected to be present in or close to the survey area, so no aerial surveys are planned during this timeframe. If the survey continues into September or October, after the bowhead whale hunt and in compliance with the CAA, aerial surveys will be conducted bi-weekly, if conditions allow, until three days after the seismic survey and cover the area immediately offshore of the barrier islands. If other operators conduct surveys in the vicinity, cooperation regarding sharing data or flight time can be considered, provided that an acceptable methodology and business relationship can be worked out in advance.

13.4 Reporting

A report on the preliminary results of the acoustic verification measurements, including as a minimum the measured 190 and 180 dB (rms) radii of the airgun sources, will be submitted within 72-hrs after collection of those measurements at the start of the field season. This report will specify the distances of the safety zones that were adopted for the survey.

A report on BP's activities and on the relevant monitoring and mitigation results will be submitted to NMFS within 90 days after the end of the seismic survey. The report will describe the operations that were conducted, the measured sound levels, and the cetaceans and seals that were detected near the operations. The report will be submitted to NMFS, providing full documentation of methods, results, and interpretation pertaining to all acoustic and vessel-based marine mammal monitoring. The 90-day report will summarize the dates and locations of seismic operations, and all whale and seal sightings[2] (dates, times, locations, activities, associated seismic survey activities). Marine mammal sightings will be reported at species level, however, especially during unfavorable environmental conditions (e.g. low visibility, high sea states) this will not always be possible. The number and circumstances of ramp-up, power-down, shut-down, and other mitigation actions will be reported. The report will also include estimates of the amount and nature of potential impact to cetaceans and seals encountered during the survey.

14 COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL HARASSMENT

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

Provided that an acceptable methodology and business relationship can be worked out in advance, BP will work with any number of external entities, including other energy companies, agencies, universities, and NGOs, in its efforts to manage, understand, and fully communicate information about environmental impacts related to the seismic activities.

BP is also interested in better understanding cumulative effects. In the past, BP has been an active participant in the National Academy's cumulative effects study. In addition, BP sponsored workshops intended to design better approaches to cumulative effects studies. The challenge in this case is determining a responsible approach to considering cumulative effects from sound.

[2] Note that it will not always be possible to identify the observed marine mammal to species level.

We are open to ideas and discussion and welcome comments from stakeholders with regard to assessment of cumulative effects from sound.

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APPENDIX A

VESSEL SPECIFICATIONS

APPENDIX B

SEISMIC ARRAY DESCRIPTION

Two source vessels will tow along predetermined lines a 8-gun array with a total discharge volume of 880 in^3 at 8 to10 m from each vessel at depths varying between 1 and 4 m. Seismic pulses will be emitted by each vessel at intervals of ~8 s and recorded by the ocean bottom receivers. The figures below provide more detailed acoustic information about the source array.

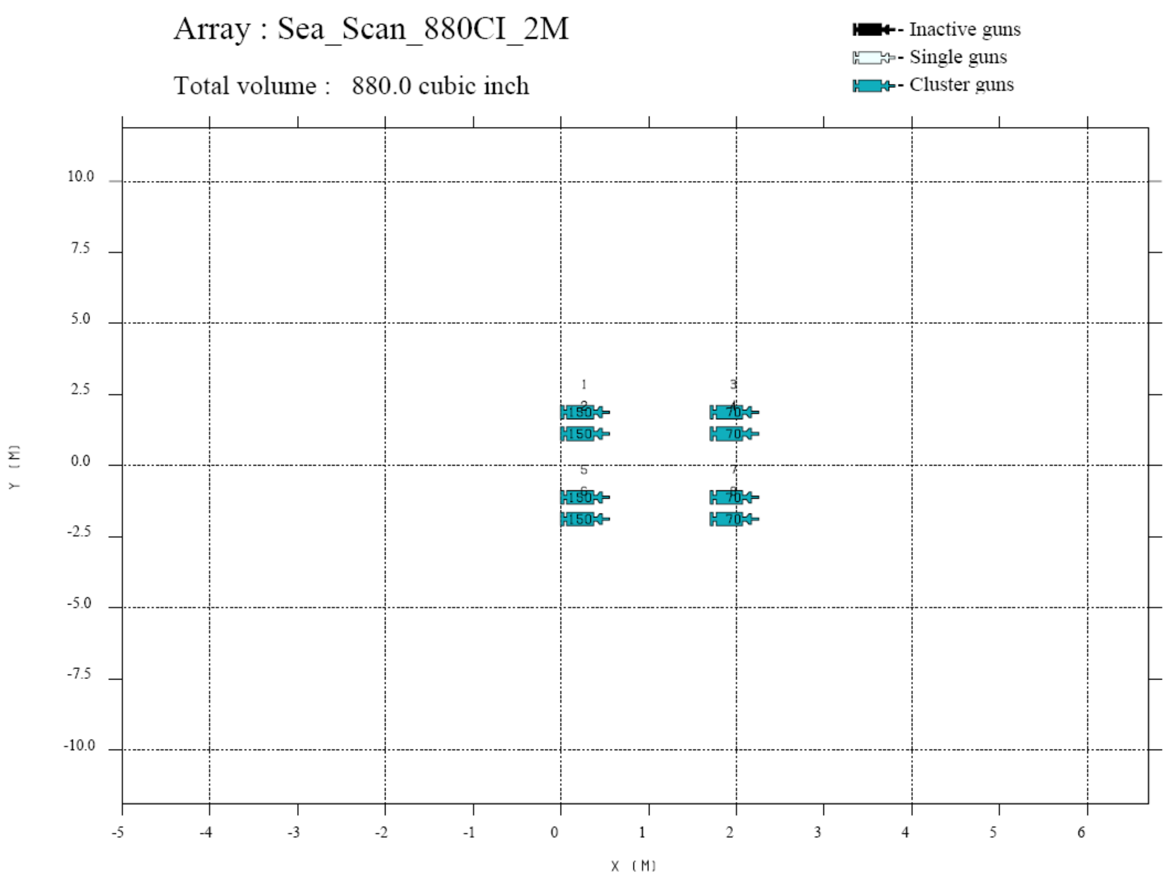

Figure B1. Spacing and configuration of the 880 in3 seismic airgun array to be towed behind the Peregrine and Maxim during the proposed survey. Four 150 in3 guns are on the left and four 70 in3 guns on the right. Measurements are in meters.

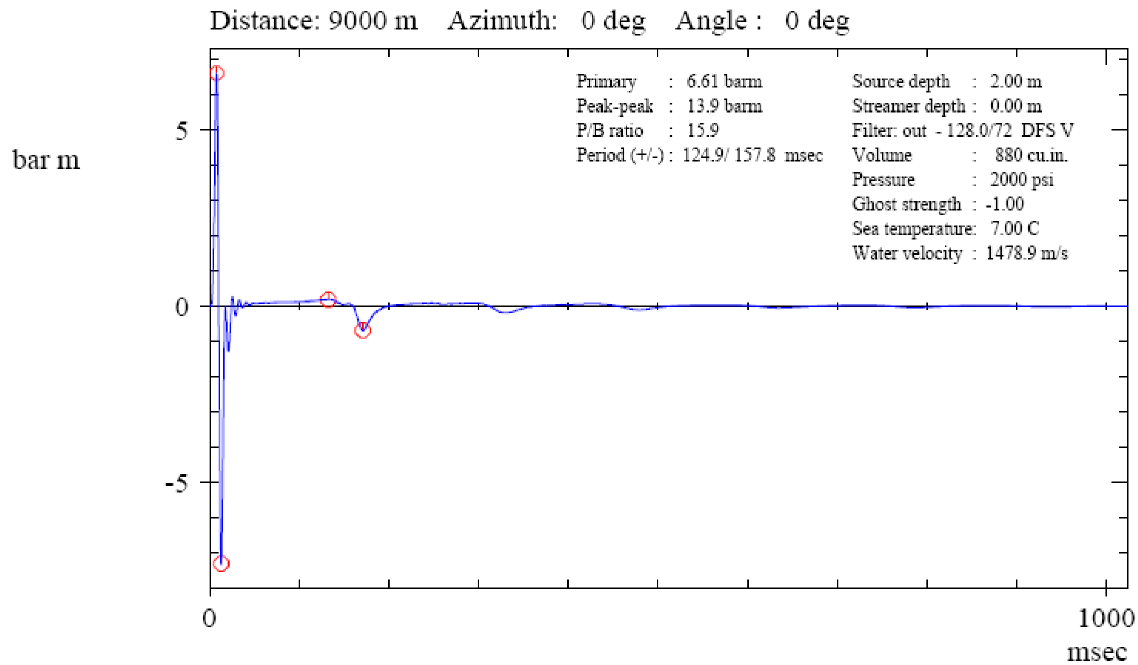

Figure B2. Far-field source signature for 8 sleeve gun 880 in3 array to be used by BPXA in the Liberty area, 2008.

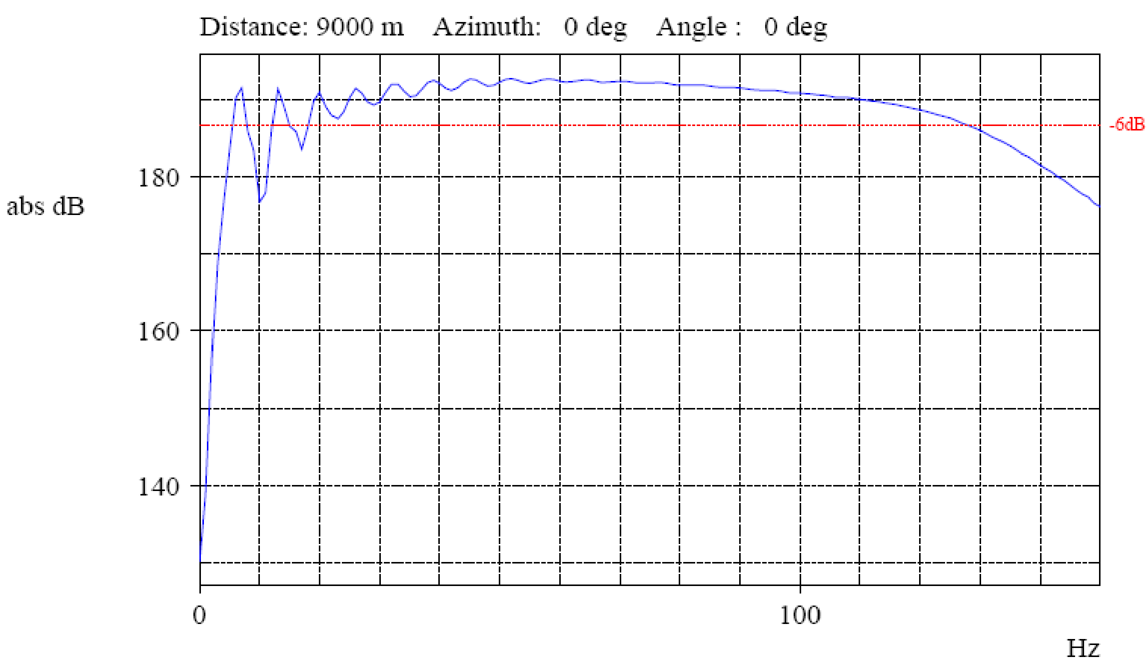

Figure B3. Far-field source amplitude spectrum for 8 sleeve gun 880 in3 array to be used by BPXA in the Liberty area, 2008.

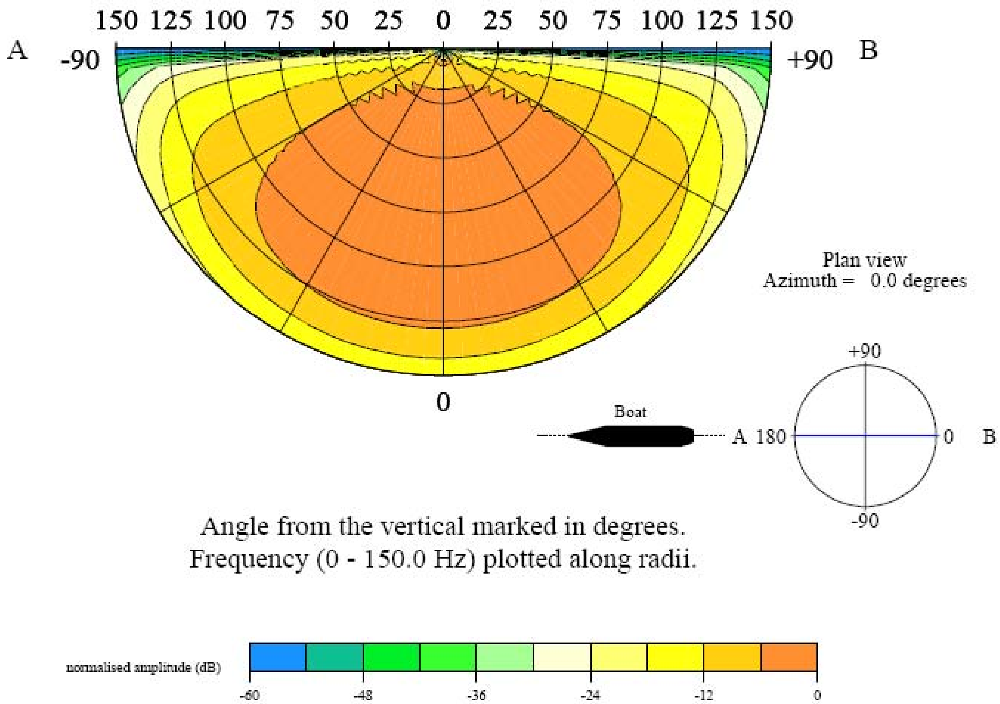

Figure B4. Source directivity plots for the 880 in3 gun array to be used by BPXA in the Liberty area, 2008 – azimuth: 0.0 degrees.

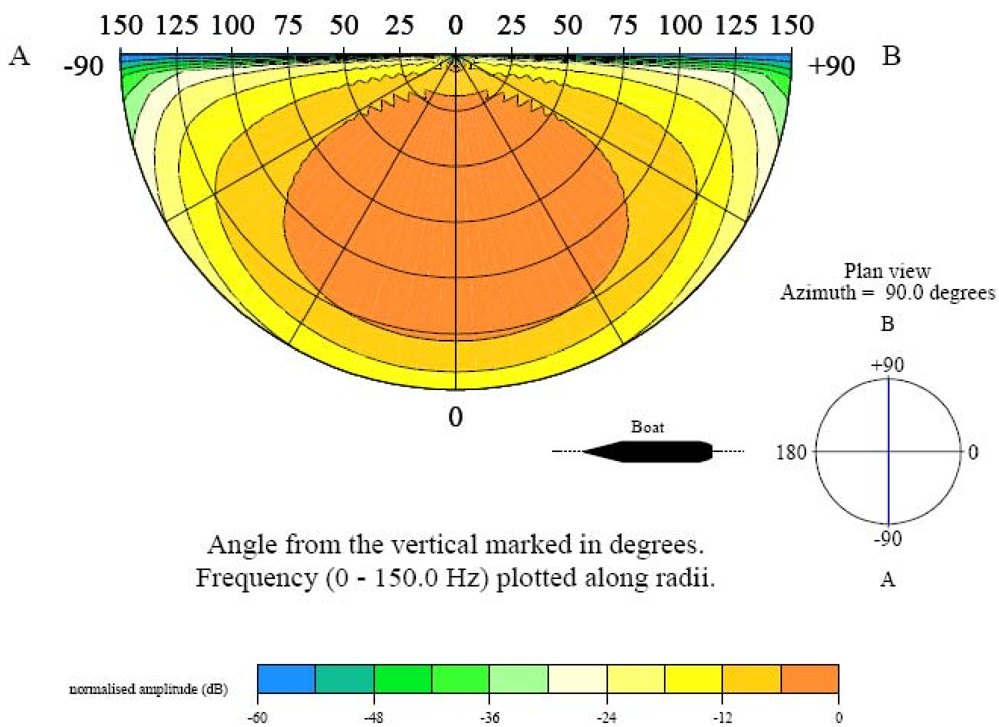

Figure B5. Source directivity plots for the 880 in3 gun array to be used by BPXA in the Liberty area, 2008 – azimuth: 90.0 degrees.

APPENDIX C

REVIEW OF POTENTIAL IMPACTS OF AIRGUN SOUNDS ON MARINE MAMMALS [3]

The following subsections review relevant information concerning the potential effects of airgun sounds on marine mammals. This information is included here as background for the briefer summary of this topic included in this IHA. This background material is little changed from corresponding subsections included in IHA applications and EAs submitted to NMFS for other seismic surveys from 2003 to date. Much of this information has also been included in varying formats in other reviews, assessments, and regulatory applications prepared by LGL Ltd., environmental research associates. Because this review is intended to be of general usefulness, it includes references to types of marine mammals that will not be found in some specific regions.

(a) Categories of Noise Effects

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

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

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(b) Hearing Abilities of Marine Mammals

The hearing abilities of marine mammals are functions of the following (Richardson et al. 1995; Au et al. 2000):

1. Absolute hearing threshold at the frequency in question (the level of sound barely audible in the absence of ambient noise). The "best frequency" is the frequency with the lowest absolute threshold.
2. Critical ratio (the signal-to-noise ratio required to detect a sound at a specific frequency in the presence of background noise around that frequency).
3. The ability to localize sound direction at the frequencies under consideration.
4. The ability to discriminate among sounds of different frequencies and intensities.

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Experiments also show that they hear and may react to many man-made sounds including sounds made during seismic exploration.

Baleen Whales (Mysticetes)

The hearing abilities of baleen whales have not been studied directly. Behavioral and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995; Ketten 2000). Baleen whales also reacted to sonar sounds at 3.1 kHz and other sources centered at 4 kHz (see Richardson et al. 1995 for a review). Frankel (2005) noted that gray whales reacted to a 21–25 kHz whale-finding sonar. Some baleen whales react to pinger sounds up to 28 kHz, but not to pingers or sonars emitting sounds at 36 kHz or above (Watkins 1986). In addition, baleen whales produce sounds at frequencies up to 8 kHz and, for humpbacks, to >15 kHz (Au et al. 2001). The anatomy of the baleen whale inner ear seems to be well adapted for detection of low-frequency sounds (Ketten 1991, 1992, 1994, 2000). The absolute sound levels that they can detect below 1 kHz are probably limited by increasing levels of natural ambient noise at decreasing frequencies. Ambient noise energy is higher at low frequencies than at mid frequencies. At frequencies below 1 kHz, natural ambient levels tend to increase with decreasing frequency.

The hearing systems of baleen whales are undoubtedly more sensitive to low-frequency sounds than are the ears of the small toothed whales that have been studied directly. Thus, baleen whales are likely to hear airgun pulses farther away than can small toothed whales and, at closer distances, airgun sounds may seem more prominent to baleen than to toothed whales. However, baleen whales have commonly been seen well within the distances where seismic (or other source) sounds would be detectable and yet often show no overt reaction to those sounds. Behavioral responses by baleen whales to seismic pulses have been documented, but received levels of pulsed sounds necessary to elicit behavioral reactions are typically well above the minimum detectable levels (Malme et al. 1984, 1988; Richardson et al. 1986, 1995; McCauley et al. 2000a; Johnson 2002).

Toothed Whales (Odontocetes)

Hearing abilities of some toothed whales (odontocetes) have been studied in detail (reviewed in Chapter 8 of Richardson et al. [1995] and in Au et al. [2000]). Hearing sensitivity of several species has been determined as a function of frequency. The small to moderate-sized toothed whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at, and above, several kHz. There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. However, Mann et al. (2005) and Cook et al.

(2006) reported that a Gervais' beaked whale showed evoked potentials from 5 to 80 kHz, with the best sensitivity at 40–80 kHz.

Despite the relatively poor sensitivity of small odontocetes at the low frequencies that contribute most of the energy in pulses of sound from airgun arrays, the sounds are sufficiently strong that their received levels sometimes remain above the hearing thresholds of odontocetes at distances out to several tens of kilometers (Richardson and Würsig 1997). However, there is no evidence that small odontocetes react to airgun pulses at such long distances, or even at intermediate distances where sound levels are well above the ambient noise level (see below).

The multibeam echosounders operated from oceanographic vessels to survey deep areas and sub-bottom profilers emit pulsed sounds at 12–15.5 kHz and 2.5–18 kHz, respectively. Those frequencies are within or near the range of best sensitivity of many odontocetes. Thus, sound pulses from the multibeam echosounder and sub-bottom profiler will be readily audible to these animals when they are within the narrow angular extent of the transmitted sound beam. Some vessels operate higher frequency (e.g., 24–455 kHz) multibeam echosounders designed to map shallower waters, and some of those will also be audible to odontocetes.

Seals and Sea Lions (Pinnipeds)

Underwater audiograms have been obtained using behavioral methods for three species of phocinid seals, two species of monachid seals, two species of otariids, and the walrus (reviewed in Richardson et al. 1995: 211*ff*; Kastak and Schusterman 1998, 1999; Kastelein et al. 2002). In comparison with odontocetes, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies, and poorer sensitivity at the best frequency.

At least some of the phocid (hair) seals have better sensitivity at low frequencies (≤1 kHz) than do odontocetes. Below 30–50 kHz, the hearing thresholds of most species tested are essentially flat down to about 1 kHz, and range between 60 and 85 dB re 1 µPa. Measurements for a harbor seal indicate that, below 1 kHz, its thresholds deteriorate gradually to ~97 dB re 1 µPa at 100 Hz (Kastak and Schusterman 1998). The northern elephant seal appears to have better underwater sensitivity than the harbor seal, at least at low frequencies (Kastak and Schusterman 1998, 1999).

For the otariid (eared) seals, the high frequency cutoff is lower than for phocinids, and sensitivity at low frequencies (e.g., 100 Hz) is poorer than for hair seals (harbor or elephant seal).

The underwater hearing of a walrus has been measured at frequencies from 125 Hz to 15 kHz (Kastelein et al. 2002). The range of best hearing was 1–12 kHz, with maximum sensitivity (67 dB re 1 µPa) occurring at 12 kHz (Kastelein et al. 2002).

Manatees and Dugong (Sirenians)

The West Indian manatee can apparently detect sounds from 15 Hz to 46 kHz, based on use of behavioral testing methods (Gerstein et al. 1999). Thus, manatees may hear, or at least detect, sounds in the low-frequency range where most seismic energy is released. It is possible that they are able to feel these low-frequency sounds using vibrotactile receptors or because of resonance in body cavities or bone conduction.

Based on measurements of evoked potentials, manatee hearing is apparently best around 1–1.5 kHz (Bullock et al. 1982). However, behavioral testing suggests their best sensitivity is at 6–20 kHz (Gerstein et al. 1999). The ability to detect high frequencies may be an adaptation to shallow water, where the propagation of low frequency sound is limited (Gerstein et al. 1999).

Sea Otter and Polar Bear (Fissipeds)

No data are available on the hearing abilities of sea otters (Ketten 1998), although the in-air vocalizations of sea otters have most of their energy concentrated at 3–5 kHz (McShane et al. 1995; Thomson and Richardson 1995; Richardson et al. 1995). Sea otter vocalizations are considered to be most suitable for short-range communication among individuals (McShane et al. 1995). Airborne sounds include screams, whines or whistles, hisses, deep-throated snarls or growls, soft cooing sounds, grunts, and barks (Kenyon 1975; McShane et al. 1995).

Data on the specific hearing capabilities of polar bears are also largely lacking. A recent study, and the only known testing of in-air hearing of polar bears, conducted measurements using auditory evoked potentials while tone pips were played to anesthetized bears (Nachtigall et al. 2007). Hearing was tested in ½ octave steps from 1 to 22.5 kHz, and best hearing sensitivity was found between 11.2 and 22.5 kHz. These data suggest that polar bears have sensitive hearing over a wide frequency range.

Data suggest that the frequencies of some medium- and high-frequency sounds may be audible to polar bears. However, polar bears' usual behavior (e.g., remaining on the ice, at the water surface, or on land) reduces or avoids their exposure to those sounds. Sea otters may be able to detect some low- and medium-frequency sounds, but as with polar bears, their largely water surface- and land-oriented behavior would reduce their exposure to those sounds.

(c) Characteristics of Airgun Pulses

Airguns function by venting high-pressure air into the water. The pressure signature of an individual airgun consists of a sharp rise and then fall in pressure, followed by several positive and negative pressure excursions caused by oscillation of the resulting air bubble. The sizes, arrangement, and firing times of the individual airguns in an array are designed and synchronized to suppress the pressure oscillations subsequent to the first cycle. The resulting downward-directed pulse has a duration of only 10–20 ms, with only one strong positive and one strong negative peak pressure (Caldwell and Dragoset 2000). Most energy emitted from airguns is at relatively low frequencies. For example, typical high-energy airgun arrays emit most energy at 10–120 Hz. However, the pulses contain some energy up to 500–1000 Hz and above (Goold and Fish 1998; Potter et al. 2006). Substantial high-frequency energy output of up to 150 kHz was found during tests of 60-in^3 and 250-in^3 airguns (Goold and Coates 2006). In fact, the output of those airguns covered the entire frequency range known to be used by marine mammals. The output included substantial energy levels that would be clearly audible to most, if not all, cetacean species (Goold and Coates 2006). Other recent studies—including controlled studies of sperm whales in the Gulf of Mexico (Tyack et al. 2006)—have also found that airguns exposed animals to significant sound energy above 500 Hz (Goold and Fish 1998; Sodal 1999). Those data increase concerns about the potential impacts of seismic sounds on odontocetes with poor low-frequency hearing but good higher-frequency hearing.

The pulsed sounds associated with seismic exploration have higher peak levels than other industrial sounds (except explosions) to which whales and other marine mammals are routinely exposed. The source levels of the 2- to 20-airgun arrays used by Lamont-Doherty Earth Observatory (L-DEO) from the R/V *Maurice Ewing* during previous projects ranged from 236 to 263 dB re 1 μPa_{p-p}, considering the frequency band up to about 250 Hz. The source level for the 36-airgun array used on the *Langseth* is 265 dB re 1 μPa_{p-p}. These are the nominal source levels applicable to downward propagation. The effective source levels for horizontal propagation are lower than those for downward propagation when numerous airguns spaced apart from one another are used. The only man-made sources with effective source levels as high as (or higher than) a large array of airguns are explosions and high-power sonars operating near maximum power.

Levels of anthropogenic underwater sounds, including those produced by seismic surveys, have been increasing worldwide. Concurrently, there is growing concern by the general public, researchers, government entities, and others regarding exposure of marine mammals to these sounds (e.g., Hildebrand 2004; Marine Technological Society 2004; Simmonds et al. 2006). In a comparison of anthropogenic underwater sound sources, airgun arrays worldwide were estimated to introduce 3.9 x 10^{13} Joules of energy into the ocean, second only to underwater nuclear explosions and ranking above military sonars (Moore and Angliss 2006). As a result, there has been increasing interest and studies on methods to estimate the numbers of animals exposed to various sound levels and to mitigate exposure to these sounds (e.g., Hollingshead and Harrison 2005).

Recent attention has focused on developing sound exposure criteria appropriate to the acoustic sensitivities of various marine mammal groups and species (e.g., Hollingshead and Harrison 2005; Miller et al. 2005a). These exposure criteria have important implications for identifying appropriate "safety radii" and sound exposure limits, including balancing mitigation with goals of geophysical seismic studies (e.g., Barton et al. 2006). Various empirical data are being collected, and modeling and predictions of the propagation and received levels of airgun sounds are being developed and applied (e.g., Breitzke 2006; Diebold et al. 2006; Frankel et al. 2006; Miller et al. 2006; Racca et al. 2006; Turner et al. 2006; Tyack et al. 2006). These recent studies are affecting the way underwater sound is modeled. For example, DeRuiter et al. (2005) reported that on-axis source levels and spherical spreading assumptions alone insufficiently describe airgun pulse propagation and the extent of exposure zones.

Several important mitigating factors need to be kept in mind. *(1)* Airgun arrays produce intermittent sounds, involving emission of a strong sound pulse for a small fraction of a second followed by several seconds of near silence. In contrast, some other sources produce sounds with lower peak levels, but their sounds are continuous or discontinuous but continuing for much longer durations than seismic pulses. *(2)* Airgun arrays are designed to transmit strong sounds downward through the seafloor, and the amount of sound transmitted in near-horizontal directions is considerably reduced. Nonetheless, they also emit sounds that travel horizontally toward non-target areas. *(3)* An airgun array is a distributed source, not a point source. The nominal source level is an estimate of the sound that would be measured from a theoretical point source emitting the same total energy as the airgun array. That figure is useful in calculating the expected received levels in the far field, i.e., at moderate and long distances. Because the airgun array is not a single point source, there is no one location within the near field (or anywhere else) where the received level is as high as the nominal source level.

The strengths of airgun pulses can be measured in different ways, and it is important to know which method is being used when interpreting quoted source or received levels. Geophysicists usually quote pk–pk levels, in bar-meters or (less often) dB re 1 μPa·m. The peak (= 0–pk) level for the same pulse is typically ~6 dB less. In the biological literature, levels of received airgun pulses are often described based on the "average" or "root-mean-square" (rms) level, where the average is calculated over the duration of the pulse. The rms value for a given airgun pulse is typically ~10 dB lower than the peak level, and 16 dB lower than the pk–pk value (Greene 1997; McCauley et al. 1998, 2000a). A fourth measure that is sometimes used is the energy, or Sound Exposure Level (SEL), in dB re 1 $\mu Pa^2 \cdot s$. Because the pulses are <1 s in duration, the numerical value of the energy is lower than the rms pressure level, but the units are different. Because the level of a given pulse will differ substantially depending on which of these measures is being applied, it is important to be aware which measure is in use when interpreting any quoted pulse level. In the past, NMFS has commonly referred to rms levels when discussing levels of pulsed sounds that might "harass" marine mammals.

Seismic sound received at any given point will arrive via a direct path, indirect paths that include reflection from the sea surface and bottom, and often indirect paths including segments through the bottom sediments. Sounds propagating via indirect paths travel longer distances and often arrive later than sounds arriving via a direct path. (However, sound traveling in the bottom may travel faster than that in the water, and thus may, in some situations, arrive slightly earlier than the direct arrival despite traveling a greater distance.) These variations in travel time have the effect of lengthening the duration of the received pulse, or may cause two or more received pulses from a single emitted pulse. Near the source, the predominant part of a seismic pulse is ~10–20 ms in duration. In comparison, the pulse duration received at long horizontal distances can be much greater. For example, for one airgun array operating in the Beaufort Sea, pulse durations were ~300 ms at a distance of 8 km, 500 ms at 20 km, and 850 ms at 73 km (Greene and Richardson 1988).

Another important aspect of sound propagation is that received levels of low-frequency underwater sounds diminish close to the surface because of pressure-release and interference phenomena that occur at and near the surface (Urick 1983; Richardson et al. 1995). Paired measurements of received airgun sounds at depths of 3 vs. 9 or 18 m have shown that received levels are typically several decibels lower at 3 m (Greene and Richardson 1988). For a mammal whose auditory organs are within 0.5 or 1 m of the surface, the received level of the predominant low-frequency components of the airgun pulses would be further reduced. In deep water, the received levels at deep depths can be considerably higher than those at relatively shallow (e.g., 18 m) depths at the same horizontal distance from the airguns (Tolstoy et al. 2004a,b).

Pulses of underwater sound from open-water seismic exploration are often detected 50–100 km from the source location, even during operations in nearshore waters (Greene and Richardson 1988; Burgess and Greene 1999). At those distances, the received levels are low, <120 dB re 1 μPa on an approximate rms basis. However, faint seismic pulses are sometimes detectable at even greater ranges (e.g., Bowles et al. 1994; Fox et al. 2002). Considerably higher levels can occur at distances out to several kilometers from an operating airgun array. In fact, recent data show that low-frequency airgun signals can be detected thousands of kilometers from their source. For example, sound from seismic surveys conducted offshore of Nova Scotia, the coast of western Africa, and northeast of Brazil were reported as a dominant feature of the underwater noise field recorded along the mid-Atlantic ridge (Nieukirk et al. 2004).

(d) Masking Effects of Seismic Surveys

Masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, although there are few specific data on this. Some whales are known to continue calling in the presence of seismic pulses. Their calls can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999; Nieukirk et al. 2004). Although there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994), more recent studies reported that sperm whales continued calling in the presence of seismic pulses (Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocetes, given the intermittent nature of seismic pulses plus the fact that sounds important to them are predominantly at much higher frequencies than are airgun sounds.

Most of the energy in the sound pulses emitted by airgun arrays is at low frequencies, with strongest spectrum levels below 200 Hz, considerably lower spectrum levels above 1000 Hz, and smaller amounts of energy emitted up to ~150 kHz. These low frequencies are mainly used by mysticetes, but generally not by odontocetes, pinnipeds, or sirenians. An industrial sound source will reduce the effective communication or echolocation distance only if its frequency is close to that of the marine mammal signal. If little or no overlap occurs between the industrial noise and the frequencies used, as in the case of many marine mammals vs. airgun sounds, communication and echolocation are not expected to be disrupted. Furthermore, the discontinuous nature of seismic pulses makes significant masking effects unlikely even for mysticetes.

A few cetaceans are known to increase the source levels of their calls in the presence of elevated sound levels, or to shift their peak frequencies in response to strong sound signals (Dahlheim 1987; Au 1993; review in Richardson et al. 1995:233ff., 364ff.; Lesage et al. 1999; Terhune 1999; Nieukirk et al. 2005; Parks et al. 2005). These studies involved exposure to other types of anthropogenic sounds, not seismic pulses, and it is not known whether these types of responses ever occur upon exposure to seismic sounds. If so, these adaptations, along with directional hearing and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the importance of masking.

(e) Disturbance by Seismic Surveys

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. In the terminology of the 1994 amendments to the MMPA, seismic noise could cause "Level B" harassment of certain marine mammals. Level B harassment is defined as "...disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."

There has been debate regarding how substantial a change in behavior or mammal activity is required before the animal should be deemed to be "taken by Level B harassment". NMFS has stated that

> "…a simple change in a marine mammal's actions does not always rise to the level of disruption of its behavioral patterns. … If the only reaction to the [human] activity on the part of the marine mammal is within the normal repertoire of actions that are required to carry out that behavioral pattern, NMFS considers [the human] activity not to have caused a disruption of the behavioral pattern, provided the animal's reaction is not otherwise significant enough to be considered disruptive due to length or severity. Therefore, for example, a short-term change in breathing rates or a somewhat shortened or lengthened dive sequence that are within the animal's normal range and that do not have any biological significance (i.e., do no disrupt the animal's overall behavioral pattern of breathing under the circumstances), do not rise to a level requiring a small take authorization." (NMFS 2001, p. 9293).

Based on this guidance from NMFS (2001) and the National Research Council (NRC 2005), we assume that simple exposure to sound, or brief reactions that do not disrupt behavioral patterns in a potentially significant manner, do not constitute harassment or "taking". By potentially significant, we mean "in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations".

Even with this guidance, there are difficulties in defining what marine mammals should be counted as "taken by harassment". For many species and situations, we do not have detailed information about their reactions to noise, including reactions to seismic and other sound pulses. Behavioral reactions of marine mammals to sound are difficult to predict. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors. If a marine mammal does react to an underwater sound by changing its behavior or moving a small distance, the impacts of the change may not be significant to the individual, let alone the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant. Given the many uncertainties in predicting the quantity and types of impacts of noise on marine mammals, it is common practice to estimate how many mammals were present within a particular distance of industrial activities, or exposed to a particular level of industrial sound. This likely overestimates the numbers of marine mammals that are affected in some biologically important manner.

The definitions of "taking" in the U.S. MMPA, and its applicability to various activities, were altered slightly in November 2003 for military and federal scientific research activities. Also, NMFS is proposing to replace current Level A and B harassment criteria with guidelines based on exposure characteristics that are specific to species and sound types (NMFS 2005). In 2005, public meetings were conducted across the nation to consider the impact of implementing new criteria for what constitutes a "take" of marine mammals. Currently, a committee of specialists on noise impact issues is drafting recommendations for new impact criteria (Gentry et al. 2004; Hollingshead and Harrison 2005; Miller et al. 2005a); those recommendations are expected to be made public soon. Thus, for projects subject to U.S. jurisdiction, changes in procedures may be required in the near future.

The sound criteria used to estimate how many marine mammals might be disturbed to some biologically-important degree by a seismic program are based on behavioral observations during studies of several species. However, information is lacking for many species. Detailed studies have been done on humpback, gray, and bowhead whales, and on ringed seals. Less detailed data are available for some other species of baleen whales, sperm whales, and small toothed whales.

Baleen Whales

Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to airgun pulses at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, baleen whales exposed to strong noise pulses from airguns often react by deviating from their normal migration route and/or interrupting their feeding and moving away. Some studies and reviews on this topic are Malme et al. (1984, 1985, 1988); Richardson et al. (1986, 1995, 1999); Ljungblad et al. (1988); Richardson and Malme (1993); McCauley et al. (1998, 2000a); Miller et al. (1999; 2005b); Gordon et al. (2004); Nowacek et al. (2007); and Moulton and Miller (in press). There is also evidence that baleen whales will often show avoidance of a small airgun source or upon onset of a ramp up when just one airgun is firing. Experiments with a single airgun showed that bowhead, humpback and gray whales all showed localized avoidance to a single airgun of 20–100 in^3 (Malme et al. 1984, 1985, 1986, 1987, 1988; Richardson et al. 1986; McCauley et al. 1998, 2000a,b). During a 2004 Caribbean seismic survey with a large airgun array, mean closest point of approach (CPA) of large whales during seismic was 1722 m compared to 1539 m during non-seismic, but sample sizes were small (Smultea et al. 2004; Holst et al. 2006).

Prior to the late 1990s, it was thought that bowhead, gray, and humpback whales all begin to show strong avoidance reactions to seismic pulses at received levels of ~160 to 170 dB re 1 μPa_{rms}, but that subtle behavioral changes sometimes become evident at somewhat lower received levels (Richardson et al. 1995). More recent studies have shown that some species of baleen whales (bowheads and humpbacks in particular) may show strong avoidance at received levels lower than 160–170 dB re 1 μPa_{rms}. The observed avoidance reactions involved movement away from feeding locations or statistically significant deviations in the whales' direction of swimming and/or migration corridor as they approached or passed the sound sources (e.g., Miller et al. 1999; McCauley et al. 2000a). In the case of the migrating whales, the observed changes in behavior appeared to be of little or no biological consequence to the animals—they simply avoided the sound source by displacing their migration route to varying degrees, but within the natural boundaries of the migration corridors (Malme et al. 1984; Malme and Miles 1985; Richardson et al. 1995).

Humpback Whales.—McCauley et al. (1998, 2000a) studied the responses of humpback whales off Western Australia to a full-scale seismic survey with a 16-airgun, 2678-in^3 array, and to a single 20 in^3 airgun with source level 227 dB re 1 µPa·m_{p-p}. They found that the overall distribution of humpbacks migrating through their study area was unaffected by the full-scale seismic program. McCauley et al. (1998) did, however, document localized avoidance of the array and of the single airgun. Observations were made from the seismic vessel, from which the maximum viewing distance was listed as 14 km. Avoidance reactions began at 5–8 km from the array, and those reactions kept most groups about 3–4 km from the operating seismic boat. McCauley et al. (2000a) noted localized displacement during migration of 4–5 km by traveling groups and 7–12 km by cow-calve pairs. Avoidance distances with respect to the single airgun were smaller but consistent with the results from the full array in terms of the received sound levels. Mean avoidance distance from the airgun corresponded to a received sound level of 140 dB re 1 μPa_{rms}; this was the level at which humpbacks started to show avoidance reactions to an approaching airgun. The standoff range, i.e., the closest point of approach (CPA) of the airgun to the whales, corresponded to a received level of 143 dB re 1 μPa_{rms}. One startle response was reported at 112 dB re 1 μPa_{rms}. The initial avoidance response generally occurred at distances of 5–8 km from the airgun array and 2 km from the single airgun. However, some individual humpback whales, especially males, approached within distances 100–400 m, where the maximum received level was 179 dB re 1 μPa_{rms}.

Humpback whales summering in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64-L (100-in^3) airgun (Malme et al. 1985). Some humpbacks seemed “startled” at received levels of 150–169 dB re 1 μPa. Malme et al. (1985) concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects, at received levels up to 172 re 1 μPa on an approximate rms basis.

It has been suggested that South Atlantic humpback whales wintering off Brazil may be displaced or even strand upon exposure to seismic surveys (Engel et al. 2004). The evidence for this was circumstantial, subject to alternative explanations (IAGC 2004), and not consistent with results from direct studies of humpbacks exposed to seismic surveys in other areas and seasons. After allowance for data from subsequent years, there was “no observable direct correlation” between strandings and seismic surveys (IWC 2007:9).

Bowhead Whales.—Bowhead whales on their summering grounds in the Canadian Beaufort Sea showed no obvious reactions to pulses from seismic vessels at distances of 6–99 km and received sound levels of 107–158 dB on an approximate rms basis (Richardson et al. 1986); their general activities were indistinguishable from those of a control group. However, subtle but statistically significant changes in surfacing–respiration–dive cycles were evident upon statistical analysis. Bowheads usually did show strong avoidance responses when seismic vessels approached within a few kilometers (~3–7 km) and when received levels of airgun sounds were 152–178 dB (Richardson et al. 1986, 1995; Ljungblad et al. 1988). In one case, bowheads engaged in near-bottom feeding began to turn away from a 30-airgun array with a source level of 248 dB re 1 μPa·m at a distance of 7.5 km, and swam away when it came within ~2 km. Some whales continued feeding until the vessel was 3 km away. This work and a more recent study by Miller et al. (2005b) show that feeding bowhead whales tend to tolerate higher sound levels than migrating bowhead whales before showing an overt change in behavior. The feeding whales may be affected by the sounds, but the need to feed may reduce the tendency to move away.

Migrating bowhead whales in the Alaskan Beaufort Sea seem more responsive to noise pulses from a distant seismic vessel than are summering bowheads. In 1996–1998, a partially-controlled study of the effect of Ocean Bottom Cable (OBC) seismic surveys on westward-migrating bowheads was conducted in late summer and autumn in the Alaskan Beaufort Sea (Miller et al. 1999; Richardson et al. 1999). Aerial surveys showed that some westward-migrating whales avoided an active seismic survey boat by 20–30 km, and that few bowheads approached within 20 km. Received sound levels at those distances were only 116–135 dB re 1 μPa_{rms}. At times when the airguns were not active, many bowheads moved into the area close to the inactive seismic vessel. Avoidance of the area of seismic operations did not persist beyond 12–24 h after seismic shooting stopped.

Gray Whales.—Malme et al. (1986, 1988) studied the responses of feeding eastern gray whales to pulses from a single 100-in^3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50% of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μPa on an (approximate) rms basis, and that 10% of feeding whales interrupted feeding at received levels of 163 dB. Malme at al. (1986) estimated that an average pressure level of 173 dB occurred at a range of 2.6–2.8 km from an airgun array with a source level of 250 dB re 1 μPa_p in the northern Bering Sea. These findings were generally consistent with the results of experiments conducted on larger numbers of gray whales that were migrating along the California coast. Malme and Miles (1985) concluded that, during migration, changes in swimming pattern occurred for received levels of about 160 dB re 1 μPa and higher, on an approximate rms basis. The 50% probability of avoidance was estimated to occur at a CPA distance of 2.5 km from a 4000-in^3 array operating off central California. This would occur at an average received sound level of ~170 dB re 1 μPa_{rms}. Some slight behavioral changes were noted at received sound levels of 140 to 160 dB re 1 μPa_{rms}.

There was no indication that western gray whales exposed to seismic noise were displaced from their overall feeding grounds near Sakhalin Island during seismic programs in 1997 (Würsig et al. 1999) or in 2001. However, there were indications of subtle behavioral effects and (in 2001) localized avoidance by some individuals (Johnson 2002; Weller et al. 2002, 2006a,b).

- re 1 μPa_{rms}Gray whales in British Columbia exposed to seismic survey sound levels up to about 170 dB re 1 μPa did not appear to be disturbed (Bain and Williams 2006). The whales were moving away from the airguns but toward higher exposure levels (into deeper water where sound propagated more efficiently, so it was unclear whether their movements reflected a response to sounds associated with seismic surveys (Bain and Williams 2006).

Rorquals.—Blue, sei, fin, and minke whales have occasionally been reported in areas ensonified by airgun pulses. Sightings by observers on seismic vessels off the U.K. from 1997 to 2000 suggest that, at times of good sightability, numbers of rorquals seen are similar when airguns are shooting and not shooting (Stone 2003). Although individual species did not show any significant displacement in relation to seismic activity, all baleen whales combined were found to remain significantly further from the airguns during shooting compared with periods without shooting (Stone 2003; Stone and Tasker 2006). Baleen whale groups sighted from the ship were at a median distance of ~1.6 km from the array during shooting and 1.0 km during periods without shooting (Stone 2003). Baleen whales, as a group, made more frequent alterations of course (usually away from the vessel) during shooting compared with periods of no shooting. In addition, fin/sei whales were less likely to remain submerged during periods of seismic shooting (Stone 2003).

In a study off Nova Scotia, Moulton and Miller (in press) found little or no difference in sighting rates and initial sighting distances of balaenopterid whales when airguns were operating *vs*. silent, but there were indications that they were more likely to be moving away when seen during airgun operations.

Discussion and Conclusions.—Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to airgun pulses at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances. However, studies done since the late 1990s of humpback and especially migrating bowhead whales, show that reactions, including avoidance, sometimes extend to greater distances than documented earlier. Avoidance distances often exceed the distances at which boat-based observers can see whales, so observations from the source vessel are biased. Studies indicate monitoring over broader areas may be needed to determine the range of potential effects of some larger seismic surveys (Richardson et al. 1999; Bain and Williams 2006; Moore and Angliss 2006).

Some baleen whales show considerable tolerance of seismic pulses. However, when the pulses are strong enough, avoidance or other behavioral changes become evident. Because the responses become less obvious with diminishing received sound level, it has been difficult to determine the maximum distance (or minimum received sound level) at which reactions to seismic become evident and, hence, how many whales are affected.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 μPa_{rms} range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed; however, lower levels have also been shown to elicit avoidance responses by some individuals. In many areas, seismic pulses diminish to these levels at distances ranging from 4.5 to 14.5 km from the source. A substantial proportion of the baleen whales within this distance range may show avoidance or other strong disturbance reactions to the seismic array. In the case of migrating bowhead whales, avoidance extends to larger distances and lower received sound levels.

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. Gray whales continued to migrate annually along the west coast of North America despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in Malme et al. 1984; Richardson et al. 1995; Angliss and Outlaw 2005). Bowhead whales continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years. Bowheads were often seen in summering areas where seismic exploration occurred in preceding summers (Richardson et al. 1987). They also have been observed over periods of days or weeks in areas repeatedly ensonified by seismic pulses. However, it is not known whether the same individual bowheads were involved in these repeated observations (within and between years) in strongly ensonified areas.

Toothed Whales

Little systematic information is available about reactions of toothed whales to noise pulses. Few studies similar to the more extensive baleen whale/seismic pulse work summarized above have been reported for toothed whales, and none similar in size and scope to the studies of humpback, bowhead, and gray whales mentioned above. However, a systematic study on sperm whales is underway (Jochens and Biggs 2003; Tyack et al. 2003; Miller et al. 2006), and there is an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone 2003; Smultea et al. 2004; Bain and Williams 2006; Holst et al. 2006; Stone and Tasker 2006; Moulton and Miller in press).

Delphinids (Dolphins) and Monodontids (Beluga).—Seismic operators sometimes see dolphins and other small toothed whales near operating airgun arrays, but in general there seems to be a tendency for most delphinids to show some limited avoidance of operating seismic vessels (e.g., Stone 2003; Holst et al. 2006; Stone and Tasker 2006; Moulton and Miller in press). Studies that have reported cases of small toothed whales close to the operating airguns include Duncan (1985), Arnold (1996), Stone (2003), and Holst et al. (2006). When a 3959-in^3, 18-airgun array was firing off California, toothed whales behaved in a manner similar to that observed when the airguns were silent (Arnold 1996). Most, but not all, dolphins often seemed to be attracted to the seismic vessel and floats, and some rode the bow wave of the seismic vessel regardless of whether the airguns were firing.

Goold (1996a,b,c) studied the effects on common dolphins of 2D seismic surveys in the Irish Sea. Passive acoustic surveys were conducted from the "guard ship" that towed a hydrophone 180-m aft. The results indicated that there was a local displacement of dolphins around the seismic operation. However, observations indicated that the animals were tolerant of the sounds at distances outside a 1-km radius from the airguns (Goold 1996a). Initial reports of larger-scale displacement were later shown to represent a normal autumn migration of dolphins through the area, and were not attributable to seismic surveys (Goold 1996a,b,c).

A monitoring study of summering belugas exposed to a seismic survey found that sighting rates, as determined by aerial surveys, were significantly lower at distances of 10–20 km compared with 20–30 km from the operating airgun array (Miller et al. 2005b). The low number of sightings from the vessel seemed to confirm a large avoidance response to the 2250-in^3 airgun array. The apparent displacement effect on belugas extended farther than has been shown for other small odontocetes exposed to airgun pulses.

Observers stationed on seismic vessels operating off the United Kingdom from 1997 to 2000 have provided data on the occurrence and behavior of various toothed whales exposed to seismic pulses (Stone 2003; Gordon et al. 2004; Stone and Tasker 2006). Dolphins of various species often showed more evidence of avoidance of operating airgun arrays than has been reported previously for small odontocetes. Sighting rates of white-sided dolphins, white-beaked dolphins, *Lagenorhynchus* spp., and all small odontocetes combined were significantly lower during periods of shooting. Except for pilot whales, all of the small odontocete species tested, including killer whales, were found to be significantly farther from large airgun arrays during periods of shooting compared with periods of no shooting. Pilot whales showed few reactions to seismic activity. The displacement of the median distance from the array was ~0.5 km or more for most species groups. Killer whales appeared to be more tolerant of seismic shooting in deeper waters.

For all small odontocete species, except pilot whales, that were sighted during seismic surveys off the U.K. in 1997–2000, the numbers of positive interactions with the survey vessel (e.g., bow-riding, approaching the vessel) were significantly fewer during periods of shooting. All small odontocetes combined showed more negative interactions (e.g., avoidance) during periods of shooting. Small odontocetes, including white-beaked dolphins, *Lagenorhynchus* spp., and other dolphin species, showed a tendency to swim faster during periods with seismic shooting; *Lagenorhynchus* spp. were also observed to swim more slowly during periods without shooting. Significantly fewer white-beaked dolphins, *Lagenorhynchus* spp., and pilot whales traveled towards the vessel and/or more were traveling away from the vessel during periods of shooting.

During two NSF-funded L-DEO seismic surveys using a large, 20-airgun array (~7000-in^3), sighting rates of delphinids were lower and initial sighting distances were farther away from the vessel during seismic than non-seismic periods (Smultea et al. 2004; Holst et al. 2005a, 2006). Monitoring results during a seismic survey in the Southeast Caribbean showed that the mean CPA of delphinids during seismic operations was 991 m compared with 172 m when the airguns were not operational (Smultea et al. 2004). Surprisingly, nearly all acoustic encounters (including delphinids and sperm whales) were made when the airguns were operating (Smultea et al. 2004). Although the number of sightings during monitoring of a seismic survey off the Yucatán Peninsula, Mexico, was small (n = 19), the results showed that the mean CPA of delphinids during seismic operations was 472 m compared with 178 m when the airguns were not operational (Holst et al. 2005b). The acoustic detection rates were nearly 5 times higher during non-seismic compared with seismic operations (Holst et al. 2005b).

Reactions of toothed whales to a single airgun or other small airgun source are not well documented, but do not seem to be very substantial (e.g., Stone 2003). Results from three NSF-funded L-DEO seismic surveys using small arrays (up to 3 GI guns and 315 in^3) were inconclusive. During a survey in the Eastern Tropical Pacific (Holst et al. 2005a) and in the Northwest Atlantic (Haley and Koski 2004), detection rates were slightly lower during seismic compared to non-seismic periods. However, mean CPAs were closer during seismic operations during one cruise (Holst et al. 2005a), and greater during the other cruise (Haley and Koski 2004). Interpretation of the data was confounded by the fact that survey effort and/or number of sightings during non-seismic periods during both surveys was small. Results from another small-array survey in southeast Alaska were even more variable (MacLean and Koski 2005).

Captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds similar in duration to those typically used in seismic surveys (Finneran et al. 2000, 2002, 2005). Finneran et al. (2002) exposed a captive bottlenose dolphin and beluga to single impulses from a water gun (80 in^3). As compared with airgun pulses, water gun impulses were expected to contain proportionally more energy at higher frequencies because there is no significant gas-filled bubble, and thus little low-frequency bubble-pulse energy (Hutchinson and Detrick 1984). The captive animals sometimes vocalized after exposure and exhibited reluctance to station at the test site where subsequent exposure to impulses would be implemented (Finneran et al. 2002). Similar behaviors were exhibited by captive bottlenose dolphins and a beluga exposed to single underwater pulses designed to simulate those produced by distant underwater explosions (Finneran et al. 2000). It is uncertain what relevance these observed behaviors in captive, trained marine mammals exposed to single sound pulses may have to free-ranging animals exposed to multiple pulses. In any event, the animals tolerated rather high received levels of sound before exhibiting the aversive behaviors mentioned above; for pooled data at 3, 10, and 20 kHz sound exposure levels during sessions with 25, 50, and 75% altered behavior were 180, 190, and 199 dB re 1 $\mu Pa^2 \cdot s$, respectively (Finneran and Schlundt 2004).

Observations of odontocete responses (or lack of responses) to noise pulses from underwater explosions (as opposed to airgun pulses) may be relevant as an indicator of odontocete responses to very strong noise pulses. During the 1950s, small explosive charges were dropped into an Alaskan river in attempts to scare belugas away from salmon. Success was limited (Fish and Vania 1971; Frost et al. 1984). Small explosive charges were “not always effective” in moving bottlenose dolphins away from sites in the Gulf of Mexico where larger demolition blasts were about to occur (Klima et al. 1988). Odontocetes may be attracted to fish killed by explosions, and thus attracted rather than repelled by “scare” charges. Captive false killer whales showed no obvious reaction to single noise pulses from small (10 g) charges; the received level was ~185 dB re 1 μPa (Akamatsu et al. 1993). Jefferson and Curry (1994) reviewed several additional studies that found limited or no effects of noise pulses from small explosive charges on killer whales and other odontocetes. Aside from the potential for temporary threshold shift (TTS), the tolerance to these charges may indicate a lack of effect or the failure to move away may simply indicate a stronger desire to eat, regardless of circumstances.

Phocinids (Porpoises).—Porpoises, like delphinids, show variable reactions to seismic operations. Calambokidis and Osmek (1998) noted that Dall's porpoises observed during a survey with a 6000-in^3, 12–16-airgun array tended to head away from the boat. Similarly, during seismic surveys off the U.K. in 1997–2000, significantly fewer harbor porpoises traveled towards the vessel and/or more were traveling away from the vessel during periods of shooting (Stone 2003). During both an experimental and a commercial seismic survey, Gordon et al. (1998 *in* Gordon et al. 2004) noted that acoustic contact rates for harbor porpoises were similar during seismic and non-seismic periods.

The limited available data suggest that harbor porpoises show stronger avoidance of seismic operations than Dall's porpoises (Stone 2003; Bain and Williams 2006). In Washington State waters, the harbor porpoise, a high-frequency specialist, appeared to be the species affected by the lowest level of sound (<145 dB re 1 μPa_{rms} at a distance >70 km) (Bain and Williams 2006). In contrast, Dall's porpoises seem relatively tolerant of airgun operations (MacLean and Koski 2005; Bain and Williams 2006). This apparent difference in responsiveness of the two species is consistent with their relative responsiveness to boat traffic in general (Richardson et al. 1995).

Beaked Whales.—There are no specific data on the behavioral reactions of beaked whales to seismic surveys. Most beaked whales tend to avoid approaching vessels of other types (e.g., Würsig et al. 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya 1986). It is likely that these beaked whales would normally show strong avoidance of an approaching seismic vessel, but this has not been documented explicitly. Northern bottlenose whales sometimes are quite tolerant of slow-moving vessels (Reeves et al. 1993; Hooker et al. 2001). However, those vessels were not emitting airgun pulses.

There are increasing indications that some beaked whales tend to strand when naval exercises, including sonar operation, are ongoing nearby (e.g., Simmonds and Lopez-Jurado 1991; Frantzis 1998; NOAA and USN 2001; Jepson et al. 2003; Barlow and Gisiner 2006; see also the "Strandings and Mortality" subsection, later). These strandings are apparently at least in part a disturbance response, although auditory or other injuries may also be a factor. Whether beaked whales would ever react similarly to seismic surveys is unknown. Seismic survey sounds are quite different from those of the sonars in operation during the above-cited incidents. There was a stranding of Cuvier's beaked whales in the Gulf of California (Mexico) in September 2002 when the R/V *Maurice Ewing* was conducting a seismic survey in the general area (e.g., Malakoff 2002). Another stranding of Cuvier's beaked whales in the Galapagos occurred during a seismic survey in April 2000; however "There is no obvious mechanism that bridges the distance between this source and the stranding site" (Gentry [ed.] 2002). The evidence with respect to seismic surveys and beaked whale strandings is inconclusive, and NMFS has not established a link between the Gulf of California stranding and the seismic activities (Hogarth 2002).

Sperm Whales.—All three species of sperm whales have been reported to show avoidance reactions to standard vessels not emitting airgun sounds (e.g., Richardson et al. 1995; Würsig et al. 1998; McAlpine 2002; Baird 2005). Thus, it is expected that they would tend to avoid an operating seismic survey vessel. There are some limited observations suggesting that sperm whales in the Southern Ocean ceased calling during some (but not all) times when exposed to weak noise pulses from extremely distant (>300 km) seismic exploration (Bowles et al. 1994). This "quieting" was suspected to represent a disturbance effect, in part because sperm whales exposed to pulsed man-made sounds at higher frequencies often cease calling (Watkins and Schevill 1975; Watkins et al. 1985). Also, there are several accounts of possible avoidance or other adverse effects of seismic vessels on sperm whales in the Gulf of Mexico (Mate et al. 1994; Johnson et al. 2004; Miller et al. 2006).

On the other hand, recent (and more extensive) data from vessel-based monitoring programs in U.K. waters suggest that sperm whales in that area show little evidence of avoidance or behavioral disruption in the presence of operating seismic vessels (Stone 2003; Stone and Tasker 2006). These types of observations are difficult to interpret because the observers are stationed on or near the seismic vessel, and may underestimate reactions by some of the more responsive species or individuals, which may be beyond visual range. However, the U.K. results do seem to show considerable tolerance of seismic surveys by at least some sperm whales. Also, a recent study off northern Norway indicated that sperm whales continued to call when exposed to pulses from a distant seismic vessel. Received levels of the seismic pulses were up to 146 dB re 1 μPa_{p-p} (Madsen et al. 2002). Similarly, a study conducted off Nova Scotia that analyzed recordings of sperm whale vocalizations at various distances from an active seismic program did not detect any obvious changes in the distribution or behavior of sperm whales (McCall Howard 1999).

An experimental study of sperm whale reactions to seismic surveys in the Gulf of Mexico is presently underway (Caldwell 2002; Jochens and Biggs 2003), along with a study of the movements of sperm whales with satellite-linked tags in relation to seismic surveys (Mate 2003). During two controlled exposure experiments where sperm whales were exposed to seismic pulses at received levels 143–148 dB re 1 μPa, there was no indication of avoidance of the vessel or changes in feeding efficiency (Jochens and Biggs 2003). The received sounds were measured on an “rms over octave band with most energy” basis (P. Tyack, pers. comm.); the broadband rms value would be somewhat higher. Neither gross diving behavior nor direction of movement changed for any of eight tagged sperm whales exposed to seismic airgun sounds at the onset of gradual ramp-up at ranges of 7 to 13 km or during full-power exposures ranging from 1.5 to 12.8 km (Jochens et al. 2006). However, some changes in foraging behavior were observed that suggested avoidance of deep dives near operating airguns. Based on a small sample size, foraging behavior was disrupted by airguns at exposure levels ranging from <130 to 162 dB re 1 μPa_{p-p} at distances of ~1–12 km from the sound source.

Conclusions.—Dolphins and porpoises are often seen by observers on active seismic vessels, occasionally at close distances (e.g., bow riding). However, some studies, especially near the U.K., show localized avoidance. Belugas summering in the Beaufort Sea tended to avoid waters out to 10–20 km from an operating seismic vessel. In contrast, recent studies show little evidence of reactions by sperm whales to airgun pulses, contrary to earlier indications.

There are no specific data on responses of beaked whales to seismic surveys, but it is likely that most if not all species show strong avoidance. There is increasing evidence that some beaked whales may strand after exposure to strong noise from sonars. Whether they ever do so in response to seismic survey noise is unknown.

Pinnipeds

Few studies of the reactions of pinnipeds to noise from open-water seismic exploration have been published (for review, see Richardson et al. 1995). However, pinnipeds have been observed during a number of seismic monitoring studies. Monitoring in the Beaufort Sea during 1996–2002 provided a substantial amount of information on avoidance responses (or lack thereof) and associated behavior. Pinnipeds exposed to seismic surveys have also been observed during seismic surveys along the U.S. west coast. Some limited data are available on physiological responses of pinnipeds exposed to seismic sound, as studied with the aid of radio telemetry. Also, there are data on the reactions of pinnipeds to various other related types of impulsive sounds.

Early observations provided considerable evidence that pinnipeds are often quite tolerant of strong pulsed sounds. During seismic exploration off Nova Scotia, grey seals exposed to noise from airguns and linear explosive charges reportedly did not react strongly (J. Parsons *in* Greene et al. 1985). An airgun caused an initial startle reaction among South African fur seals but was ineffective in scaring them away from fishing gear (Anonymous 1975). Pinnipeds in both water and air sometimes tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding or reproduction (Mate and Harvey 1987; Reeves et al. 1996). Thus, pinnipeds are expected to be rather tolerant of, or habituate to, repeated underwater sounds from distant seismic sources, at least when the animals are strongly attracted to the area.

In the U.K., a radio-telemetry study has demonstrated short-term changes in the behavior of harbor (=common) seals and grey seals exposed to airgun pulses (Thompson et al. 1998). In this study, harbor seals were exposed to seismic pulses from a 90-in^3 array (three 30-in^3 airguns), and behavioral responses differed among individuals. One harbor seal avoided the array at distances up to 2.5 km from the source and only resumed foraging dives after seismic stopped. Another harbor seal exposed to the same small airgun array showed no detectable behavioral response, even when the array was within 500 m. All grey seals exposed to a single 10-in^3 airgun showed an avoidance reaction: they moved away from the source, increased swim speed and/or dive duration, and switched from foraging dives to predominantly transit dives. These effects appeared to be short-term as all grey seals either remained in, or returned at least once to, the foraging area where they had been exposed to seismic pulses. These results suggest that there are interspecific as well as individual differences in seal responses to seismic sounds.

Off California, visual observations from a seismic vessel showed that California sea lions “typically ignored the vessel and array. When [they] displayed behavior modifications, they often appeared to be reacting visually to the sight of the towed array. At times, California sea lions were attracted to the array, even when it was on. At other times, these animals would appear to be actively avoiding the vessel and array” (Arnold 1996). In Puget Sound, sighting distances for harbor seals and California sea lions tended to be larger when airguns were operating; both species tended to orient away whether or not the airguns were firing (Calambokidis and Osmek 1998).

Monitoring work in the Alaskan Beaufort Sea during 1996–2001 provided considerable information regarding the behavior of seals exposed to seismic pulses (Harris et al. 2001; Moulton and Lawson 2002). Those seismic projects usually involved arrays of 6–16 airguns with total volumes 560–1500 in^3. The combined results suggest that some seals avoid the immediate area around seismic vessels. In most survey years, ringed seal sightings tended to be farther away from the seismic vessel when the airguns were operating then when they were not (Moulton and Lawson 2002). However, these avoidance movements were relatively small, on the order of 100 m to (at most) a few hundreds of meters, and many seals remained within 100–200 m of the trackline as the operating airgun array passed by. Seal sighting rates at the water surface were lower during airgun array operations than during no-airgun periods in each survey year except 1997.

The operation of the airgun array had minor and variable effects on the behavior of seals visible at the surface within a few hundred meters of the array (Moulton and Lawson 2002). The behavioral data indicated that some seals were more likely to swim away from the source vessel during periods of airgun operations and more likely to swim towards or parallel to the vessel during non-seismic periods. No consistent relationship was observed between exposure to airgun noise and proportions of seals engaged in other recognizable behaviors, e.g., "looked" and "dove". Such a relationship might have occurred if seals seek to reduce exposure to strong seismic pulses, given the reduced airgun noise levels close to the surface where "looking" occurs (Moulton and Lawson 2002).

Monitoring results from the Canadian Beaufort Sea during 2001–2002 were more variable (Miller et al. 2005b). During 2001, sighting rates of seals (mostly ringed seals) were similar during all seismic states, including periods without airgun operations. However, seals were seen closer to the vessel during non-seismic than seismic periods. In contrast, during 2002, sighting rates of seals were higher during non-seismic periods than seismic operations, and seals were seen farther from the vessel during non-seismic compared to seismic activity (a marginally significant result). The combined data for both years showed that sighting rates were higher during non-seismic periods compared to seismic periods, and that sighting distances were similar during both seismic states. Miller et al. (2005b) concluded that seals showed very limited avoidance to the operating airgun array.

In summary, visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. These studies show that pinnipeds frequently do not avoid the area within a few hundred meters of an operating airgun array. However, initial telemetry work suggests that avoidance and other behavioral reactions may be stronger than evident to date from visual studies.

Fissipeds.—Behavior of sea otters along the California coast was monitored by Riedman (1983, 1984) while they were exposed to a single 100-in^3 airgun and a 4089-in^3 array. No disturbance reactions were evident when the airgun array was as close as 0.9 km. Otters also did not respond noticeably to the single airgun. The results suggest that sea otters may be less responsive to marine seismic pulses than other marine mammals. Also, sea otters spend a great deal of time at the surface feeding and grooming. While at the surface, the potential noise exposure of sea otters would be much reduced by the pressure release effect at the surface.

(f) Hearing Impairment and Other Physical Effects

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds, but there has been no specific documentation of this in the case of exposure to sounds from seismic surveys. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnipeds should not be exposed to impulsive sounds exceeding 180 and 190 dB re 1 μPa_{rms}, respectively (NMFS 2000). Those criteria have been used in establishing the safety (=shut-down) radii planned for numerous seismic surveys. However, those criteria were established before there was any information about the minimum received levels of sounds necessary to cause auditory impairment in marine mammals. As discussed below,

- the 180 dB criterion for cetaceans is probably quite precautionary, i.e., lower than necessary to avoid temporary auditory impairment let alone permanent auditory injury, at least for delphinids.
- temporary threshold shift (TTS) is not injury and does not constitute "Level A harassment" in MMPA terminology.
- the minimum sound level necessary to cause permanent hearing impairment ("Level A harassment") is higher, by a variable and generally unknown amount, than the level that induces barely-detectable TTS.

- the level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage.

NMFS is presently developing new noise exposure criteria for marine mammals that account for the now-available scientific data on TTS, the expected offset between TTS and permanent threshold shift (PTS), differences in the acoustic frequencies to which different marine mammal groups are sensitive, and other relevant factors. For preliminary information about this process, and about the structure of the new criteria in marine and terrestrial mammals see Wieting (2004), Miller et al. (2005a), and NMFS (2005).

Several aspects of the monitoring and mitigation measures that are now often implemented during seismic survey projects are designed to detect marine mammals occurring near the airgun array, and to avoid exposing them to sound pulses that might, at least in theory, cause hearing impairment. In addition, many cetaceans show some avoidance of the area with ongoing seismic operations (see above). In these cases, the avoidance responses of the animals themselves will reduce or (most likely) avoid the possibility of hearing impairment.

Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that might (in theory) occur include stress, neurological effects, bubble formation, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strong pulsed sounds.

Temporary Threshold Shift (TTS)

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a sound must be stronger in order to be heard. TTS can last from minutes or hours to (in cases of strong TTS) days. However, it is a temporary phenomenon, and (especially when mild) is not considered to represent physical damage or "injury". Rather, the onset of TTS is an indicator that, if the animals is exposed to higher levels of that sound, physical damage is ultimately a possibility.

The magnitude of TTS depends on the level and duration of noise exposure, among other considerations (Richardson et al. 1995). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. Only a few data have been obtained on sound levels and durations necessary to elicit mild TTS in marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound.

Baleen Whales.—There are no data, direct or indirect, on levels or properties of sound that are required to induce TTS in any baleen whale. The frequencies to which mysticetes are most sensitive are lower than those to which odontocetes are most sensitive, and natural background noise levels at those low frequencies tend to be higher. 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 mysticetes.

In practice during seismic surveys, no cases of TTS are expected given the strong likelihood that baleen whales would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS. (See above for evidence concerning avoidance responses by baleen whales.) This assumes that the ramp up (soft start) procedure is used when commencing airgun operations, to give whales near the vessel the opportunity to move away before they are exposed to sound levels that might be strong enough to elicit TTS. As discussed above, single-airgun experiments with bowhead, gray, and humpback whales show that those species do tend to move away when a single airgun starts firing nearby, which simulates the onset of a ramp up.

Toothed Whales.—Ridgway et al. (1997) and Schlundt et al. (2000) exposed bottlenose dolphins and beluga whales to single 1-s pulses of underwater sound. TTS generally became evident at received levels of 192–201 dB re 1 μPa_{rms} at 3, 10, 20, and 75 kHz, with no strong relationship between frequency and onset of TTS across this range of frequencies. At 75 kHz, one dolphin exhibited TTS at 182 dB re 1 μPa_{rms}, and at 0.4 kHz, no dolphin or beluga exhibited TTS after exposure to levels up to 193 dB re 1 μPa_{rms} (Schlundt et al. 2000). There was no evidence of permanent hearing loss; all hearing thresholds returned to baseline values at the end of the study.

Finneran et al. (2000) exposed bottlenose dolphins and a beluga whale to single underwater pulses designed to generate sounds with pressure waveforms similar to those produced by distant underwater explosions. Pulses were 5.1–13 ms in duration, and the measured frequency spectra showed a lack of energy below 1 kHz. Exposure to those impulses at a peak received SPL (sound pressure level) of up to 221 dB re 1 μPa did not produce temporary threshold shift, although disruption of the animals' trained behaviors occurred.

A similar study was conducted by Finneran et al. (2002) using an 80-in^3 water gun, which generated impulses with higher peak pressures and total energy fluxes than used in the aforementioned study. Water gun impulses were expected to contain proportionally more energy at higher frequencies than airgun pulses (Hutchinson and Detrick 1984). "Masked TTS" (MTTS refers to the fact that measurements were obtained under conditions with substantial, but controlled, background noise) was observed in a beluga after exposure to a single impulse with a SPL of 226 dB re 1 μPa_{p-p}, 160 kPa re 1 μPa_p, and total energy flux of 186 dB re 1 μPa^2•s. Thresholds returned to within 2 dB of pre-exposure value ~4 min after exposure. No MTTS was observed in a bottlenose dolphin exposed to one pulse with pressure of 228 dB re 1 μPa_{p-p}, equivalent to 207 kPa re 1 μPa_p and total energy flux of 188 dB re 1 μPa^2•s (Finneran et al. 2002). In this study, TTS was defined as occurring when there was a 6 dB or larger increase in post-exposure thresholds. Pulse duration at the highest exposure levels, where MTTS became evident in the beluga, was typically 10–13 ms.

The data quoted above all concern exposure of small odontocetes to single pulses of duration 1 s or shorter, generally at frequencies higher than the predominant frequencies in airgun pulses. With single short pulses, the TTS threshold appears to be (to a first approximation) a function of the energy content of the pulse (Finneran et al. 2002). The degree to which this generalization holds for other types of signals is unclear (Nachtigall et al. 2003).

Finneran et al. (2005) examined the effects of tone duration on TTS in bottlenose dolphins. Bottlenose dolphins were exposed to 3 kHz tones for periods of 1, 2, 4, or 8 s, with hearing tested at 4.5 kHz. For 1-s exposures, TTS occurred with SELs of 197 dB, and for exposures >1 s, SEL ≥195 dB resulted in TTS. (SEL is equivalent to energy flux, in dB re 1 μPa^2·s.) At SEL of 195 dB, the mean TTS (4 min after exposure) was 2.8 dB. Finneran et al. (2005) suggested that an SEL of 195 dB is the likely threshold for the onset of TTS in dolphins and white whales exposed to mid-frequency tones of durations 1-8 s, i.e., TTS onset occurs at a near-constant SEL, independent of exposure duration. That implies that a doubling of exposure time results in a 3 dB lower TTS threshold.

Mooney et al. (2005) exposed a bottlenose dolphin to octave-band noise ranging from 4 to 8 kHz at SPLs of 160–172 dB re 1 μPa for periods of 1.8–30 min. Recovery time depended on the shift and frequency, but full recovery always occurred within 40 min (Mooney et al. 2005). They reported that to induce TTS in a bottlenose dolphin, there is an inverse relationship of exposure time and SPL; as a first approximation, as exposure time was halved, an increase in noise SPL of 3 dB was required to induce the same amount of TTS.

Additional data are needed in order to determine the received sound levels at which small odontocetes would start to incur TTS upon exposure to repeated, low-frequency pulses of airgun sound with variable received levels. Given the results of the aforementioned studies and a seismic pulse duration (as received at close range) of ~20 ms, the received level of a single seismic pulse might need to be on the order of 210 dB re 1 μPa_{rms} (~221–226 dB re 1 $\mu Pa \cdot m_{p-p}$) in order to produce brief, mild TTS. Exposure to several seismic pulses at received levels near 200–205 dB re 1 μPa_{rms} might result in slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Seismic pulses with received levels of 200–205 dB or more are usually restricted to a radius of no more than 100 m around a seismic vessel.

To better characterize this radius, it would be necessary to determine the total energy that a mammal would receive as an airgun array approached, passed at various CPA distances, and moved away. At the present state of knowledge, it would also be necessary to assume that the effect is directly related to total energy even though that energy is received in multiple pulses separated by gaps. The lack of data on the exposure levels necessary to cause TTS in toothed whales when the signal is a series of pulsed sounds, separated by silent periods, is a data gap.

Pinnipeds.—TTS thresholds for pinnipeds exposed to brief pulses (either single or multiple) of underwater sound have not been measured. Two California sea lions did not incur TTS when exposed to single brief pulses with received levels of ~178 and 183 dB re 1 μPa_{rms} and total energy fluxes of 161 and 163 dB re 1 $\mu Pa^2 \cdot s$ (Finneran et al. 2003). However, 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. For sounds of relatively long duration (20–22 min), Kastak et al. (1999) reported that they could induce mild TTS in California sea lions, harbor seals, and northern elephant seals by exposing them to underwater octave-band noise at frequencies in the 100–2000 Hz range. Mild TTS became evident when the received levels were 60–75 dB above the respective hearing thresholds, i.e., at received levels of about 135–150 dB. Three of the five subjects showed shifts of ~4.6–4.9 dB and all recovered to baseline hearing sensitivity within 24 hours of exposure.

Schusterman et al. (2000) showed that TTS thresholds of these pinnipeds were somewhat lower when the animals were exposed to the sound for 40 min than for 20–22 min, confirming that there is a duration effect in pinnipeds. Similarly, Kastak et al. (2005) reported that threshold shift magnitude increased with increasing SEL in a California sea lion and harbor seal. They noted that doubling the exposure duration from 25 to 50 min i.e., +3 dB change in SEL, had a greater effect on TTS than an increase of 15 dB (95 *vs*. 80 dB) in exposure level. Mean threshold shifts ranged from 2.9 to 12.2 dB, with full recovery within 24 h (Kastak et al. 2005). Kastak et al. (2005) suggested that sound exposure levels resulting in TTS onset in pinnipeds may range from 183 to 206 dB re 1 $\mu Pa^2 \cdot s$, depending on the absolute hearing sensitivity.

There are some indications that, for corresponding durations of sound, some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes (Kastak et al. 1999, 2005; Ketten et al. 2001; *cf*. Au et al. 2000). However, TTS onset in the California sea lion and northern elephant seal may occur at a similar sound exposure level as in odontocetes (Kastak et al. 2005).

Likelihood of Incurring TTS.—A marine mammal within a radius of ≤100 m around a typical array of operating airguns might be exposed to a few seismic pulses with levels of ≥205 dB, and possibly more pulses if the mammal moved with the seismic vessel.

As shown above, most cetaceans show some degree of avoidance of seismic vessels operating an airgun array. It is unlikely that these cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the vessel and the marine mammal. TTS would be more likely in any odontocetes that bow- or wake-ride or otherwise linger near the airguns. However, while bow- or wake-riding, odontocetes would be at or above the surface and thus not exposed to strong sound pulses given the pressure-release effect at the surface. But if bow-or wake-riding animals were to dive intermittently near airguns, they would be exposed to strong sound pulses, possibly repeatedly. If some cetaceans did incur mild or moderate TTS through exposure to airgun sounds in this manner, this would very likely be a temporary and reversible phenomenon.

Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are not as strong or consistent as those of cetaceans (see above). Pinnipeds occasionally seem to be attracted to operating seismic vessels. As previously noted, there are no specific data on TTS thresholds of pinnipeds exposed to single or multiple low-frequency pulses. It is not known whether pinnipeds near operating seismic vessels, and especially those individuals that linger nearby, would incur significant TTS.

NMFS (1995, 2000) concluded that cetaceans should not be exposed to pulsed underwater noise at received levels exceeding 180 dB re 1 μPa_{rms}. The corresponding limit for pinnipeds has been set at 190 dB, although the HESS Team (1999) recommended 180-dB limit for pinnipeds in California. The 180 and 190 dB re 1 μPa_{rms} levels 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 any TTS measurements for marine mammals were available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As discussed above, TTS data that have subsequently become available imply that, at least for dolphins, TTS is unlikely to occur unless the dolphins are exposed to airgun pulses stronger than 180 dB re 1 μPa_{rms}. Furthermore, it should be noted that mild TTS is not injury, and in fact is a natural phenomenon experienced by marine and terrestrial mammals (including humans).

It has been shown that most large whales tend to avoid ships and associated seismic operations. In addition, ramping up airgun arrays, which is standard operational protocol for many seismic operators, should allow cetaceans to move away from the seismic source and to avoid being exposed to the full acoustic output of the airgun array. [Three species of baleen whales that have been exposed to pulses from single airguns showed avoidance (Malme et al. 1984–1988; Richardson et al. 1986; McCauley et al. 1998, 2000a,b). This strongly suggests that baleen whales will begin to move away during the initial stages of a ramp up, when a single airgun is fired.] Thus, whales will likely not be exposed to high levels of airgun sounds. Likewise, any whales close to the trackline could move away before the sounds from the approaching seismic vessel become sufficiently strong for there to be any potential for TTS or other hearing impairment. Therefore, there is little potential for whales to be close enough to an airgun array to experience TTS. Furthermore, in the event that a few individual cetaceans did incur TTS through exposure to airgun sounds, this is a temporary and reversible phenomenon.

Permanent Threshold Shift (PTS)

When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges. Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times (time required for sound pulse to reach peak pressure from the baseline pressure). Such damage can result in a permanent decrease in functional sensitivity of the hearing system at some or all frequencies.

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS (see Finneran et al. 2002), there has been speculation about the possibility that some individuals occurring very close to airguns might incur TTS (Richardson et al. 1995, p. 372*ff*).

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. The low-to-moderate levels of TTS that have been induced in captive odontocetes and pinnipeds during recent controlled studies of TTS have been confirmed to be temporary, with no measurable residual PTS (Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002; Nachtigall et al. 2003, 2004). However, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter 1985). In terrestrial mammals, the received sound level from a single non-impulsive sound exposure must be far above the TTS threshold for any risk of permanent hearing damage (Kryter 1994; Richardson et al. 1995). However, there is special concern about strong sounds whose pulses have very rapid rise times. In terrestrial mammals, there are situations when pulses with rapid rise times can result in PTS even though their levels are only a few dB higher than the level causing slight TTS. The rise time of airgun pulses is fast, but not nearly as fast as that of explosions, which are the main concern in this regard.

Some factors that contribute to onset of PTS, at least in terrestrial mammals, are as follows:

- exposure to single very intense sound,
- repetitive exposure to intense sounds that individually cause TTS but not PTS, and
- recurrent ear infections or (in captive animals) exposure to certain drugs.

Cavanagh (2000) has reviewed the thresholds used to define TTS and PTS. Based on this review and SACLANT (1998), it is reasonable to assume that PTS might occur at a received sound level 20 dB or more above that inducing mild TTS. However, for PTS to occur at a received level only 20 dB above the TTS threshold, the animal probably would have to be exposed to a strong sound for an extended period, or to a strong sound with rather rapid rise time.

Sound impulse duration, peak amplitude, rise time, and number of pulses are the main factors thought to determine the onset and extent of PTS. Based on existing data, Ketten (1994) has noted that the criteria for differentiating the sound pressure levels that result in PTS (or TTS) are location and species-specific. PTS effects may also be influenced strongly by the health of the receiver's ear.

Given that marine mammals are unlikely to be exposed to received levels of seismic pulses that could cause TTS, it is highly unlikely that they would sustain permanent hearing impairment. If we assume that the TTS threshold for exposure to a series of seismic pulses may be on the order of 220 dB re 1 μPa_{p-p} in odontocetes, then the PTS threshold might be as high as 240 dB re 1 μPa_{p-p} or 10 bar-m. Such levels are found only in the immediate vicinity of the largest airguns (Richardson et al. 1995:137; Caldwell and Dragoset 2000). It is very unlikely that an odontocete would remain within a few meters of a large airgun for sufficiently long to incur PTS. The TTS (and thus PTS) thresholds of baleen whales and/or pinnipeds (e.g. harbor seal) may be lower, and thus may extend to a somewhat greater distance. However, baleen whales generally avoid the immediate area around operating seismic vessels, so it is unlikely that a baleen whale could incur

PTS from exposure to airgun pulses. Pinnipeds, on the other hand, often do not show strong avoidance of operating airguns.

Although it is unlikely that airgun operations during most seismic surveys would cause PTS in marine mammals, caution is warranted given the limited knowledge about noise-induced hearing damage in marine mammals, particularly baleen whales. Commonly-applied monitoring and mitigation measures, including visual and passive acoustic monitoring, course alteration, ramp ups, and power downs or shut downs of the airguns when mammals are seen within the "safety radii", would minimize the already-low probability of exposure of marine mammals to sounds strong enough to induce PTS.

(g) Strandings 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 have slower rise times, and there is no proof that they can cause serious injury, death, or stranding. However, the spatiotemporal association of mass strandings of beaked whales with naval exercises and possibly an L-DEO seismic survey in 2002 has raised the possibility that beaked whales may be especially susceptible to injury and/or behavioral reactions that can lead to stranding when exposed to strong pulsed sounds.

In March 2000, several beaked whales that had been exposed to repeated pulses from high intensity, mid-frequency military sonars stranded and died in the Providence Channels of the Bahamas Islands, and were subsequently found to have incurred cranial and ear damage (NOAA and USN 2001). Based on post-mortem analyses, it was concluded that an acoustic event caused hemorrhages in and near the auditory region of some beaked whales. These hemorrhages occurred before death. They would not necessarily have caused death or permanent hearing damage, but could have compromised hearing and navigational ability (NOAA and USN 2001). The researchers concluded that acoustic exposure caused this damage and triggered stranding, which resulted in overheating, cardiovascular collapse, and physiological shock that ultimately led to the death of the stranded beaked whales. During the event, five naval vessels used their AN/SQS-53C or -56 hull-mounted active sonars for a period of 16 h. The sonars produced narrow (<100 Hz) bandwidth signals at center frequencies of 2.6 and 3.3 kHz (-53C), and 6.8–8.2 kHz (-56). The respective source levels were usually 235 and 223 dB re 1 μPa, but the -53C briefly operated at an unstated but substantially higher source level. The unusual bathymetry and constricted channel where the strandings occurred were conducive to channeling sound. That and the extended operations by multiple sonars apparently prevented escape of the animals to the open sea. In addition to the strandings, there are reports that beaked whales were no longer present in the Providence Channel region after the event, suggesting that other beaked whales either abandoned the area or perhaps died at sea (Balcomb and Claridge 2001).

Other strandings of beaked whales associated with operation of military sonars have also been reported (e.g., Simmonds and Lopez-Jurado 1991; Frantzis 1998; Hohn et al. 2006; Southall et al. 2006), although in most cases, the connection between the stranding and naval sonar activity was not conclusively established (Cox et al. 2006). In these cases, it was not determined whether there were noise-induced injuries to the ears or other organs. Another stranding of beaked whales (15 whales) happened on 24–25 September 2002 in the Canary Islands, where naval maneuvers were taking place, although the specifics of the naval activities are not readily available (D'Spain et al. 2006), and the sound levels received by the cetaceans prior to stranding are unknown.

Based on the strandings in the Canary Islands, Jepson et al. (2003) proposed that cetaceans might be subject to decompression injury in some situations. Fernández et al. (2005a) showed that those beaked whales did indeed have gas bubble-associated lesions and fat embolisms.

Fernández et al. (2005b) also found evidence of fat embolism in three beaked whales that stranded 100 km north of the Canaries in 2004 during naval exercises. Examinations of several other stranded species have also revealed evidence of gas and fat embolisms (e.g., Arbelo et al. 2005; Jepson et al. 2005a; Méndez et al 2005; Dalton 2006). These effects were suspected to be induced by exposure to sonar sounds, but the mechanism of injury was not auditory. Most of the afflicted species were deep divers. Gas and fat embolisms could occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004; Moore and Early 2004; Arbelo et al. 2005; Fernández et al. 2005a; Jepson et al. 2005b). Rommel et al. (2006) suggested that the evolution of gas bubbles is driven by behaviorally altered dive profiles, e.g., extended surface intervals. Previously it was widely assumed that diving marine mammals are not subject to the bends or air embolism.

It is important to note that seismic pulses and mid-frequency sonar pulses are quite different. Sounds produced by the types of airgun arrays used to profile sub-sea geological structures are broadband with most of the energy below 1 kHz. Typical military mid-frequency sonars operate at frequencies of 2–10 kHz, generally with a relatively narrow bandwidth at any one time (though the center frequency may change over time). Because seismic and sonar sounds have considerably different characteristics and duty cycles, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar pulses can, in special circumstances, lead to hearing damage and, indirectly, mortality suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity pulsed sound.

As noted earlier, in September 2002, there was a stranding of two Cuvier's beaked whales in the Gulf of California (Mexico) when a seismic survey by the R/V *Maurice Ewing* was underway in the general area. (Malakoff 2002). The airgun array in use during that project was the *Ewing*'s 20-airgun 8490-in^3 array. This might be a first indication that seismic surveys can have effects, at least on beaked whales, similar to the suspected effects of naval sonars. However, the evidence linking the Gulf of California strandings to the seismic surveys was inconclusive, and not based on any physical evidence (Hogarth 2002; Yoder 2002). The ship was also operating its multibeam echosounder at the same time but, as discussed elsewhere, this source had much less potential than the aforementioned naval sonars to affect beaked whales. Although the link between the Gulf of California strandings and the seismic (plus multibeam echosounder) survey is inconclusive, this plus the various incidents involving beaked whale strandings "associated with" naval exercises suggests a need for caution in conducting seismic surveys in areas occupied by beaked whales.

(h) Non-auditory Physiological Effects

Possible types of non-auditory physiological effects or injuries that might theoretically occur in marine mammals exposed to strong underwater sound might include stress, neurological effects, bubble formation, and other types of organ or tissue damage. However, studies examining such effects are limited. If any such effects do occur, they would probably be limited to unusual situations. Those could include cases when animals are exposed at close range for unusually long periods, when the sound is strongly channeled with less-than-normal propagation loss, or when dispersal of the animals is constrained by shorelines, shallows, etc.

Long-term exposure to anthropogenic noise may have the potential of causing physiological stress that could affect the health of individual animals or their reproductive potential, which in turn could (theoretically) cause effects at the population level (Gisiner [ed.] 1999). Romano et al. (2004) examined the effects of single underwater impulse sounds from a seismic water gun (up to 228 dB re 1 µPa·m_{p-p}) and single pure tones (sound pressure level up to

201 dB re 1 μPa) on the nervous and immune systems of a beluga and a bottlenose dolphin. They found that neural-immune changes to noise exposure were minimal. Although levels of some stress-released substances (e.g., catecholamines) changed significantly with exposure to sound, levels returned to baseline after 24 hr. Further information about the occurrence of noise-induced stress in marine mammals is not available at this time. However, it is doubtful that any single marine mammal would be exposed to strong seismic sounds for sufficiently long that significant physiological stress would develop. This is particularly so in the case of seismic surveys where the tracklines are long and/or not closely spaced.

High sound levels could potentially cause bubble formation of diving mammals that in turn could cause an air or fat embolism, tissue separation, and high, localized pressure in nervous tissue (Gisiner [ed.] 1999; Houser et al. 2001). Moore and Early (2004) suggested that sperm whales are subjected to natural bone damage caused by repeated decompression events during their lifetimes. Those authors hypothesized that sperm whales are neither anatomically nor physiologically immune to the effects of deep diving. The possibility that marine mammals may be subject to decompression sickness was first explored at a workshop (Gentry [ed.] 2002) held to discuss whether the stranding of beaked whales in the Bahamas in 2000 (Balcomb and Claridge 2001; NOAA and USN 2001) might have been related to air cavity resonance or bubble formation in tissues caused by exposure to noise from naval sonar. A panel of experts concluded that resonance in air-filled structures was not likely to have caused this stranding. Among other reasons, the air spaces in marine mammals are too large to be susceptible to resonant frequencies emitted by mid- or low-frequency sonar; lung tissue damage has not been observed in any mass, multi-species stranding of beaked whales; and the duration of sonar pings is likely too short to induce vibrations that could damage tissues (Gentry [ed.] 2002). Opinions were less conclusive about the possible role of gas (nitrogen) bubble formation/growth in the Bahamas stranding of beaked whales. Workshop participants did not rule out the possibility that bubble formation/growth played a role in the stranding, and participants acknowledged that more research is needed in this area.

Jepson et al. (2003) first suggested a possible link between mid-frequency sonar activity and acute and chronic tissue damage that results from the formation *in vivo* of gas bubbles, based on 14 beaked whales that stranded in the Canary Islands close to the site of an international naval exercise in September 2002. The interpretation that the effect was related to decompression injury was initially unproven (Piantadosi and Thalmann 2004; Fernández et al. 2004). However, there is increasing evidence and suspicion that decompression illness can occur in beaked whales and perhaps some other odontocetes, and that there may, at times, be a connection to noise exposure (see preceding section).

Gas and fat embolisms may occur if cetaceans ascend unusually quickly when exposed to aversive sounds, or if sound in the environment causes the destabilization of existing bubble nuclei (Potter 2004; Moore and Early 2004; Arbelo et al. 2005; Fernández et al. 2005a; Jepson et al. 2005b). Thus, air and fat embolisms could be a mechanism by which exposure to strong sounds could, indirectly, result in non-auditory injuries and perhaps death. However, even if those effects can occur during exposure to mid-frequency sonar, there is no evidence that those types of effects could occur in response to airgun sounds.

The only available information on acoustically-mediated bubble growth in marine mammals is modeling assuming prolonged exposure to sound. Crum et al. (2005) tested *ex vivo* bovine liver, kidney, and blood to determine the potential role of short pulses of sound to induce bubble nucleation or decompression sickness. In their experiments, supersaturated bovine tissues and blood showed extensive bubble production when exposed to low-frequency sound. Exposure to 37 kHz at ~50 kPa caused bubble formation in blood and liver tissue, and exposure to three acoustic pulses of 10,000 cycles, each 1 min, also produced bubbles in kidney tissue. Crum et al.

(2005) speculated that marine mammal tissue may be affected in similar ways under such conditions. However, these results may not be directly applicable to free-ranging marine mammals exposed to sonar.

Recent controlled exposure of head tissue from a neonate Cuvier's beaked whale to high-intensity sonar-like sounds (3.5 kHz at 180 dB re 1 μPa received level) and related computational modeling indicated no evidence of any significant injurious effects to the tissue at this sound level (Krysl et al. 2006). The authors concluded that within the range of parameters tested, such tissues are not likely to suffer direct mechanical or thermal damage. However, more animal tissues and parameters will need to be tested to extrapolate the results of this study and model to other situations.

In summary, very little is known about the potential for seismic survey sounds to cause either auditory impairment or other non-auditory physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to short distances. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways. Marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes, and some pinnipeds, are unlikely to incur auditory impairment or other physical effects.

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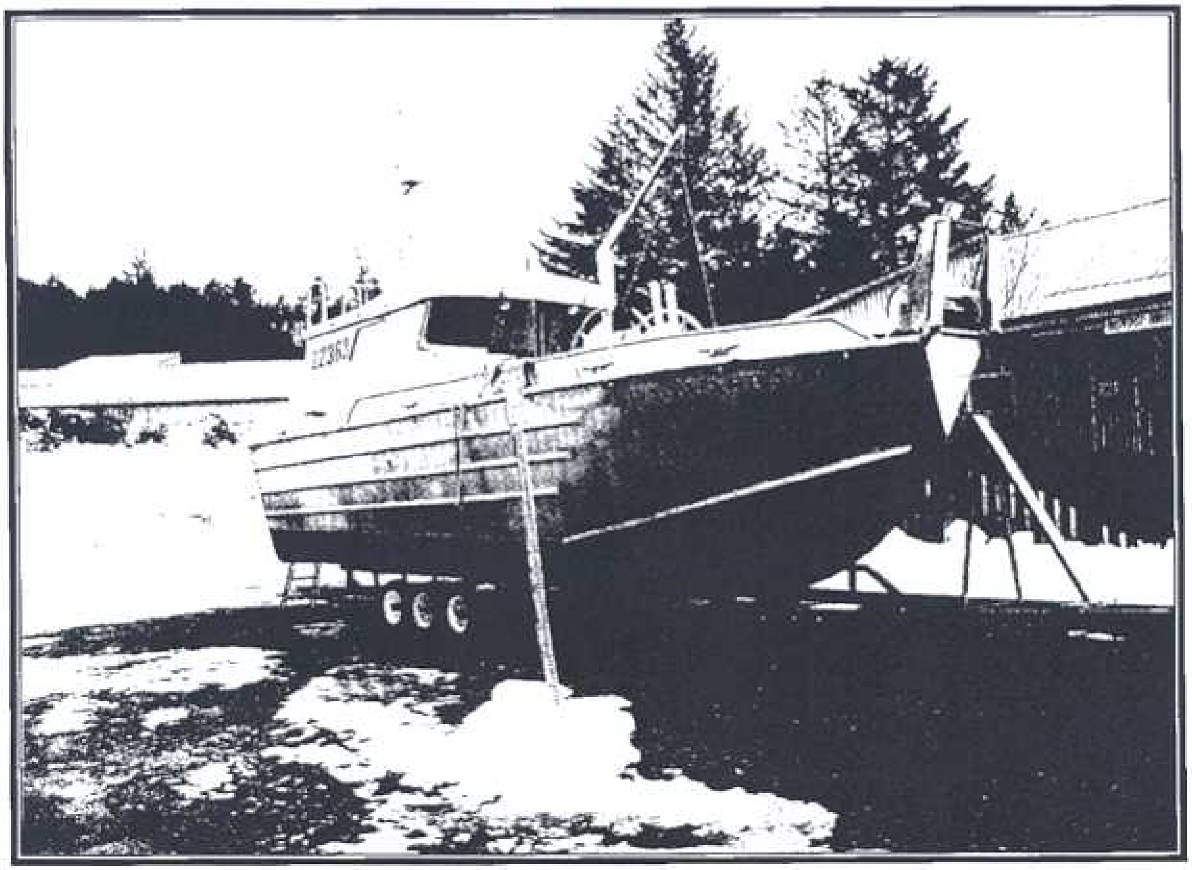


Survey Report of Fishing Vessel
"*Canvasback*"
Documentation Nº: 696778
Surveyed in Cordova, Alaska
Report Date: February 19, 2007

Acting at the request of John Bocci, the undersigned did attend February 16, 2007, onboard the fishing vessel **Canvasback** while the vessel was out of the water on a trailer, Cordova Harbor, Cordova, Alaska. Attending the survey were John Bocci, owner/operator and Troy Tirrell AMS, undersigned.

The purpose of this inspection was to ascertain the condition of the vessel and provide an evaluation for insurance.

The vessel was carefully examined and tested in accessible places in a nondestructive way without any penetration of structural members. Except for removal of panels, floorboards and other loose items, no probing of inaccessible areas was carried out except visually with a flashlight, pick awl, hammer, scraper, and mirrors where possible.

The engines were inspected on the basis of exterior surface inspection and not observed operating. The hull, engines, fuel system, and related equipment were inspected for leaks, condition, and with regard to USCG, ABYC, and NFPA rules and standards.

Note: Numbers within parenthesis ( ) are quantities.

Vessel: *F/V Canvasback*

Doc. №: 1093742 **Gross Ton:** 18 **Net Ton:** 14

HIN: PD0032140074

ADFG №: 22363

Radio call sign: WDC-9169

Type of Vessel: 32-foot aluminum twin diesel waterjet bowpicker

Service: Commercial salmon gillnet fishing

Waters Navigated: Prince William Sound, Copper River delta, Alaska

Owner: John Bocci, P.O. Box 1312, Cordova, AK 99574

Vessel Location for Survey: Out of the water on a trailer, Cordova Harbor, Cordova, Alaska

Survey Requested by: Owner

Builder: All-American Marine **Year Built**: 2000

Builder Location: Ferndale, Washington

Type of Survey: Condition & Value for Insurance

Hull Details

Dimensions: **LOA**: 32′ **Beam**: 14′ **Draft**: 20″
Hull Construction: Welded aluminum with 1/4" bottom & 3/16" sides
Hull Description: Planing bottom with slight vee, square stern, hard chine & raked bow (port sheer cut out for longlining roller)
Framing:
(6) 2 1/2″ external hull stringers/keel coolers
(4) 3/8" x 6" flat bar engine bed stringers
3/16" x 2" x 4" angle frames on 18" centers on bottom
3/16" x 2" x 2" T frames on 18" centers on sides
Bulkheads: (4) bent aluminum
Decks: 3/16" plate with 2" x 2" box beams

Propulsion

Engines: (2) Cummins 6BTA 5.9
Horsepower: 315 each @ 2800 RPM
Type: Turbocharged & aftercooled 6-cylinder diesel
Year: Both 2007
Tach Gauge Hours: Port: 3500 Starboard: 3515
(both engines are new rebuilds with 0 hours at time of inspection)
Serial Nº:
Port: 60237888 Starboard: 60239426
Cooling: (6) 2 1/2″ external hull stringers/keel coolers
Exhaust: Wet exhaust w/fiberglass silencers
Transmissions: (2) Borg Warner Velvet Drive 10-18-002
Ratio: 1:1
Drive Units: (2) Hamilton 273 waterjets

Serial №: Port: 091 Starboard: 090
Propellers/Impellers: (2) five blade
Transmission: (2) Borg Warner Velvet Drive 10-18-002
Ratio: 1:1
Serial №: Port: 26874 Starboard: 26862
Remarks: Engine room is very clean

Hydraulics:
(2) Spencer load-sensing variable volume 0-2.77 cubic inch pump direct driven off portside of both main engines
(2) 6 gpm Vickers pump with steel 1 gal. tanks run off of jet units for shift
(1) aluminum 25 gal. reservoir tank, keel cooled, portside

Trim Tabs: (4) stainless steel rams on welded aluminum trim tabs & powered off of jet hydraulics

Batteries: (3) 8d in aluminum frame box located center & starboard in engine room

Sea Cocks: (2) Mylar **Type:** Ball
Remarks: In working order

Steering: (2) Seastar hydraulic steering helms with hydraulic rams

Engine Controls: (2) station Hynatic throttle & shift controls
Morris cable for transmission hydraulic assist off of jet

Tanking Sytem:
Fuel Tank: 400 gal. welded aluminum located forward & center under deck
Fuel Filters: (2) Racor 900FG fuel filters & secondary on engines
Fuel Lines: USCG type A-1 neoprene hoses with Parker push-lock hose & fittings
Water Tank: (1) est. 60 gal., aluminum, located in forepeak

Bilge Pumps:
(1) Rule 3500 located in fish hold
(1) Rule 2000 located in engine room

Other Pumps:
(1) 1 ¼" Jabsco hydraulic washdown
Flo-Jet freshwater pump
Flo-Jet ¾" 12v deck hose

Stoves & Heaters:
Dickinson "Alaska" oil stove/oven
Seaward 3-burner propane stove/oven with 5 gal. steel propane tank mounted outside of cabin in forward steering console
(2) Heatercraft engine heat cabin heaters with ducting
Seaward engine heat hot water heater

Anchor Gear: 20 KG Bruce anchor with 30' x 3/8" lead chain & 100' x ¾" Samson line

Head: Marine flushing toilet w/ holding tank & shower head

Deck Machinery & Equipment:
Net reel: 46" x 42" aluminum drum, sliding rail & swivel w/Twister drive
Levelwind: aluminum
Bow roller: Kinematics hydraulic power roller
Herring shaker: yes
Mooring cleats: (6) 10"
Watertight hatch: (1) Freeman, on foredeck
Handrails: 1" pipe handrail around top of cabin
Other: Live bleeding tank, raingear locker starboard side cabin forward

Electronics:
VHF radio: Standard Omni
CB radio: Radioshack TRC-503
Other radios: Midland Lowband, Kenwood TM-701A
Radar: JRC Raster Scan 2000 Model NCD3845 SN: LE5581
Fathometers: Furuno 667 color video fishfinder, Vexilar
Map plotter: Simrad Shipmate CP32
Laptop: Toshiba laptop w/Nobletec software
Stereo: Jensen AM/FM cassette
Cell phone: American bag phone

Navigation Equipment:
Running & anchor lights for class
Compass: Ritchie 3", magnetic
Deck lights: (9) halogen

Horn: manual Air

Electrical:

Insulated stranded marine copper wire, secured w/tie backs
DC panel with breakers
(4) cabin lights: bunk, helm
(2) marine alternators, 110 amp. each, mounted on engines
Xantrex 2000 watt inverter/charger
Norcold Tek II 12vDC refrigerator

Lifesaving Equipment:

(2) immersion suit, adult
Oil pressure & water temperature alarm
Marine first aid kit
Life ring with 60' throw line
Orion day/night offshore signal flares (dated: 2008)
USCG Fishing Vessel Safety Exam (dated Feb. 2007)

Portable Fire Extinguishers:

(2) 2.5 lb. dry chemical (A,B,C) at helm stations; gauge in the green

Fish Hold:

Est. 26,000 lb. capacity
(9) watertight aluminum hatch covers

General Description and Arrangement:

The F/V ***Canvasback*** is a modern Alaska aluminum bowpicker fishing vessel. Vessel's 11' x 11' cabin is offset 22" to port for a lead line shoot/walkway, and has a ladder on the stern to the flying bridge. A helm station with bucket seat is located on the flying bridge. Forward of cabin is a self-bailing open deck containing net reel, bow anchor, steering station, and rain gear locker. Flush deck fish holds are amidships, and wheelhouse containing helm and accommodations is aft. Access to cabin is through a watertight aluminum companionway forward.

Forward to port in cabin is helm station with bench seat and navigation equipment; next aft is galley containing oil stove, sink, counter, and storage. To starboard is settee with bench seating and storage. Next aft is a marine head. Three stacking bunks are located at back of cabin.

The cabin is finished with teak cabinets and trim, vinyl sole, Scandia white headliner, and Formica counter tops. Forward windows are rubber mounted with metal frames. Sliding windows are located on port and starboard sides of cabin.

Recommendations:

Found
Life ring cracked
Recommend
Replace life ring

Comments:

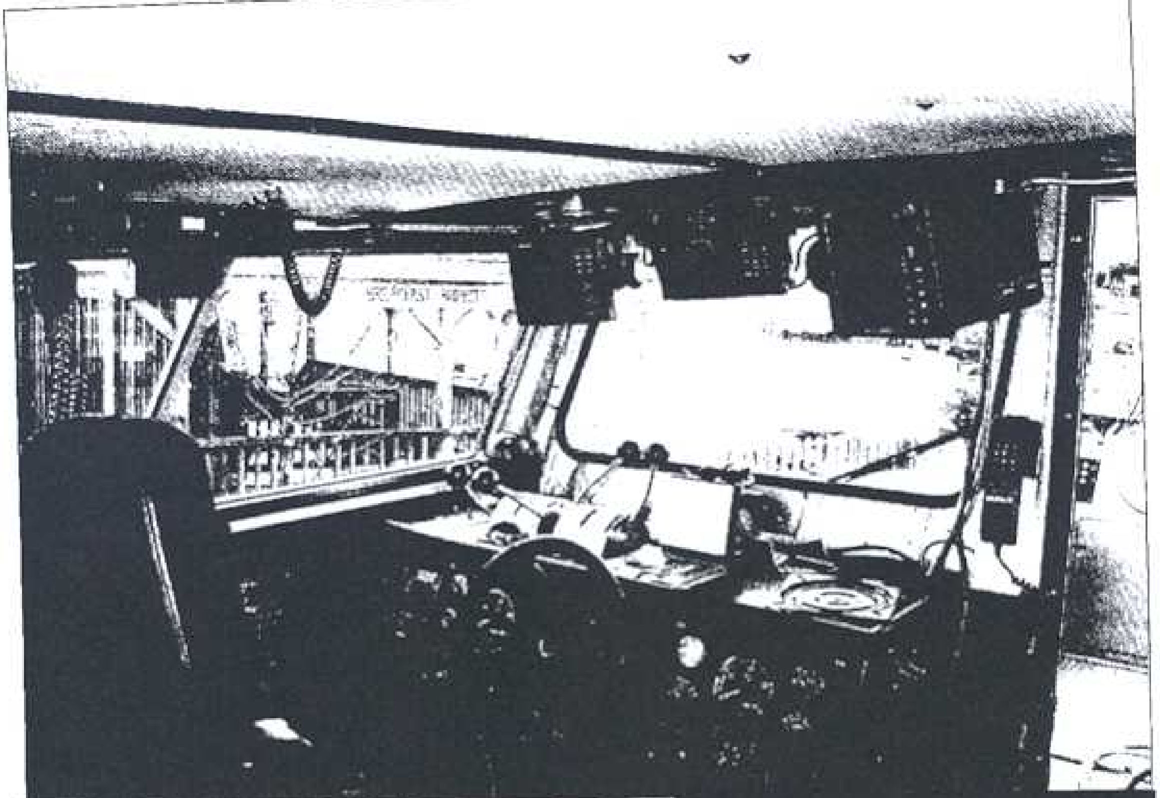
The F/V **Canvasback** is state of the art design and exceptionally well maintained. The overall condition of the vessel is excellent for a vessel its age, and the vessel appears well suited for commercial fishing in Alaskan waters.

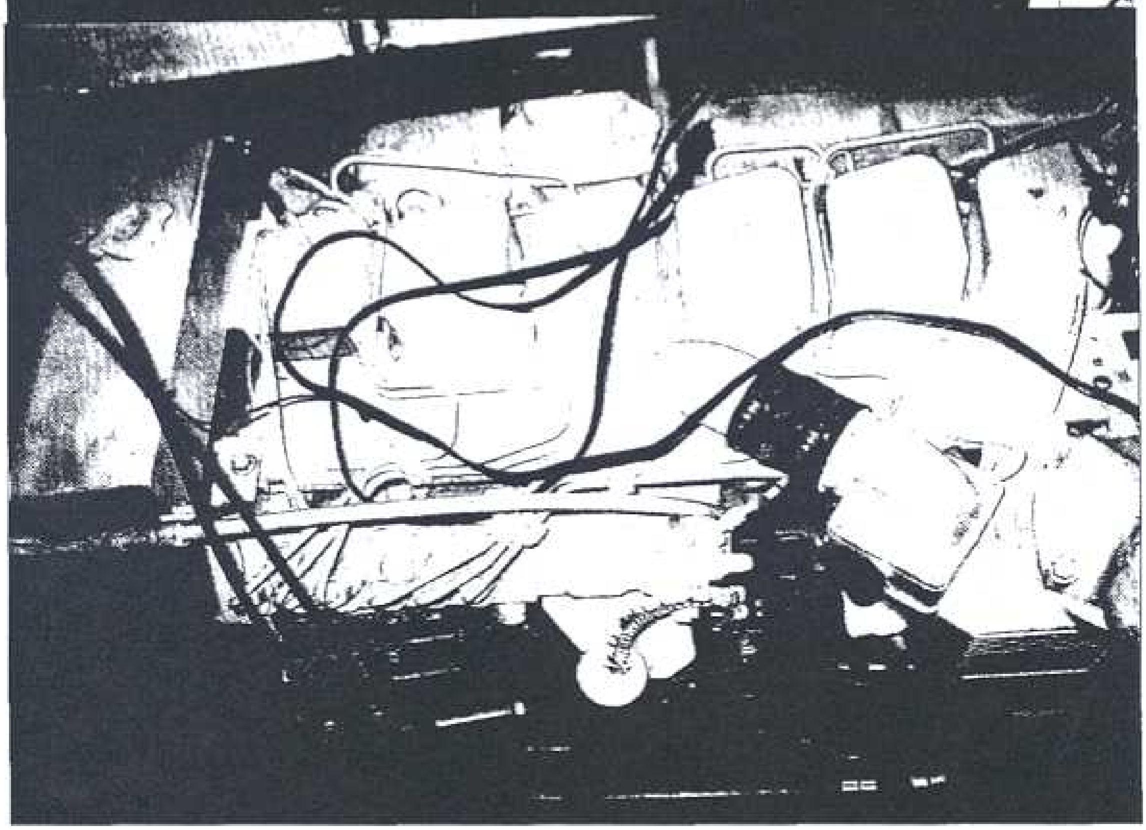
Value:

Estimated market value.............$ 170,000
Estimated replacement cost (new)...$ 290,000

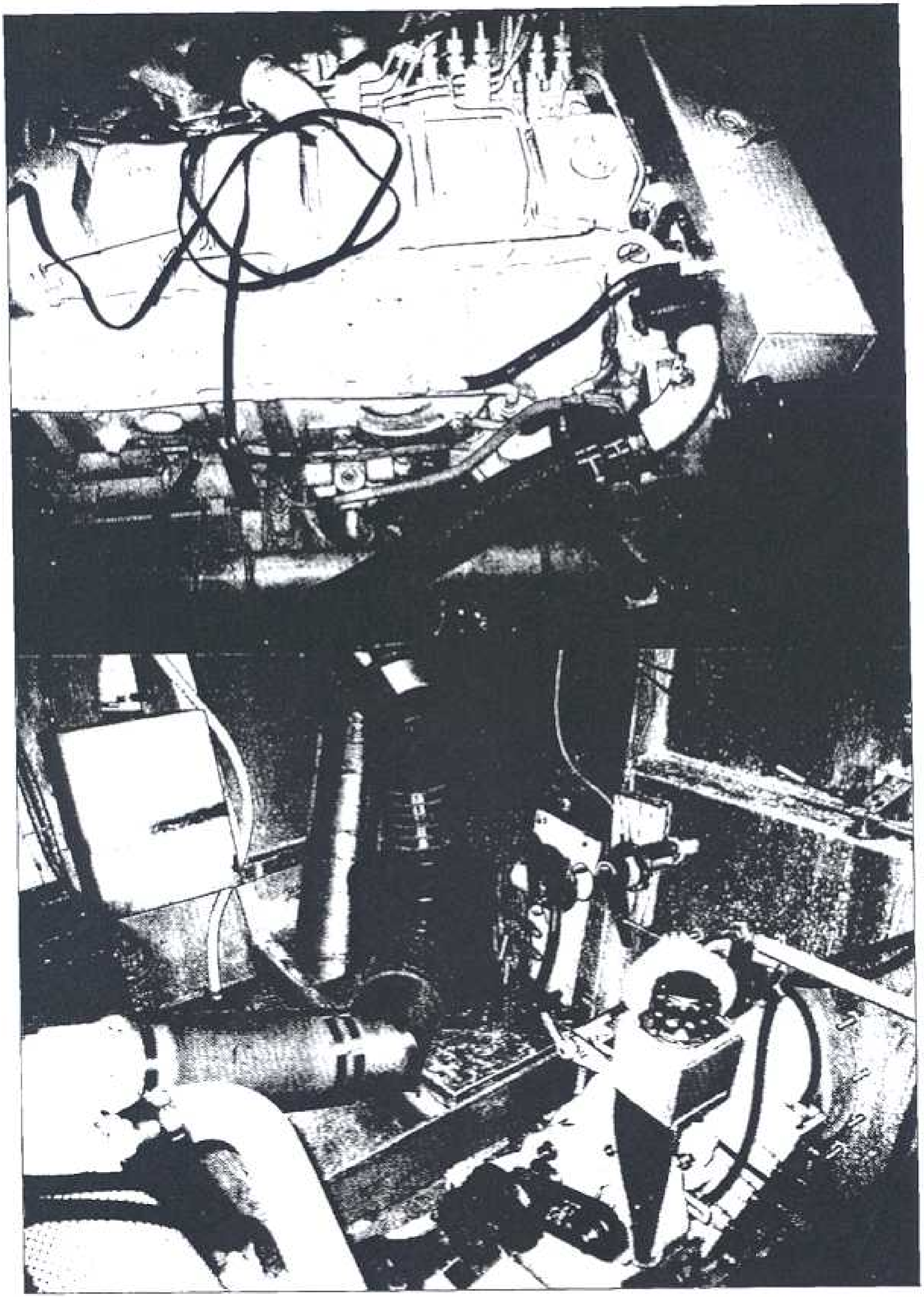
The above reported conditions are based on a careful examination of all parts available for inspection without removal of structural members, joinerwork or ceiling, unless specifically noted. The engines and electrical systems were not functionally tested. All metallic parts are reported on the basis of exterior surface inspection only. The entire report is based on the best use of the knowledge and experience of the surveyor without prejudice, but does not constitute a guarantee of the vessel or its parts.

Troy L. Tirrell AMS
Accredited Marine Surveyor
Member of SAMS, ASA, IAMI, & ABYC

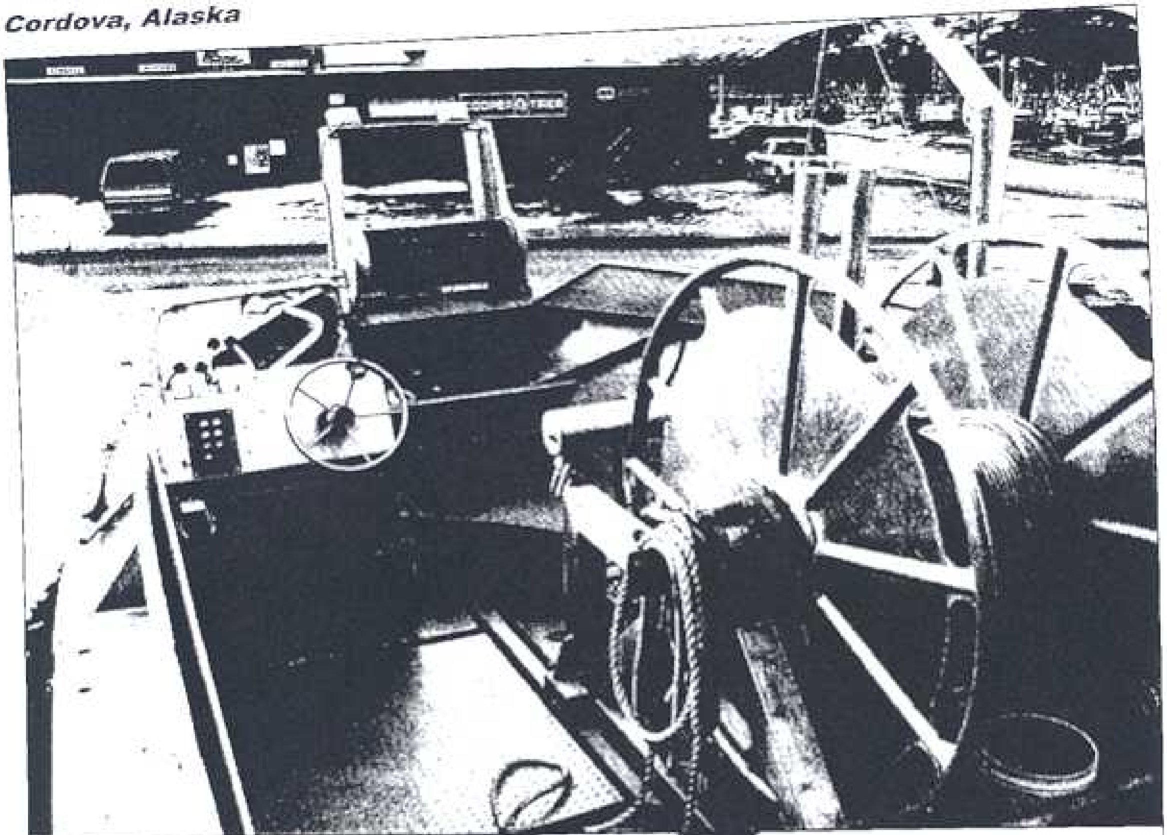


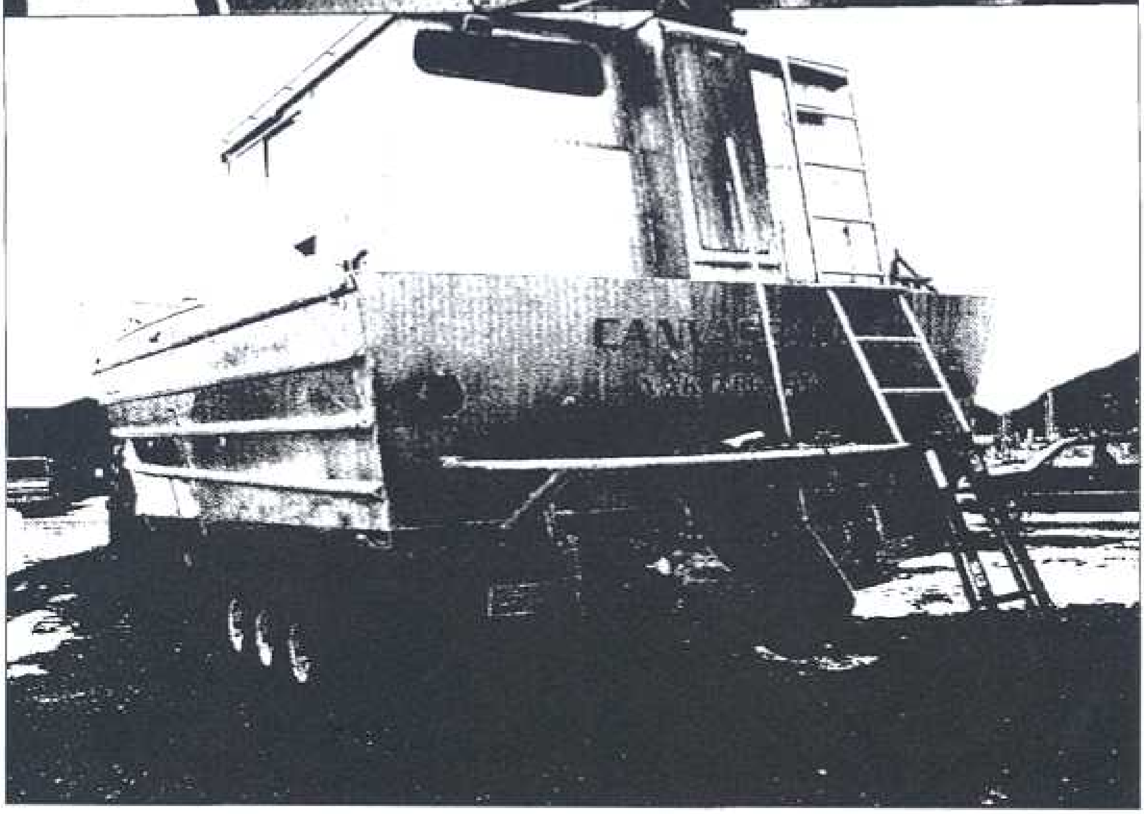


F/V Canvasback



F/V Canvasback





F/V Canvasback

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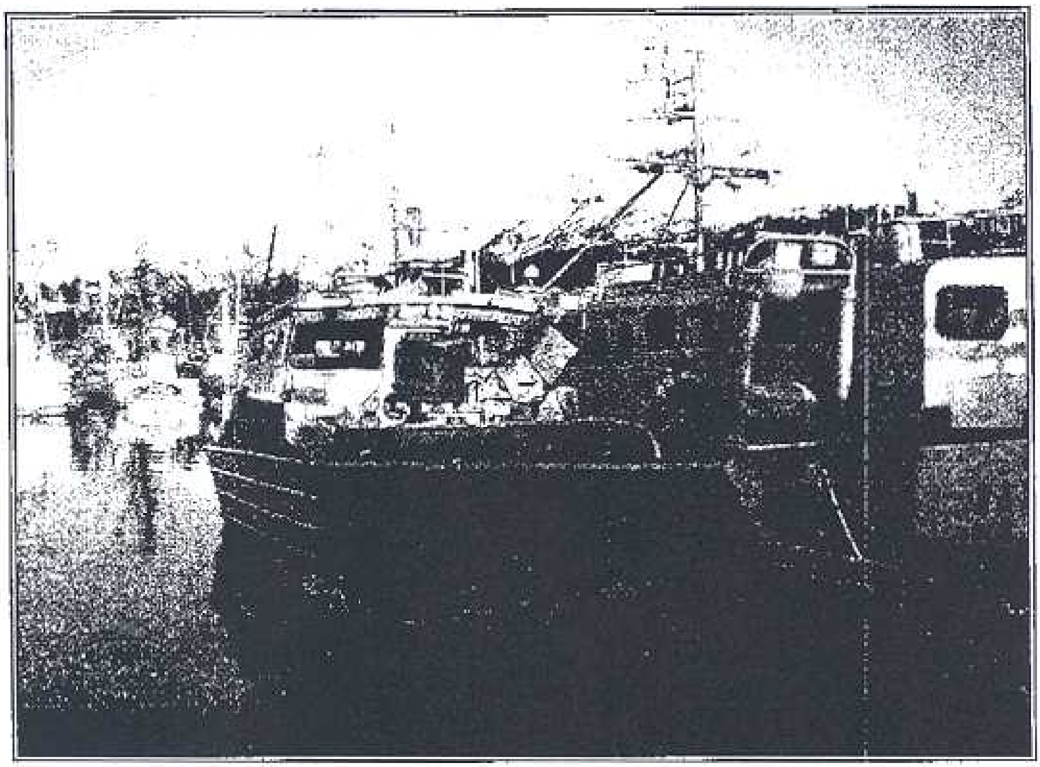


Survey Report of Fishing Vessel
"*Cape Fear*"
Documentation Nº: 1063695
Surveyed in Cordova, Alaska
Report Date: April 13, 2004

Acting at the request of Rob Eckley the undersigned did attend March 29, 2004, on board the fishing vessel **Cape Fear** while the vessel was in the owner's warehouse Mile 1.5 Whitshed Road, Cordova, Alaska. Attending the survey were Rob Eckley the owner/operator and Troy Tirrell, AMS the undersigned.

The purpose of this inspection was to ascertain the condition and supply an evaluation of the vessel for Insurance.

The vessel was carefully examined and tested in accessible places in a nondestructive way without any penetration of structural members. Except for removal of panels, floor boards and other loose items, no probing of inaccessible areas was carried out except visually with a flashlight, pick awl, hammer, scraper and mirrors as best possible.

The engines were inspected on the basis of exterior surface inspection only. The hull, engines, fuel system and related equipment were inspected for leaks, condition, and with regard to USCG, ABYC, and NFPA rules and standards.

Note: Numbers within parenthesis ( ) are quantities.

Vessel: F/V *Cape Fear*

Doc. Nº: 1063695 **Gross Tons:** 15 **Net Tons:** 12

ADFG No.: 70393 **HIN:** PP-98-32126-055

Radio Call Sign: WCY-6755

Vessel Weight: 14,383 lbs. with 100 gal. of fuel onboard

Type of Vessel: 32-foot aluminum twin diesel waterjet bowpicker

Service: Commercial salmon gillnet & longline fishing

Waters Navigated: Prince William Sound, Copper River delta, Alaska

Owner: Robert Eckley, Box 1274, Cordova, AK 99574

Vessel Location for Survey: Dry docked on a trailer in owner's warehouse Mile 1.5 Whitshed Road, Cordova, Alaska.

Survey Requested by: Owner

Builder: All-American Marine **Year Built:** 1998

Builder Location: Ferndale, Washington

Type of Survey: Condition & Value for Owner

Hull Details

Dimensions:
LOA: 32' **Beam:** 12' 6" **Draft:** 20"
Hull Construction: Welded aluminum with 1/4" bottom & 3/16" sides
Hull Description: Planing bottom with slight vee, square stern, 9" reverse chine & raked bow
Framing: (6) 2 1/2" external hull stringers/keel coolers
(4) 3/8" x 6" flat bar engine bed stringers
3/16" x 2" x 4" angle frames on 18" centers on bottom
3/16" x 2" x 2" T frames on 18" centers on sides
Bulkheads: (4) bent aluminum
Decks: 3/16" plate with 2" x 2" box beams

Propulsion

Engines: (2) Cummins 6BTA 5.9-M2 **Horsepower:** 315 each
Type: Turbocharged & aftercooled, 6-cylinder diesel
Year: 1998
Tach Gauge Hours: Port: 4489 Starboard: 4251
new starboard engine installed @ 3681, Sept. 2003
Serial Nos.: Port: 45629907 Starboard: 46293198
Rebuilt spare engine: Serial No.: 45629947
Cooling: (6) 2 1/2" external hull stringers/keel coolers
Exhaust: Wet with fiberglass Naoualift silencers high temperature silicone hose and double clamped

Transmission: (2) Borg Warner Velvet Drive 10-18-002 with high performance clutch plates
Ratio: 1:1
Drive Units: (2) Hamilton 273 waterjets
Serial Nos.: Port: 9733 Starboard: 9734
Ventilation: Engine is natural air ventilated to outside
Remarks: The starboard engine in like new condition. New exhaust 2004
Impellers: (2) five-blade

Hydraulics:

Spencer load-sensing variable volume 0-2.77 cubic inch pump direct driven off portside of port engine
(2) 6 gpm Vickers pumps with steel 1 gal. tanks run off of jet units
(1) aluminum 17 gal. reservoir tank, keel cooled, portside
(1) 7 gpm. pump direct driven off 10 hp. Yanmar single cylinder diesel engine, located in engine room SN: 05805 (new 2004)

Trim Tabs:

(2) cavitation/trim tabs under jets units with Bennett dual plastic rams

Batteries:

(2) 4d in aluminum frame box located center in engine room (new in 2001)

Sea Cocks: (2) ball **Type:** Mylar **Remarks:** In working order

Steering: (2) Seastar hydraulic steering helms with draulic rams

Engine Controls:

(2) station Morse cable throttle & shift controls with hydraulic assist off of jet

Fuel Tankage:

386 gal. welded aluminum located center under forward deck
Removable 187 gal. welded aluminum mounted on transom
Total fuel capacity: 574 gal.
Fuel Filters: (2) Racor 900FG fuel filters & secondary on engines
Fuel Lines: USCG type A-1 neoprene hoses with pushlock

fittings

Water Tank: (1) est. 160 gal., aluminum, located in forepeak

Bilge Pumps:
(1) Rule 2000 located in fish hold
(1) Rule 2000 located in engine room

Other Pumps:
1 ¼" Jabsco hydraulic washdown (REV. TO ENGINE ROOM EVACUATE) RRE.
2" Pacer hydraulic driven net wash/washdown & suction with plastic housing
Jabsco oil change pump
SurFlo freshwater pump

Stoves & Heaters:
Dickinson "Pacific" oil stove/oven
1-burner propane stove/oven with 2 gal. aluminum tank mounted outside of cabin in forward steering counsel
Heatercraft engine heat cabin heater
Seaward engine heat 6 gal. hot water heater
Little microwave oven

Anchor Gear: 20 kg. Bruce anchor with 60' x 3/8" lead chain & 150' x ½" Samson line

Head: Marine flushing toilet w/ holding tank & showerhead

Deck Machinery & Equipment:
Net reel: 45" x 43" Howard Fabrication aluminum drum with Twister drive, mounted on sliding track
Levelwind: Kolstrand automatic
Bow roller: Kinematics, hydraulic power roller
Long line roller: Kolstrand
Long line hauler: Kabelvng
Herring shaker: Howard Fabrication with aluminum ramp
Raingear locker starboard side cabin forward
Mooring cleats: (6) 10"
Watertight hatch: (1) Freeman, on foredeck
Handrails: 1" pipe handrail around top of cabin
Other: Removable aluminum 1" pipe boarding ladder

Electronics:
VHF radios: Standard Omni, Uniden MC535
VHF hand held: Apelco, Raytheon

SSB radio: Stevens SEA 222
CB radio: Uniden Pro-510
Other radio: Kenwood Dual Band TM-733
Radar: Furuno 1721
Fathometers: Si-Tex CVS-210 1000 watt fish finder
GPS: Furuno Navigator
Map plotter: Echotec CTM 900 with PWS chip
Computer: Dell Inspiron 4100 with Maptec software
Cell phone: Motorola 3 watt bag phone
Stereo: Pioneer with 10 CD changer and Bose speakers
Other stereo: Legacy DVD/VCD/MP3 player
TV: Westinghouse 15" flat screen
VCR: Sylvania
- CARBON MONOXIDE DETECTOR (RRE)

Navigation Equipment:

Running & anchor lights for class
Compass: Ritchie 3", magnetic
Deck lights: (9) halogen
Horn: Falcon Air
(2) pyrometers

Electrical:

Insulated stranded marine copper wire, secured w/tie backs
DC panel with breakers
Xantrex Freedom Marine 20 inverter
DCv amp and volt meters
(3) cabin lights: bunk, helm
(2) marine alternators, 110 amp. each, mounted on main engines
Norcold Tek II 12vDC refrigerator
(2) SMOKE DETECTORS - (RRE)

Lifesaving Equipment:

(3) Imperial immersion suits, Mustang, adult size
Healer first aid kit
Oil pressure & water temperature alarm
Life ring with 60' throw line
Orion day/night signal flares outside waters pack of 6, 3 & 3

Other:

Eckley Welding three-axle steel trailer (new 2003)

Portable Fire Extinguishers:

RRE (2) - ~~(1)~~ 2.5 lb. dry chemical (A,B,C) at helm station; full charge
(1) 10 lb. dry chemical (A,B,C) at on deck in rain

gear locker; full charge

Fish Hold:

Est. 23,000 lb. capacity
(9) watertight aluminum hatch covers
(6) aft fish holds are spray foam insulated

General Description & Arrangement:

The F/V **Cape Fear** is a modern Alaska aluminum bowpicker fishing vessel with a house aft and self-bailing open deck forward containing net reel, steering station and rain gear locker. Flush deck fish holds are amidships and wheelhouse containing helm and accommodations aft. Access to cabin is through a watertight aluminum companionway forward.

Forward to port in cabin is helm station with bucket seat and navigation equipment; next aft is galley containing stoves, sink, counter and storage. To starboard is settee with bench seating and storage. Next aft is a marine head. Two stacking bunks are located at back of cabin.

The cabin is finished with teak cabinets and trim, carpet sole, fabric hull liner and Formica counter tops. Forward windows are rubber mounted with all other windows mounted with metal frames. Sliding windows are located on port and starboard sides of cabin.

Recommendations:

No deficiencies found at this time

Comments:

The F/V ***Cape Fear*** is very well designed and exceptionally well maintained. Some of the improvements done in 2003-2004 are: extended cabin, rebuilt bunks with new upholstery, galley shelving and survival suit storage, new Yanmar axillary, new starboard main engine, rebuilt spare engine, 9" reverse chine, 187 gal. portable fuel tank, all new wet exhaust systems, aft window, trailer, SSB radio, custom boarding ladder, water filter, TV & stereo and many other aluminum fabrication details.

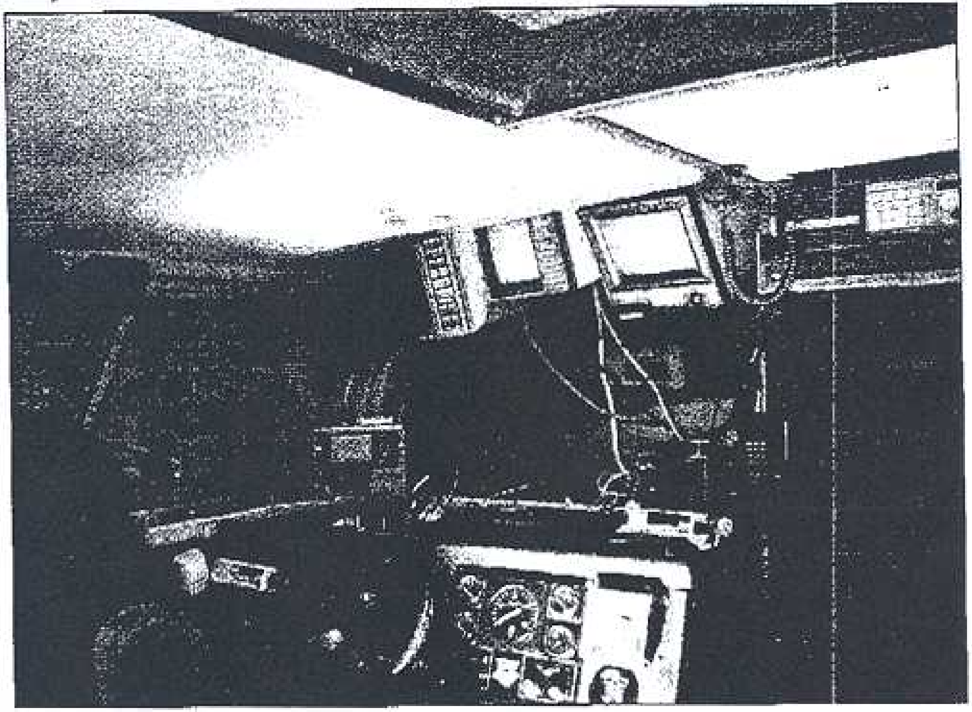
The overall condition of the vessel is excellent and the vessel appears well suited for commercial fishing in Alaskan waters.

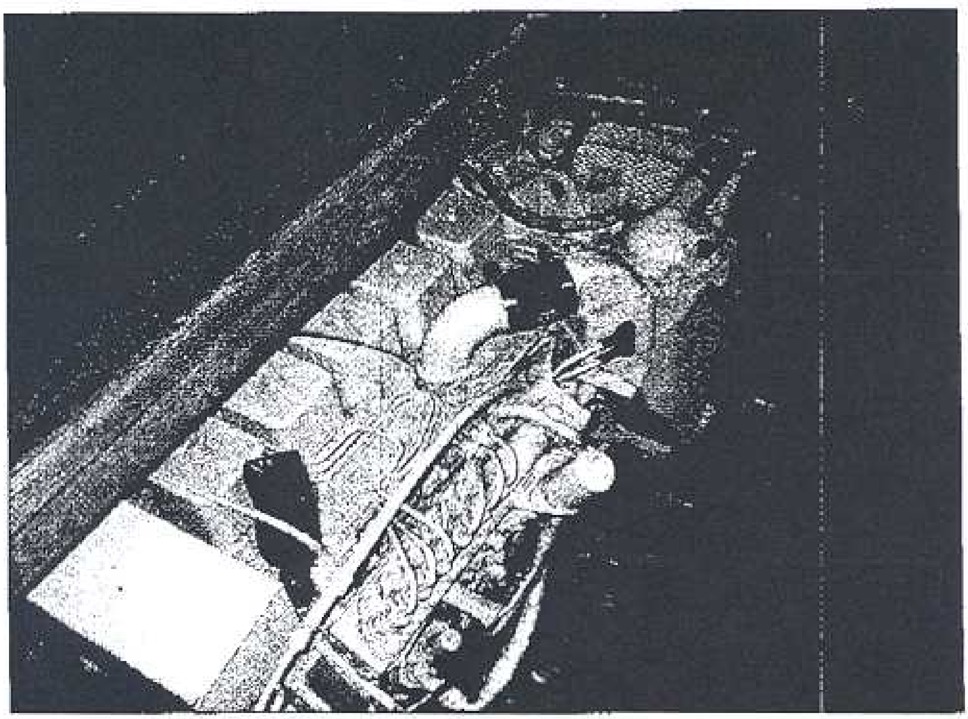
Value:

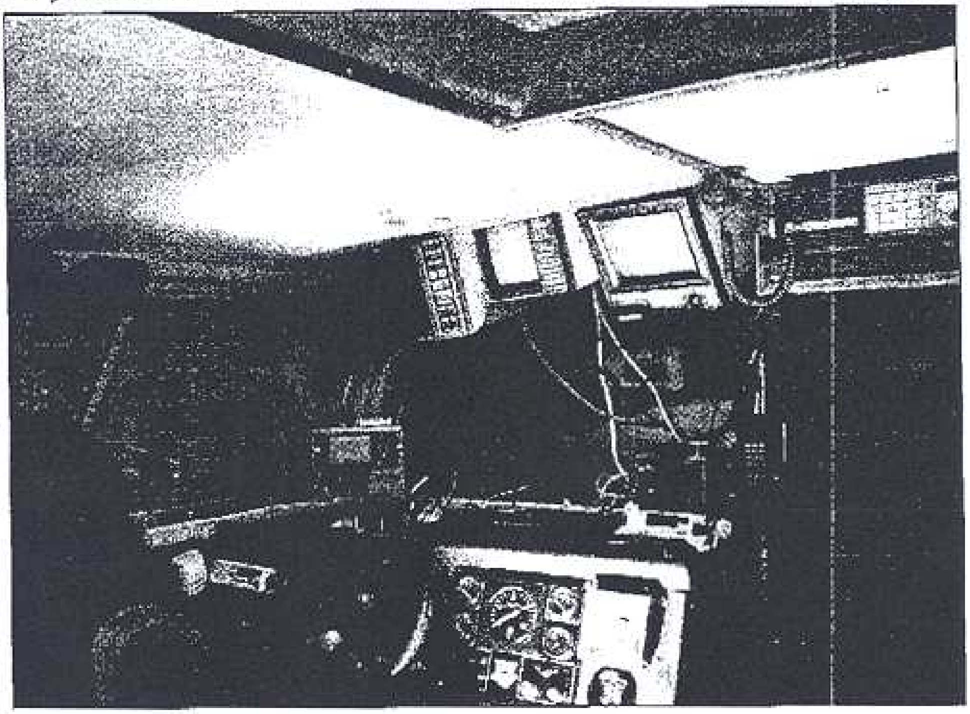
Estimated market value-------------------------- $135,000
Estimated replacement cost (new)---------------- $230,000

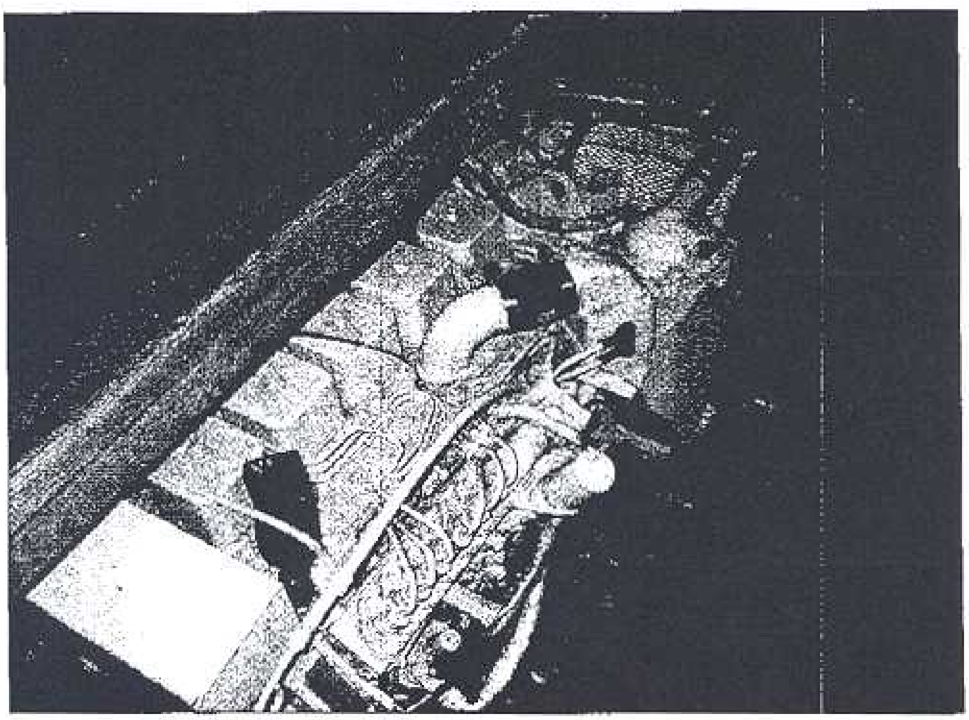
The above reported conditions are based on a careful examination of all parts available for inspection without removal of structural members, joinerwork or ceiling, unless specifically noted. The engines and electrical systems were not functionally tested. All metallic parts are reported on the basis of exterior surface inspection only. The entire report is based on the best use of the knowledge and experience of the surveyor without prejudice, but does not constitute a guarantee of the vessel or its parts.

Troy L. Tirrell, AMS
Accredited Marine Surveyor
Member of SAMS, MIAS, IAMI & ABYC

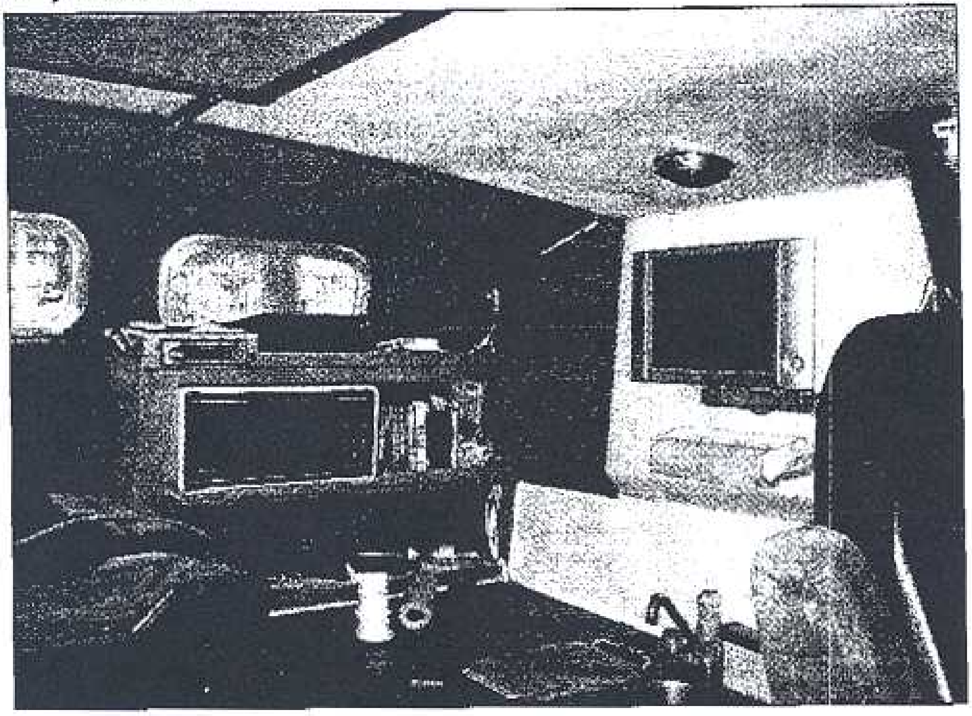


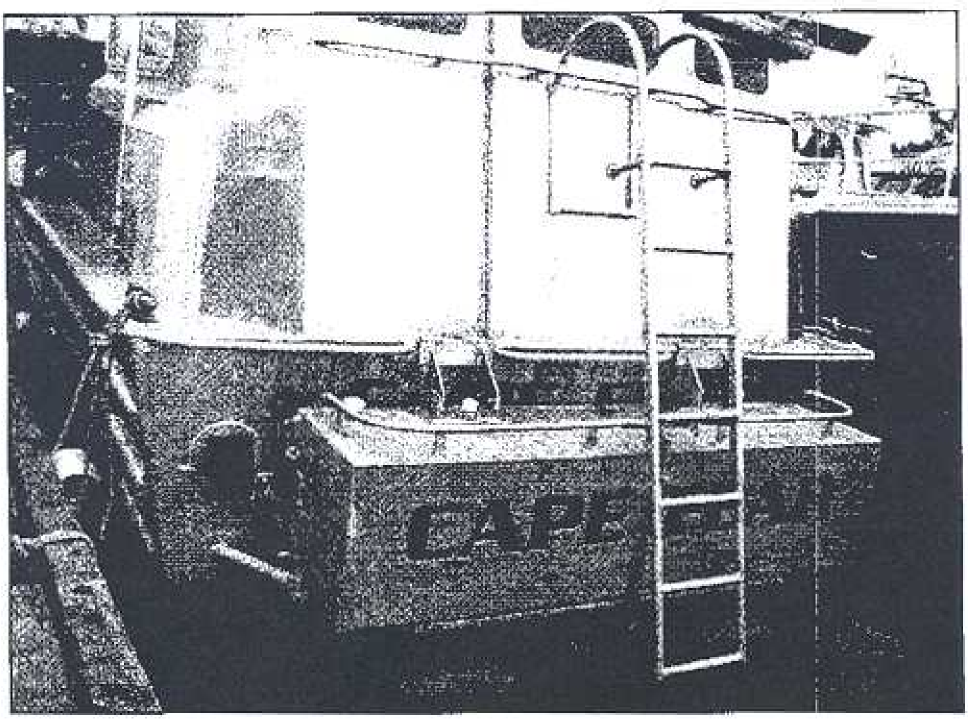




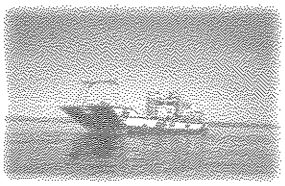


F/V Cape Fear





F/V Cape Fear



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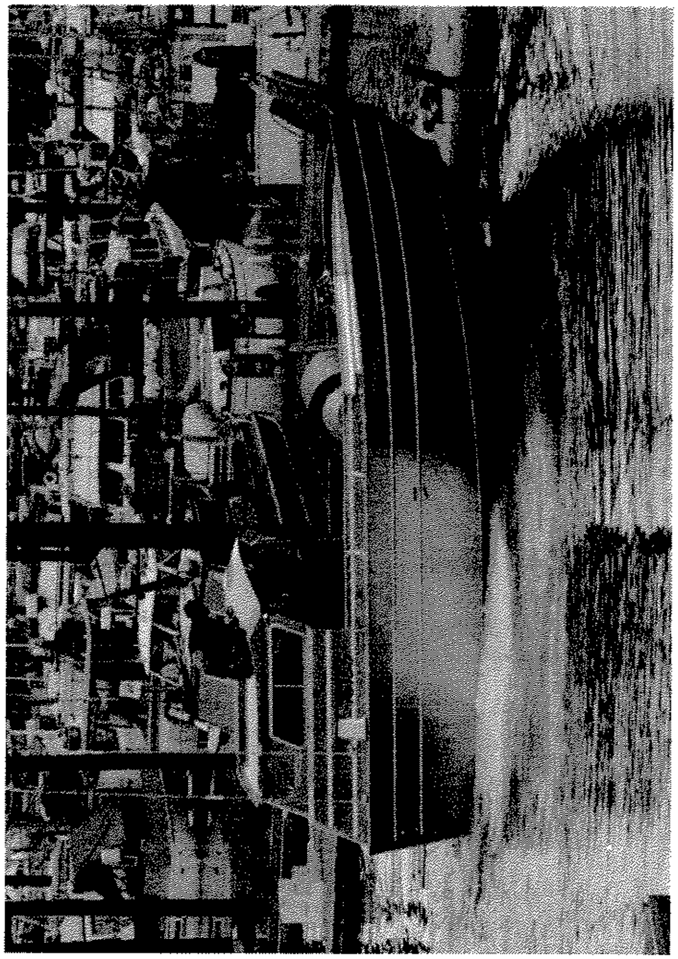
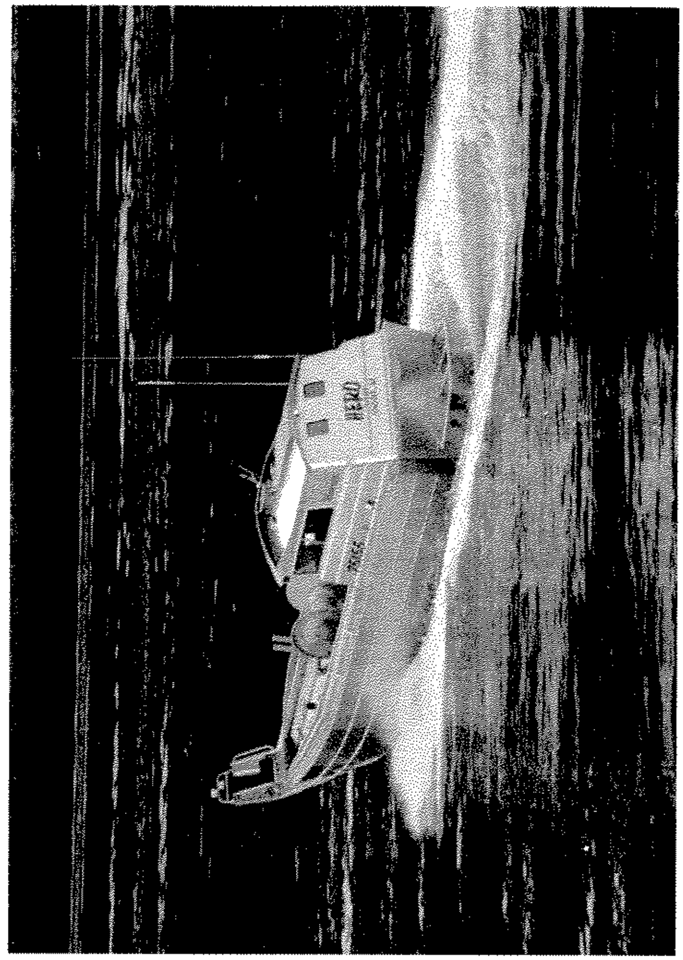
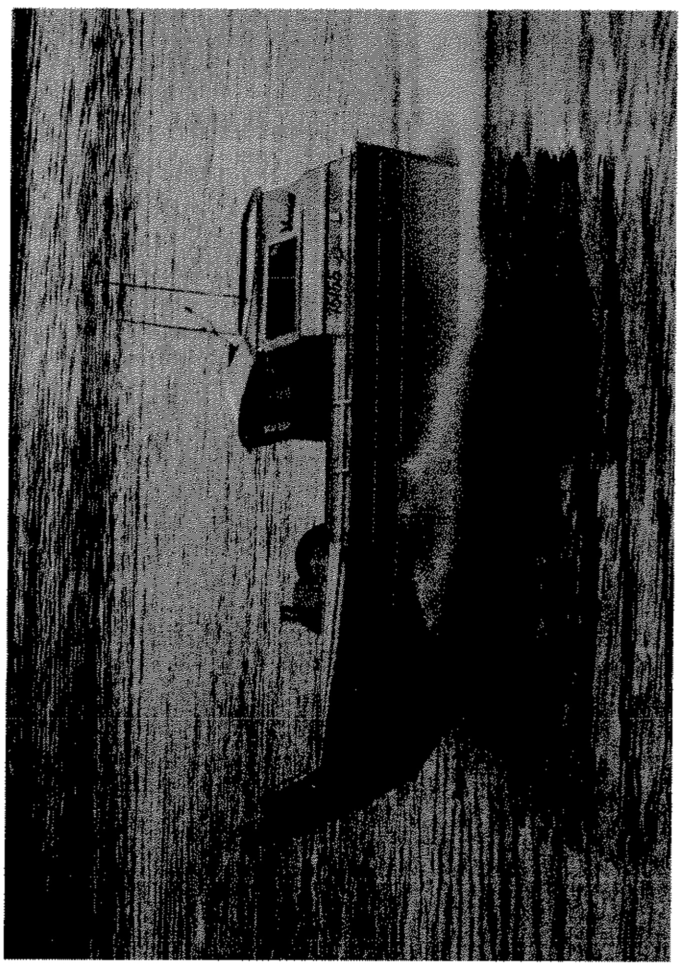
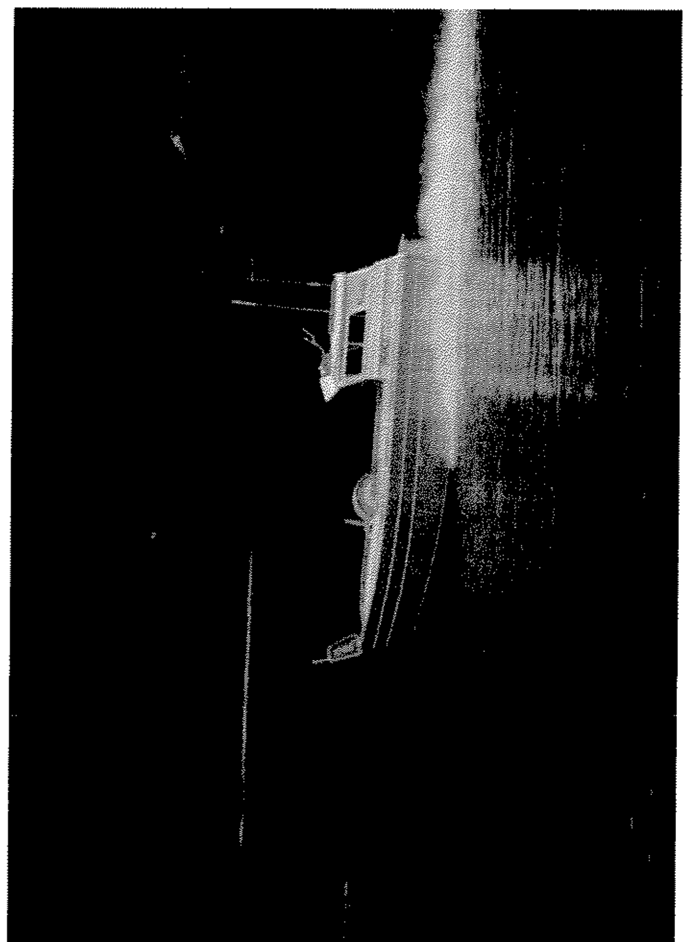
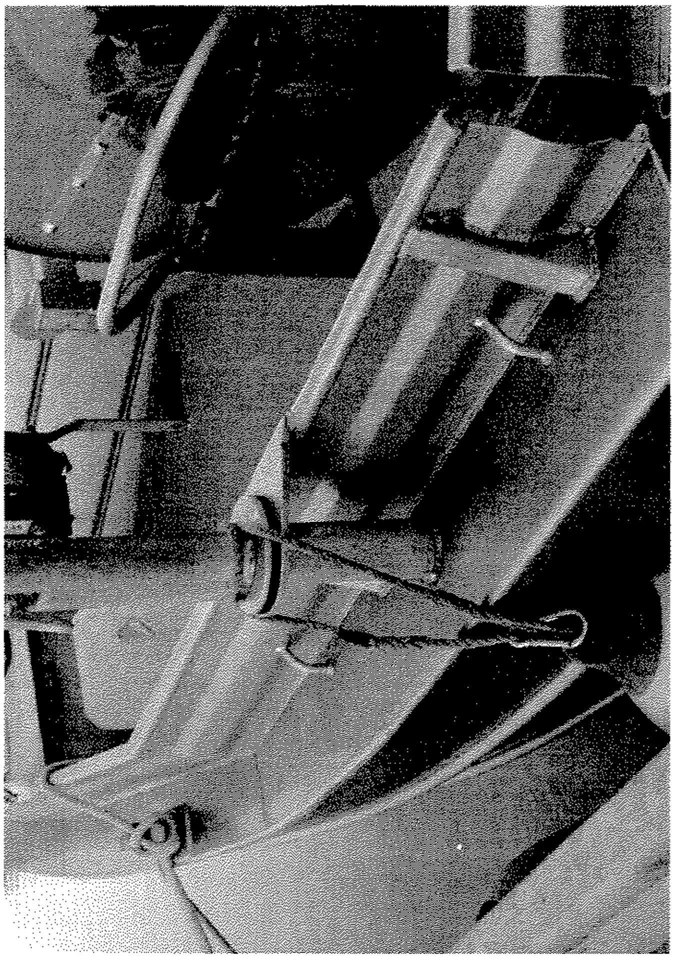
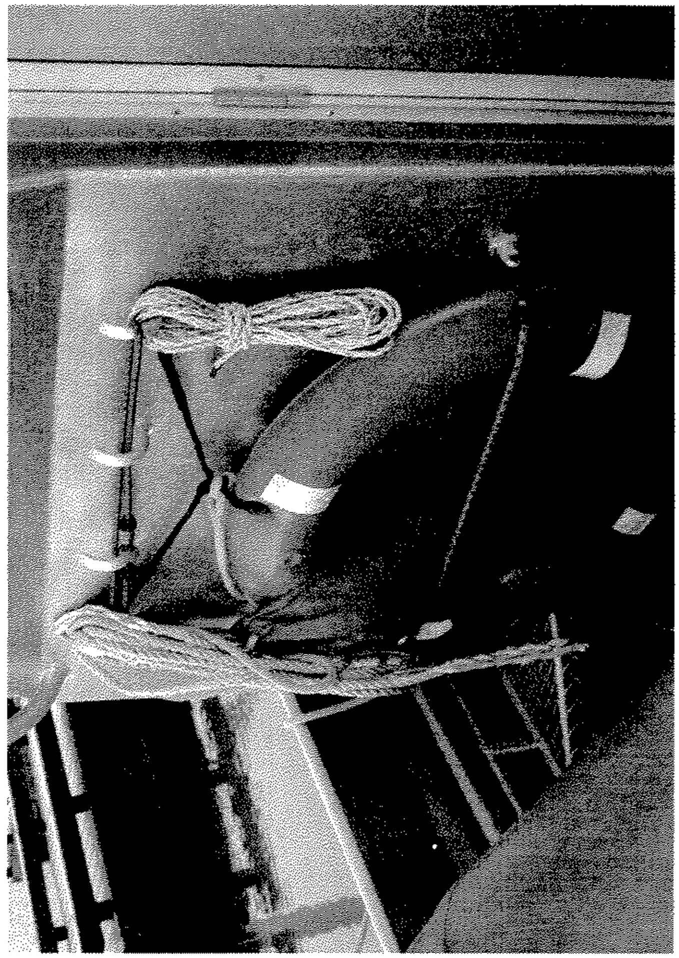
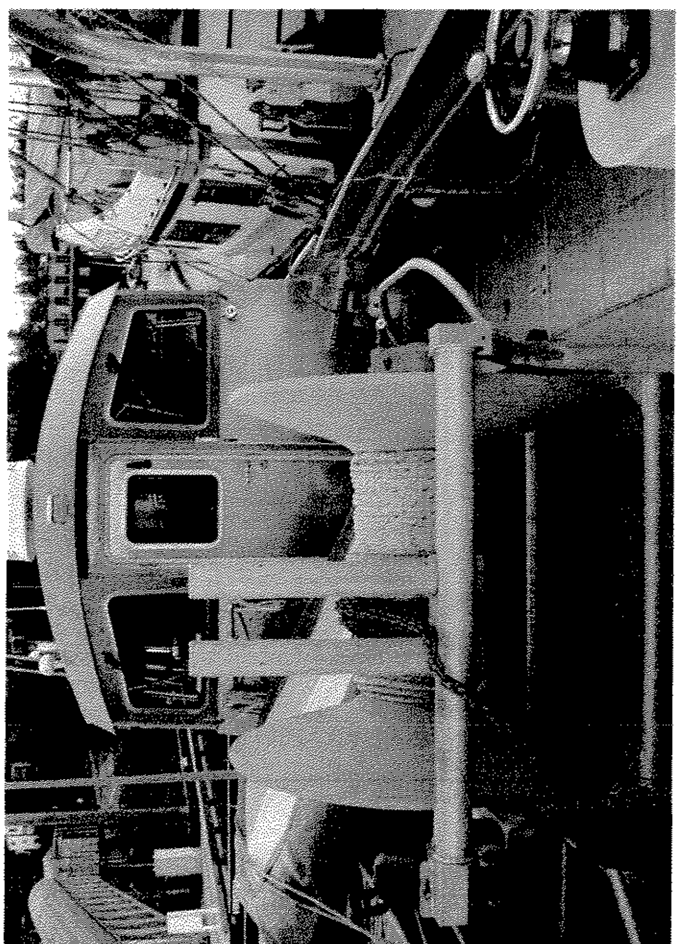
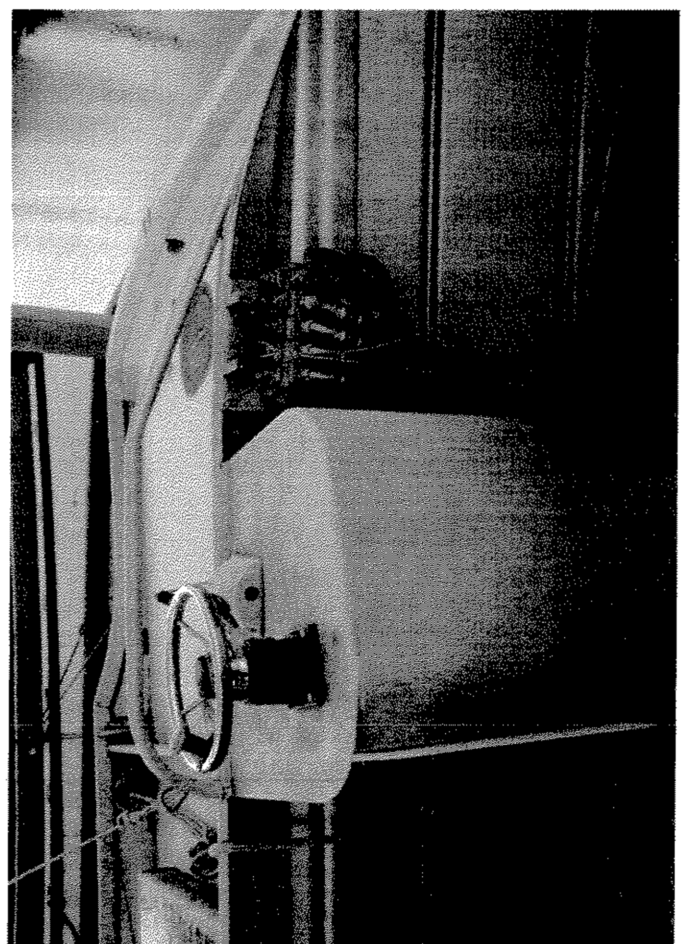
F/V Rumpleminz Bowpicker

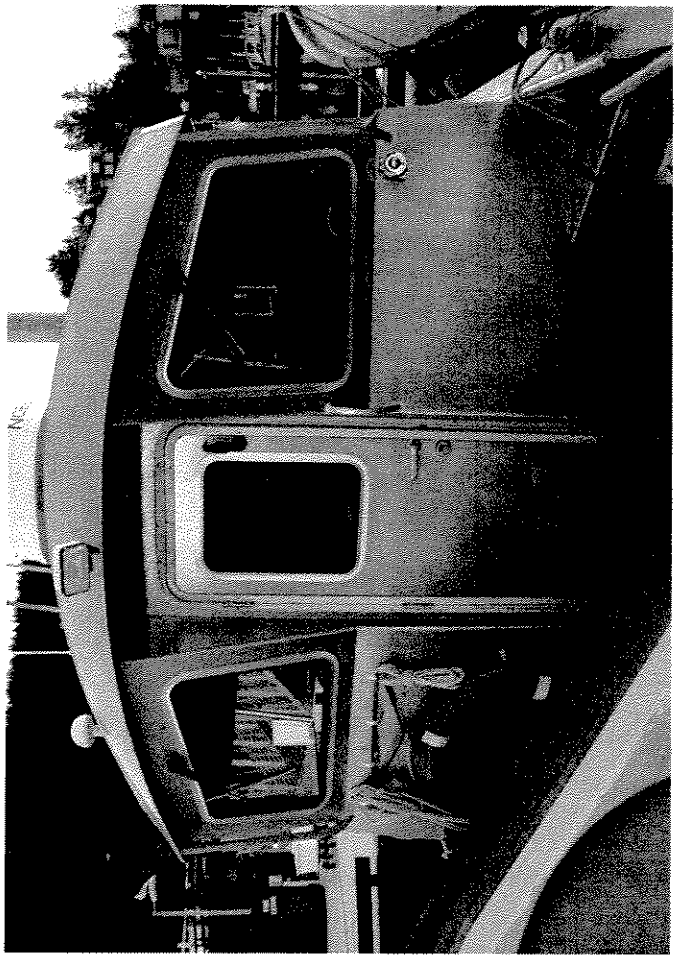
New construction 2007-2008
32x14 Draft 24"

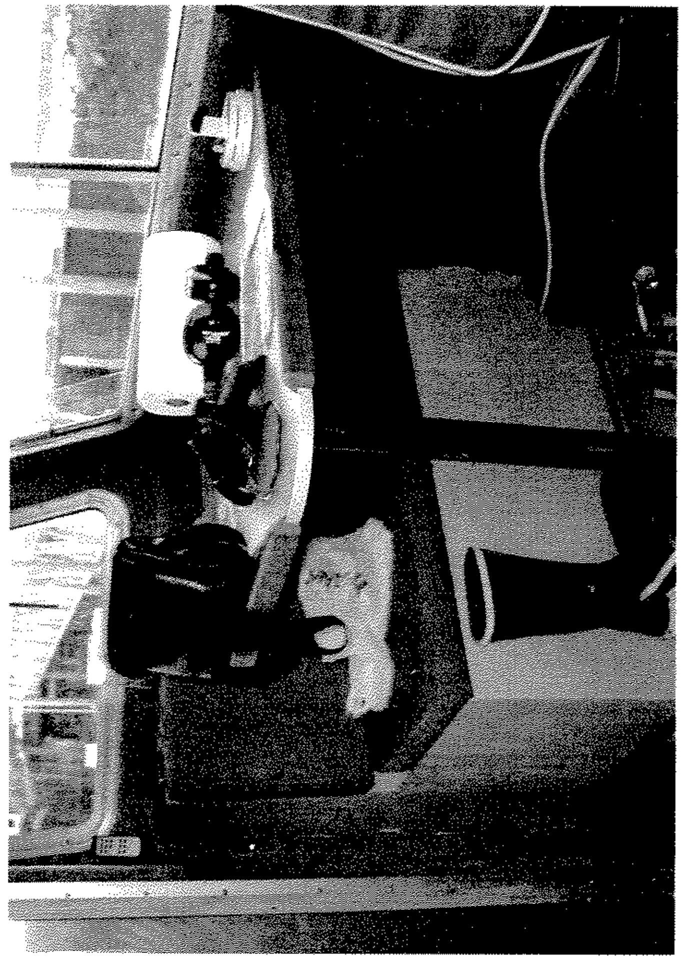
Twin C9 500 hp cat engines
Twin 13" Ultra jet Jet drives
1 power bow roller
Keel coolers for engines
Fish hold/deck space 14'x15'
Fuel capacity 350 gallons
Water 20 gallons
1 3000 watt inverter for AC with 4-4D batteries
VHF, plotter, radar, depth finder
2" wash down / fine pump
Duel hydraulics
High water alarm
(Cabin) Sleeps 2, small galley with head, shower, table for 4 people, stove, sink.
(Safety gear) 1 six man life raft, two 30" life rings.
2 swing stations for boat transfer. One 406 epirb
4 fire extinguishers, 4 survival suits, 4 life jackets type 1
USCG approved Nav lights
Davit with pot puller
Fuel consumption 30 gallons per hour 32kt
Working speed 3-5kt 10 gallons per hour

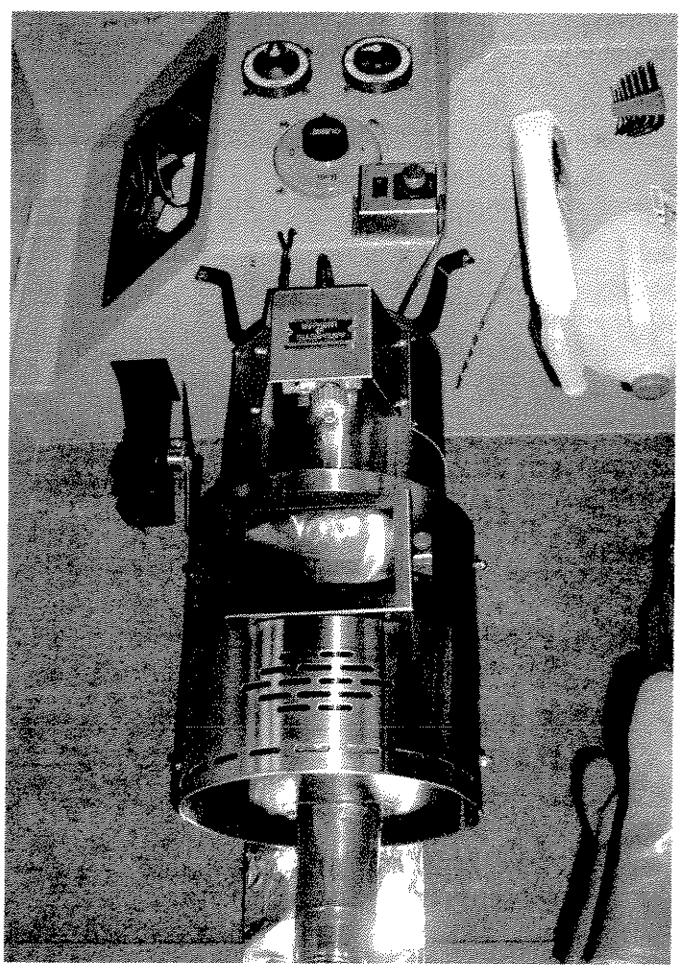
P.O. Box 770768 • Eagle River, AK 99577
Jeff Johnson, Owner • (907) 258-6448 • Fax (907) 258-4654

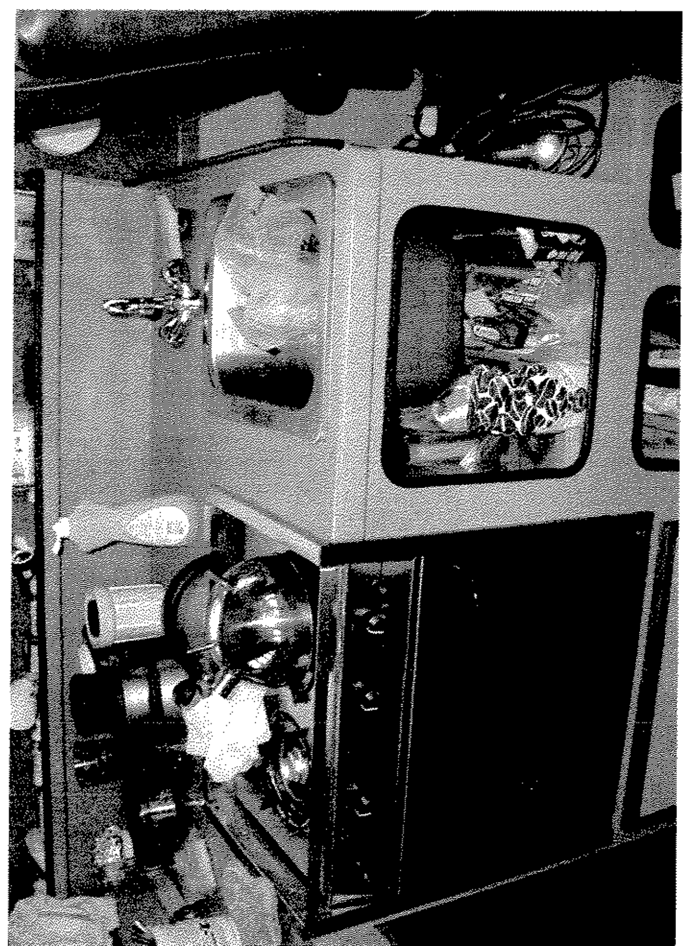













Rocky Point Enterprises, Inc.
P.O. Box 1047
Homer, Alaska 99603

MARINE SURVEYOR

Commercial • Fishing • Pleasure
Condition • Value • Insurance

Capt. Dale W. Johnson
(907) 235-8967
Fax (907) 235-2108

MARINE SURVEY REPORT

F/V SLEEP ROBBER

June 15, 2007

This is to certify that the attending surveyor, upon the request of Mr. Jeff Jenson, did attend the F/V Sleep Robber while it lay afloat at Homer, Alaska on June 13, 2007 for the purpose of conducting a condition and value survey to be used for the purpose of obtaining financing and/or insurance. The closing paragraph of this survey is incorporated wholly by reference herein and will not be duplicated here.

GENERAL VESSEL PARTICULARS

VESSEL NAME: Sleep Robber

VESSEL OWNER: Jeff Jenson
Box 770955
Eagle River, AK 99577

VESSEL TYPE: gillnet

HAILING PORT: Juneau, Alaska

OFFICIAL NUMBER: 1047324

HULL CONSTRUCTION: welded aluminum

GROSS TONS: 14 NET TONS: 18

REGISTERED LENGTH: 32.0' BREADTH: 14.0' DEPTH: 6.0'

YEAR BUILT: 1996 BUILT BY: Bennett Marine at Bellingham, WA

PROPULSION: Twin Volvo Penta TAMD-63-L diesel engines with
Borg Warner marine gears/Hamilton jet drives

ENGINE ALARMS: high temperature, low lube oil

FIRE EXTINGUISHERS: (2) 2 1/2 lb. dry chemical, (1) 5 lb. dry chemical

HEAT/SMOKE/VAPOR SENSORS: YES, (1) Xintex #S-2A propane vapor sensor

BILGE ALARMS: NONE

BILGE PUMPS: (1) 12 volt Rule #2000, (1) 12 volt Rule #3500

LAST DRYDOCKED: June 8, 2007 REASON: storage and engine overhaul

LIFESAVING EQUIPMENT: (1) life ring, (4) survival suits, (1) marine flare kit

RECOMMENDATIONS OUTSTANDING ON THIS SURVEY: YES **NUMBERS: 1 - 2**

GENERAL AND ARRANGEMENT:

This is a welded aluminum hull constructed of apparent good and adequate scantlings by Bennett Marine at Bellingham, Washington in 1996. The vessel has one deck, hinged navigation mast, raked stem, transom stern, hard chined planing hull, self bailing open work deck forward, net reel and fish holds midships, cabin aft.

The foredeck is surrounded by 28" to 32" bulwarks and contains a bow mounted Maritime Fabricators power roller, next aft a Freeman flush deck hatch to the forward void/storage compartment, to starboard forward a helm with full engine controls, next aft a hydraulic driven net reel with levelwind on slide rails and ten individual fish holds with single section aluminum covers (six 36" x 38" and four 30" x 41").

The flying bridge in accessed by steps from port aft and contains an engine removal hatch with aluminum cover, Durable plastic seat/storage locker, full width console with helm.

The cabin is entered by watertight aluminum door from midships forward and contains from port aft the galley with cupboard and counter space, Princess three burner propane range/oven, single basin stainless steel sink, next forward the helm with seat, full engine controls, instruments, gauges, various electronics, to starboard the galley messing table with fore and aft seating, aft three tiered berths.

Hatches in cabin sole access engine room.

Vessel interior is finished with a vinyl sole, Formica and wood trimmed overhead, carpeted bulkheads with Diamond Sea Glaze aluminum frame windows.

MASTS/BOOMS/RIGGING: (1) 3 1/4" hinged aluminum pipe navigation mast
with 1 3/4" aluminum forebraces

GROUND TACKLE/DECK GEAR: (1) 20 kg Bruce anchor with 1/2" chain, 3/4" double braided nylon, (1) Maritime Fabricators hydraulic net roller, (1) Kinematics Twister hydraulic driven 51" X 36" aluminum net reel with levelwind on aluminum slide rail with 360° swivel mount.

PROPULSION & ASSOCIATED EQUIPMENT:

ENGINES: two MAKE: Volvo Penta MODEL: TAMD-63-L FUEL: diesel

HORSEPOWER (each): 318 TOTAL: 626 HOURS: 2 hrs (reported overhaul April 2007)

COOLING: double keel cooled (engines & aftercoolers)

EXHAUST: dry exhaust to wet jacketed mufflers

MARINE GEAR MAKE: Borg Warner MODEL: Velvet Drive RATIO: 1:1

JET UNITS: Hamilton #273

HYDRAULICS: (1) Cessna 3.8 cu. in. load sensing pump direct driven from port main engine

STARTING SYSTEM: 12 volt FUEL SHUTOFFS AT ENGINES: YES

ENGINE ROOM VENTILATION: natural

ALARMS: high temperature, low lube oil

CLUTCH & THROTTLE CONTROLS: Solo electronic, (3) station

STEERING: Jastram hydraulic, (3) station

OTHER: (1) set Webber Marine electro-hydraulic trim tabs, (1) Propex 10,000 BTU propane fired forced air furnace with 12 volt blower (external air supply and exhaust), (1) Pacer 2" X 2" hydraulic driven centrifugal washdown pump, (2) engine exhaust pyrometers

FUEL:

NUMBER OF TANKS: one

LOCATION: forward compartment

TOTAL CAPACITY: 400 gallons

FUEL FEED LINES: neoprene

FILL CONNECTIONS: flush deck

CONSTRUCTION: aluminum

FILTERS: (2) pair Racor #75/1000

SHUTOFF VALVES AT TANKS: YES

VENTS: overboard

FLAME SCREENS: NONE

POTABLE WATER:

NUMBER OF TANKS: one

LOCATION: forward compartment

CONSTRUCTION: aluminum

TOTAL CAPACITY: 30 gallons

ELECTRICAL:

AUXILIARY GENERATOR SETS: NONE

BATTERIES & CHARGERS: (6) 12 volt Group 27 heavy duty batteries (arranged in 3 banks of 2 batteries each), secured in acid resistant trays with covers charged by engine alternator, fit with battery disconnect switches.

DISTRIBUTION, WIRING & OVERLOAD PROTECTION: Marine wiring, fuse panel and circuit breaker distribution, good condition.

ELECTRONICS & NAVIGATION:

RADIOTELEPHONES: (1) Standard #CMP847P VHF-FM, (1) Icom #IC-M58 VHF-FM,
(1) Midland business band radio

RADAR: (1) Furuno #1940, 24 mile

GPS: (1) Garmin #152 with plotter, (1) Northstar #941X with plotter

PLOTTER: (1) Echo Tec #CTM950

DEPTHSOUNDER: (1) Garmin #340C color video

COMPASS: (1) Ritchie 3 1/2" bubble

SEARCHLIGHT/DECKLIGHTS: (9) 12 volt sealed beam decklights, (1) ACR 12 volt searchlight

NAVIGATION LIGHTS: for type

AUTOPILOT: NONE

OTHER: (1) Dual #MX-D41 AM/FM/CD stereo deck with (2) speakers

GENERAL COMMENTS:

Vessel appears sound and well built, overall condition and maintenance very good. Vessel was attended afloat, underwater body was not inspected. Vessel ADF&G #69852

ESTIMATED VALUES:

MARKET: $175,000.00 **REPLACEMENT: $295,000.00**

RECOMMENDATIONS:

1. Procure and install an approved CO alarm in enclosed accommodation area.

2. Vessel to be fit with high water alarm in bilges.

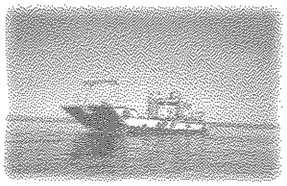
The above report is an unbiased opinion of the attending surveyor after careful examination of the vessel while it lay afloat and without making removals or opening up to expose parts normally concealed or testing for tightness or visibly and physically surveying the machinery internals or inaccessible areas, and without testing electronics, machinery and equipment. Further, no determination of intact stability or inherent structural integrity has been made. Although in the evaluated opinion of the attending surveyor the vessel is considered a good risk for the service intended, with the exceptions noted, it is fully understood by all that this report does not constitute a warranty of the vessel in any respect and that no liability is accepted by the reliance of anyone on the opinions set forth herein. It is further understood that this survey is for the benefit of Mr. Jeff Jenson only, and may not be relied upon by any other persons without written consent by surveyor and that anyone using this survey for any purpose agrees to hold Rocky Point Enterprises, Inc. and/or it's employees, representatives and surveyors harmless for any errors and/or omissions regarding this survey. Further, any prospective buyer should make his/her own personal inspection of the vessel including sea trialing of the vessel.

Submitted Without Prejudice,
Captain Dale W. Johnson
Rocky Point Surveys, Inc.

Dale W. Johnson

Dale W. Johnson, Marine Surveyor

Attending Surveyor: Dale W. Johnson
DWJ/DJ



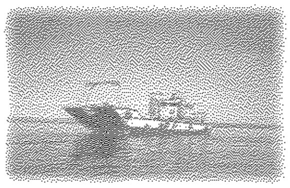
Peregrine Falcon, Inc.

Specializing in Seismic Research • Oil Spill Response • Fish Tendering • Freight Hauling

M/V Maxime spec sheet

New construction 2007
16x40 landing craft (jet drive)
2- 315hp cummings with 274 hamilton jets
1- 8kw gen set northern lights
Electronics- VHF radar, plotter, depth finder, full nav lights
4 bunks with galley, head with shower, table four 4 people, stove, sink
Duel hydraulics
Wash down / fire pump
Safety gear- one 12 man life raft/elliot, 4 survival suits, 4 type 1 life jackets
2 life rings, one 406 epirb, 2 swing stations for boat transfer, 4 fire extinguishers
1 high water alarm
Deck space approx 14'x20'
Draft 24"
250lb anchor with winch
Deck lights
Hydraulic bow ramp
800 gallons fuel
Fuel consumption 24 gallons per hour-8kt
10 gallons per hour 3-5kt working speed
Water capacity 1000 gallons
1 davit with pot puller

P.O. Box 770768 • Eagle River, AK 99577
Jeff Johnson, Owner • (907) 258-6448 • Fax (907) 258-4654



Peregrine Falcon, Inc.

Specializing in Seismic Research • Oil Spill Response • Fish Tendering • Freight Hauling

M/V QAYAQ Spirit

42'x14' USCG inspected 32 passenger
3 – 420hp yanman diesel
3 – 292 Hamilton jet with gears
Seating for 34 people
Covered back deck approx 14'x14'
2 side port r starboard loading swing stations
500 gallon fuel capacity
Large dry storage bow area
Fold down ladder ramp for loading people from beach
32kt cruise speed fully loaded
Fuel consumption cruise speed 33 gallons per hour
Safety equipment- two 20 man life raft eliott
32 type 1 life jackets, 1- 406 epirb
1 automatic engine room fire extinguisher, 4 ABC fire extinguishers
3 – 30" life rings, 4 survival suits.
USCG approved nav lights, Deck lights
Electronics- 2 VHF, 1 anemometer, 1 GPS
1 plotter depth finder,1 radar, 1 hailer
1 - 2500 watt inverter
1 – 50 gallon fresh water tank
1 head with sink
1 wash down 12 volt pump

P.O. Box 770768 • Eagle River, AK 99577
Jeff Johnson, Owner • (907) 258-6448 • Fax (907) 258-4654

DHS, USCG, CG-1270 (REV. 06-04)

OMB APPROVED 1625-0027

UNITED STATES OF AMERICA

DEPARTMENT OF HOMELAND SECURITY
UNITED STATES COAST GUARD

NATIONAL VESSEL DOCUMENTATION CENTER

CERTIFICATE OF DOCUMENTATION

VESSEL NAME	OFFICIAL NUMBER	IMO OR OTHER NUMBER	YEAR COMPLETED
QAYAQ SPIRIT	1160606	PEB42120D904	2004

HAILING PORT	HULL MATERIAL	MECHANICAL PROPULSION
WHITTIER, AK	ALUMINUM	YES

GROSS TONNAGE	NET TONNAGE	LENGTH	BREADTH	DEPTH
27 GRT	22 NRT	42.0	14.0	7.0

PLACE BUILT
ANCHORAGE, AK

OWNERS
GORDON P HEDDELL
MARILYNN N HEDDELL

OPERATIONAL ENDORSEMENTS
COASTWISE
REGISTRY

MANAGING OWNER
GORDON P HEDDELL
200 W 34TH AVE #991
ANCHORAGE, AK 99503

RESTRICTIONS
NONE

ENTITLEMENTS
NONE

REMARKS
NONE

ISSUE DATE
MARCH 19, 2007

THIS CERTIFICATE EXPIRES
APRIL 30, 2008

VDS
9984004

DIRECTOR, NATIONAL VESSEL DOCUMENTATION CENTER

U.S. Department of Homeland Security
United States Coast Guard

Commanding Officer
United States Coast Guard
Marine Safety Office

510 L Street, Suite 100
Anchorage, AK 99501-1964
Phone: (907) 271-6700
FAX: (907) 271-6751

16711/QAYAQ SPIRIT
August 11, 2004

Honey Charters
200 W. 34th Ave #99?
Anchorage, AK 99503

Subject: STABILITY LETTER FOR M/V QAYAQ SPIRIT, O.N. 1160606

Dear Mr. Heddell:

A simplified stability test, witnessed by the U.S. Coast Guard in accordance with Title 46, Code of Federal Regulations, Subpart 178.310, was performed on the M/V QAYAQ SPIRIT (O.N.1160606) in Seward, Alaska on May 12, 2004. On the basis of this test, stability calculations have been performed. Results indicate that the M/V QAYAQ SPIRIT, as presently outfitted and equipped and subject to the restrictions specified below, has satisfactory stability for the carriage of thirty-four (34) persons and eighteen (18) kayaks on exposed waters under all reasonable operating conditions. Since the passenger capacity and route are based on other criteria as well as stability and may be further limited thereby, you are cautioned that:

THE MAXIMUM PASSENGERS ALLOWED AND TOTAL PERSONS ALLOWED SHALL BE AS SPECIFIED ON THE CERTIFICATE OF INSPECTION.

The following restrictions apply:

1. The superstructure shall not be altered without authorization and supervision of the cognizant Officer in Charge, Marine Inspection.

2. Bulkheads and structures shall not be removed or altered without authorization and supervision of the cognizant Officer in Charge, Marine Inspection.

3. No permanent ballast or other weights shall be added, removed, altered, and/or relocated without authorization and supervision of the cognizant Officer in Charge, Marine Inspection.

4. Bilges shall be kept pumped to a minimum content.

5. It shall be the responsibility of the licensed master to maintain the vessel in a satisfactory, stable condition at all times.

6. A maximum of 1080 pounds of kayaks may be carried evenly distributed on the cabin top on exposed waters

16710/P007566
Serial: H1-0103426
May 29, 2002

QAYAQ SPIRIT; O.N. 1116427; Stability Letter

7. HULL OPENINGS: Any openings that could allow water to enter the hull should be kept closed when rough weather or sea conditions exist or are anticipated

8. WEIGHT CHANGES: This stability letter has been issued based upon the following light ship parameters:

Displacement	10.18	Long Tons
VCG	3.65	Feet Above the Baseline
LCG	7.67	Feet aft of Amidships

Amidships is 21 feet aft of the bow. Any alteration resulting in a change in these parameters will invalidate this stability letter. No fixed ballast or other such weights shall be added, removed, altered and/or relocated without the authorization and supervision of the cognizant OCMI. This vessel is not fitted with permanent ballast.

9. BILGES: The vessel's bilges and voids shall be kept pumped to minimum content at all times consistent with pollution prevention requirements.

10. LIST: You should make every effort to determine the cause of any list of the vessel before taking corrective action.

11. TOWING: This vessel is not authorized for towing.

This stability letter shall be posted under glass or other suitable transparent material in the pilothouse of the vessel so that all pages are visible.

A. D. Wiest
A. D. WIEST
Lieutenant Commander, U. S. Coast Guard
By direction of the Commanding Officer

Certification Date:	27 May 2004
Expiration Date:	27 May 2009
IMO Number:	

United States of America
Department of Homeland Security
United States Coast Guard

Certificate of Inspection

Vessel Name	Official Number	Call Sign	Service
QAYAQ SPIRIT	1160606		Passenger (Inspected)

Hailing Port	Hull Material	Horsepower	Propulsion
WHITTIER AK	Aluminum	420	Jet Drive

Place Built	Delivery Date	Date Keel Laid	Gross Tons	Net Tons	DWT	Length
ANCHORAGE, AK UNITED STATES	27May2004	08Jan2004	R-27			R-42

Owner	Operator
GORDON P HEDDELL 200 W 34TH AVE # 991 ANCHORAGE, AK 99503-3969 UNITED STATES	GORDON P HEDDELL 200 W 34TH AVE # 991 ANCHORAGE, AK 99503-3969 UNITED STATES

This vessel must be manned with the following licensed and unlicensed personnel. Included in which there must be 0 certified lifeboatmen, 0 certified tankermen, 0 HSC type rating, and 0 GMDSS Operators.

1 Master	0 Master & 1st Class pilot	0 Radio Officer(s)	0 Chief Engineer	0 QMED/Rating
0 Chief Mate	0 Mate & 1st Class Pilot	0 Able Seamen/ROANW	0 1st Asst. Engr/2nd Engr.	0 Oilers
0 2nd Mate/OICNW	0 Lic. Mate/OICNW	0 Ordinary Seamen	0 2nd Asst. Engr/3rd Engr.	
0 3rd Mate/OICNW	0 1st Class Pilot	1 Deckhands	3rd Asst. Engr.	
			Lic. Engr.	

In addition, this vessel may carry 30 passengers, 0 other persons in crew, 0 persons in addition to crew, and no others. Total persons allowed: 32

Route Permitted and Conditions of Operation:

---Lakes, Bays, and Sounds plus Limited Coastwise---

GULF OF ALASKA, BETWEEN CAPE ST ELIAS AND CAPE ELIZABETH, ALASKA. NOT MORE THAN 20 MILES FROM A HARBOR OF SAFE REFUGE.

IF THE VESSEL IS AWAY FROM THE DOCK, OR PASSENGERS ARE ON BOARD OR HAVE ACCESS TO THE VESSEL FOR A PERIOD EXCEEDING 12 HOURS IN A 24 HOUR PERIOD AN ALTERNATE CREW SHALL BE PROVIDED.

WHEN OPERATING AS AN UNINSPECTED PASSENGER VESSEL (CARRYING SIX (6) OR LESS PASSENGERS FOR HIRE) ON A LIMITED COASTWISE ROUTE, THE CREW MAY BE REDUCED TO ONE (1) "OPERATOR OF UNINSPECTED PASSENGER VESSELS" OR EQUIVALENT. VESSEL MUST BE IN COMPLIANCE WITH THE

SEE NEXT PAGE FOR ADDITIONAL CERTIFICATE INFORMATION

With this Inspection for Certification having been completed at Anchorage, AK, the Officer in Charge, Marine Inspection, Western Alaska certified the vessel, in all respects, is in conformity with the applicable vessel inspection laws and the rules and regulations prescribed thereunder.

Annual/Periodic/Quarterly Reinspections			
Date	Zone	A/P/Q	Signature
16May2005	SEC Anchorage	A	Woods, Scott A
08Jun2006	SEC Anchorage	A	Howells, Darre
6 Jun 07	Ank	A	Bowh[illegible]

This Amended certificate issued by:

M. E. DeLuke, LT, USCG, By direction
Officer in Charge, Marine Inspection

Western Alaska
Inspection Zone

Department of Homeland Security
United States Coast Guard

Certificate of Inspection

QAYAQ SPIRIT

Certification Date: 27May2004

REQUIREMENTS OF 46 CFR PART 25.

ALL LOADING OR UNLOADING OF PASSENGERS, GEAR, OR CARGO AT REMOTE SITES AND OVER THE BOW OF THE VESSEL MUST BE CONDUCTED WITH THE ASSISTANCE OF THE CREW AND SHORESIDE PERSONNEL.

ONE CHILD LIFE PRESERVER SHALL BE CARRIED FOR EACH CHILD ON BOARD.

Overnight accommodations for 0 passengers.

---Lifesaving Equipment---

	Number	Persons		Required
Total Equipment for		32	Life Preservers(Adult)	32
Lifeboats(Total)	0	0	Life Preservers(Child)	4
Lifeboats(Port)*	0	0	Ring Buoys(Total)	1
Lifeboats(Starbd)*	0	0	With Lights*	1
Motor Lifeboats*	0	0	With Line Attached*	1
Lifeboats W/Radio*	0	0	Other*	0
Rescue Boats/Platforms	0	0	Immersion Suits	0
Inflatable Rafts	0	0	Portable Lifeboat Radios	0
Life Floats/Buoyant App	4	32	Equipped with EPIRB?	Yes
			(* included in totals)	

---Fire Fighting Equipment---

Fixed Extinguishing Systems

Capacity	Agent	Space Protected
330	Halocarbon (Formerly: FM 200, FE241)	ENGINE ROOM

Fire Extinguishers - Hand portable and semi-portable

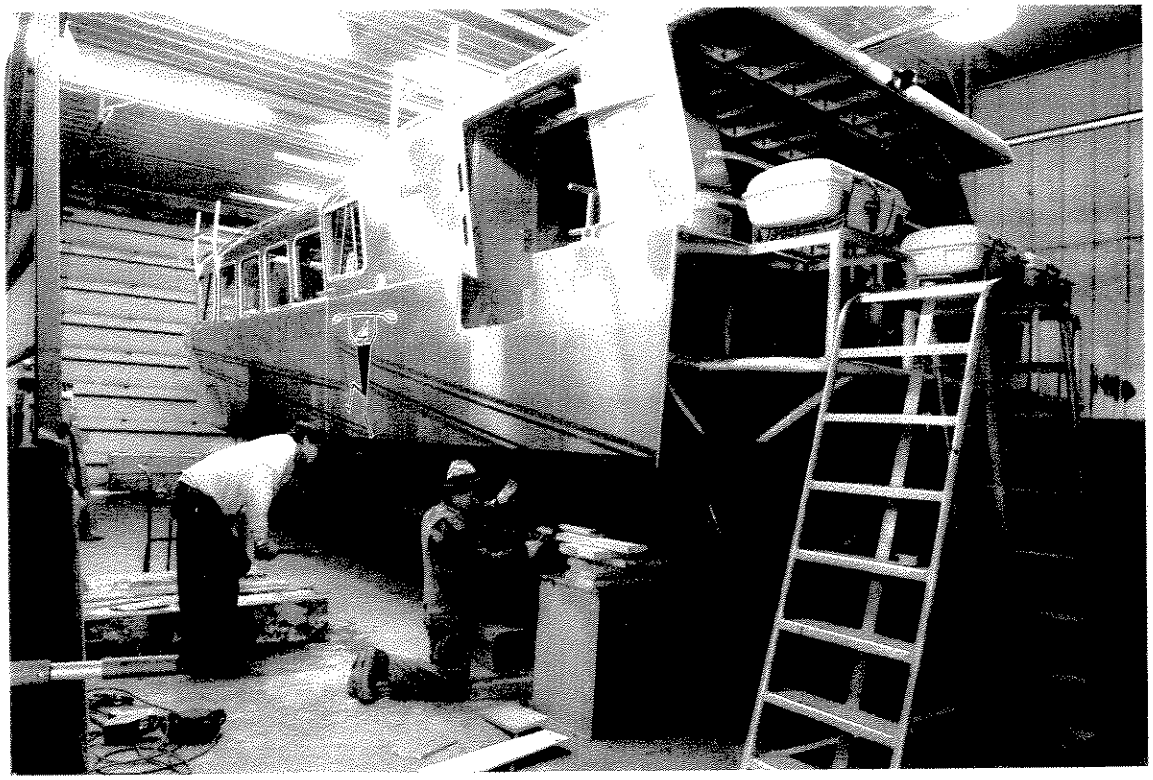
Qty	Class Type
1	B-I
3	B-II

END

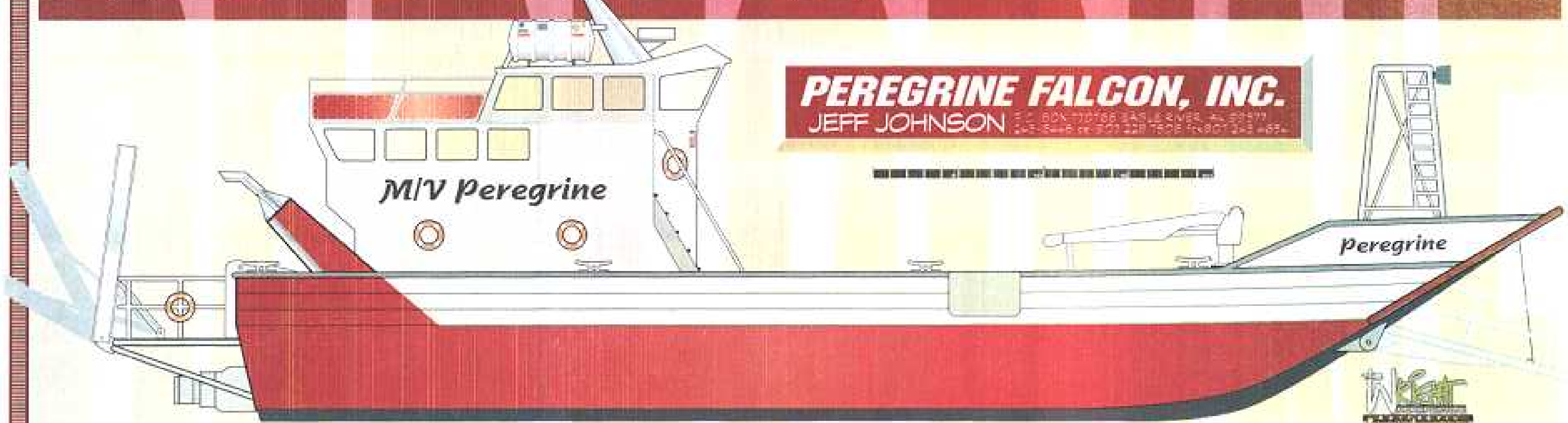

BAY BARGE COMPANY
QAYAQ SPIRIT


HONEY CHARTERS


OVERSIZE



M/V PEREGRINE



PEREGRINE FALCON, INC.
JEFF JOHNSON

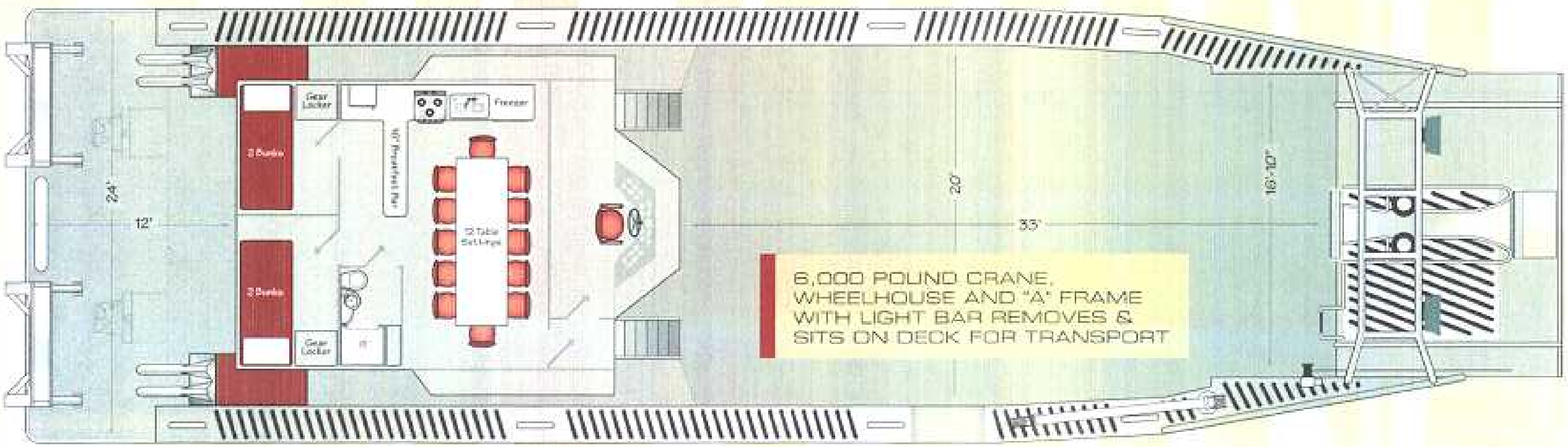
BOAT DRAFTS 2.5 FT.

3@405 HP CUMMINS MAINS
24" TRACTOR JETS OUTSIDE ENGINES
34" TUNNEL PROP

HYDRAULIC SYSTEMS:
- JETS / STEERING
- GUN "A" FRAMES AND CRANE
- SYSTEM RUNS SQUIRTER DECK & TWO ANCHOR WINCHES

20 KW NORTHERN LIGHT GENERATOR SET
30 KW NORTHERN LIGHT GENERATOR SET
800 GALLON P/DAY WATER MAKER

SLEEPING QUARTERS FOR 13 PEOPLE



6,000 POUND CRANE, WHEELHOUSE AND "A" FRAME WITH LIGHT BAR REMOVES & SITS ON DECK FOR TRANSPORT

SPEC SHEET

Grayling Marine International, Inc. and Peregrine Marine International, Inc built the M/V Peregrine in 1990. Her Length Overall is 90', with Beam of 24', and Depth 8.' 3", Drafting 36". Her Gross and net tons are 131 and 111 respectively. The M/V Peregrine is an all aluminum plate constructed landing craft style vessel. She has a semi-v bottom square transom stern and a raked bow with a bow gate that raises hydraulically with cable and pulley operations from port and starboard sides. The vessel is designed with a reverse chine, gull wing design to a square chine, straight sides with raised, compartmental bulwarks to port and starboard sides, and small bow compartments forward at the bow gate.

OAL: 90' BEAM: 24 ' DRAFT: 36" DEPTH: 8' 3"

Bow Gate/Winches: Bow Gate is 15' 6" wide, all aluminum 5086 construction with non-skid applications, and aluminum pipe safety rails around the entire bow compartment and gate area. 2-Hydraulic Ramp Winchs, maximum line pull 12,000 lbs (top wrap).

Aft Work Deck Area: 15' long x 24' wide. Approximately 360 sq ft deck space.

Cargo Deck: 33' x 20' x 6' x 10' = 720 sq ft of usable space – 50 Ton Capacity.

Deck: All decks are aluminum star plate aft walkways or plate construction with non-skid applications on stairs and lower cargo decks. Forward bow deck and main weather deck are aluminum plate construction.

EXPERIENCE

The M/V Peregrine and crew has an excellent safety and environmental record working for Western Geco, Northern Geophysical, Fairweather Geophysical, BP Phillips, Arctic Geo Science, and Veritas.

The M/V Peregrine has worked in the seismic field in Cook Inlet and Prudhoe Bay as a shallow water cable boat, air gun boat and streamer boat. Owner/Captain Jeff Johnson has 17 years experience working Cook Inlet and 6 years experience in Prudhoe Bay and is very familiar with extreme tides, shallow water, and working around ice in shallow water.

Other work experience includes oil spill response, freight hauling, and tendering.

Owner/Captain Jeff Johnson is also the owner/operator of Sea State One Marine, LLC, a custom boat manufacturing company that constructs the "Peregrine" boat line.

PROPULSION/STEERING

Main Engine(s):	3-Cummins 2006 QSL9, 405 HP, 6 cylinder, diesel engine. 12 V DC start
Tractor Jets:	2-North American Marine Jets (port and starboard side jet drive units) 24", Jet I 300 with 2 Twin Disc 1-34" Propeller in Tunnel
Fuel Consumption:	35 GPH at Cruise.
Controls:	Morse flexible cable controls at main helm.
Cooling:	Integral aluminum pipe keel cooler.
Vessel Speed:	Cruise @ 8 knots, normal operation.
Generator:	2-Northern Lights Volts: 120V/220V AC 1 phase 1-KW: 20kw 60 cycles 1-Kw: 30kw 60 cycles

CAPACITIES & INFORMATION

Fuel Capacity: 7200 gallons - 16 tanks

Hydraulic Capacity: 3 separate systems- (2)-59 gallon and (1)-30 gallon aluminum tanks.

Water Capacity: 1500 gallons, 4-tanks, all aluminum.

Waste Oil Capacity: Portable 5 gallon buckets.

Watermaker: 800 GPD - Filtration Concepts

Fuel Transfer Station at aft deck

2 - Sodium driving lights

8 – Halogen deck lights

1 USCG Approved Sewage System (Humphrey)

Crane: 1 - Auto Crane, straight boom hydraulic crane with 20' extension, starboard forward deck, 1 - Ramsey hydraulic winch/worm drive, 50' of 7/16 galvanized cable and full hydraulic controls inset mounted at the crane pedestal.

New 2007 Marine Crane Model T-7000M/3S 27' Reach #6000 Maximum Lift Capacity.

Hydraulic Control Station: H-Frame Seismic gun rack frames is located on starboard forward back deck.

2 - 4" x 12" x 1/2" X 16' aluminum channel H-Frames on port and starboard sides of stern. These articulate on lower aluminum brackets with 2 each hydraulic rams, 4" bore x 48" stroke, rated 3000 psi. With #8000 capacity including Winch.

1 - Centerline forward, all aluminum hydraulic seismic cable Squirter, dual horizontal cable discharge unit with articulating rubber tire hydraulic roller assembly with aluminum pipe hand rails port and starboard sides. Roller assembly is operated by dual hydraulic ram on aluminum bar stock for thwart ship movements.

1 - Kolstrand power block 12" steel shivs with aluminum plate lower frame and #12 aluminum ship's cleat attached to the crane for seismic cable operations.

2 – Swing Boarding Stations Midship.

1 - 800 GPD Watermaker – Filtration Concepts

1 - Miller Welding Machine – wire/stick feed for aluminum/steel.

16 – Survival Suits

16 – Life Jackets

2 – Solas Liferaft (20-man capacity) & 1 – Solas Liferaft (12-man capacity)

1 – 16' Achilles raft with 35HP jet drive

ELECTRONICS & NAVIGATION

Furuno 36 mile Radar	1831 Mark II
Goldstar 24 mile radar	Turbo 951
Furuno Auto Pilot	FAP-300
Stephen SSB Radio	SEA-222
Cetrek GPS	Chart Link
Simrad 12 Color Plotter/Sounder	CA54
Magellan GPS Navigation Compass	5000 DX
Uniden VHF Radio	MC 625
Raytheon VHF Radio/Hailer	Ray 202
Set of 3-5" brass clock, barometer and anemometer	Downeaster
2-Standard VHF Radios	GX2320S
2-Low Range digital depth sounder	System 3000
Data Marine digital depth sounder	CD 400
Jensen AM/FM Cassette Player w/ 4 remote speakers	XCC 7100
31" Liquid-filled navigational Ritchie compass	Power Damp
Focus closed circuit TV system with 1 remote station	
2 Satellite Telephone s	Iridium 9505 and Globalstar

LIVING QUARTERS & FACILITIES

- M/V Peregrine accommodates (13) people with two rear cabin staterooms sleeping two each, upper quarters sleeping four, and lower crew quarters sleeping five. Sleeping areas are equipped with a TV/DVD/VCR. Video library of 750+ movies.

- Removable deck housing unit sleeps six.

- Full Galley

  Full size refrigerator
  Full size upright freezer and two chest freezers
  Ceramic top stove/oven - standard size
  Two Microwave ovens
  Dishwasher
  Large double-sink
  Seating for eight

- Washer/Dryer – stackable, front-loading

- Heads - two complete heads with shower, upper & lower cabin – USCG-approved system

M/V Peregrine
U.S.C.G. Classified Oceanographic Research Vessel

Commercial Charter Clients

Veritas Geophysical
- 2001 Seismic Cable & Gunboat (Marathon Oil)
- 2005 Seismic (Conoco/Phillips)
- 2002 Seismic (Andarco) Cook Inlet
- 2006 Seismic Well Shoot

Terra Surveys
- 2005 Survey Vessel - Norton Sound – 10 people

American Marine Corporation
- 2005 Supply Vessel/Crew Housing/Beach Support – Cook Inlet – 12 people

NOAA
- 2004 Research Vessel for Seal Tagging
- 2005 Cook Inlet Seal Tagging
- 2006 Cook Inlet Seal Tagging

Northern Geophysical
- 1996 Streamer Vessel/Gunboat – Cook Inlet (Phillips)
- 1996 Beaufort Sea/Northstar Island (BP)
- 1997 Beaufort Sea (BP)

Western Geophysical
- 1998 Cable Boat - Beaufort Sea (BP)
- 1999 Supply Vessel – Beaufort Sea (BP)
- 2000 Supply Vessel – Beaufort Sea (BP)
- 2001 Gunboat – Beaufort Sea (BP)
- 2006 Supply Vessel Beaufort and Chukchi Seas

Offshore Divers
- 2004 Dive Boat – Cook Inlet (State of Alaska)

Deepwater Corrosion
- 2002 Survey Streamer – Cook Inlet (Phillips Pipeline)
- 2004 Survey Streamer – Cook Inlet (Tesoro Pipeline)

U.A.F.
- 2006 Augustine Island Research

BP Exploration (Alaska) Inc.
900 East Benson Boulevard
P.O. Box 196612
Anchorage, Alaska 99519-6612
(907) 561-5111

December 14, 2007

Mr. Craig Perham
Office Marine Mammals Management
U.S. FISH AND WILDLIFE SERVICE
1011 East Tudor Road
Anchorage, Alaska 99503

REQUEST OF LETTER OF AUTHORIZATION
PURSUANT TO SECTION 101(A)(5) OF THE MARINE MAMMAL PROTECTION ACT
COVERING 3D OBC LIBERTY SEISMIC SURVEY AND BATHYMETRY SURVEY

Dear Mr. Perham,

BP Exploration (Alaska) Inc. (BPXA) plans to conduct a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea in the period July/August 2008, with an "as needed" extension of additional days at the end of September/October. Prior to the seismic survey a bathymetry survey is planned, to obtain more detailed information on the shallow water sections of the survey area (<6 ft). The intention is to conduct this bathymetry survey in the winter as soon as the ice has sufficient thickness, which can be as early as mid January 2008. Pursuant to 50 CFR 18, Subpart J and Section 101 (a) (5) of the Marine Mammal Protection Act (MMPA), BPXA requests a Letter of Authorization (LOA) allowing unintentional take of polar bears and Pacific walrus incidental to the activities related to the 3D OBC seismic and bathymetry surveys in the Alaskan Beaufort Sea. Under sections 109(h) and 112(c) of the Marine Mammal Protection Act, BPXA also requests authorization to take polar bears by harassment for the protection of human life and polar bears while conducting survey activities.

The seismic survey will take place within the Liberty and Duck Island Units, state and federal waters in the Foggy Island Bay area. Although portions of the survey area are covered under the existing BPXA operations LOA, a separate LOA request for polar bear and walrus specifically covering the planned Liberty seismic survey is being submitted.

The items required to be addressed pursuant to 50 CFR § 228.38 are set forth in this letter or attached documents:

- Request for Letter of Authorization (Attachment I)
- Polar Bear and Walrus Sighting Forms (Attachment II)
- Field Operating Procedure, Polar Bear Protocol (Attachment III)
- Polar Bear Awareness and Interaction Plan specific to this project (Attachment IV)

As you know, we would welcome an inspection or site visit by you or any of your colleagues to confirm that our activities are appropriately managed with regard to polar bear conservation. Please contact me if I can help facilitate a site visit.

Thank you for your prompt attention to this request. If you have any questions, please contact me at 564-4383 or Erika Denman at 564-5911 (email Erika.Denman@bp.com).

Sincerely,

Bill Streever, Ph.D.
Environmental Studies Leader
BPXA

cc: with attachments

Rance Wall, MMS

Pete Sloan, MMS

Mike Holley, USACE

Matt Radar, ADNR/DOG

Attachments

Hardcopy bcc w/attachments:

Read File

Liberty files (C/O April Carter)

HSE File: 951.01 (Liberty Seismic Survey)

Electronic bcc w/ attachments:

Cash Fay

Erika Denman

Larry Wyman

Gwen Perrin

Carl Lundgren

Jeff Hastings, CGG Veritas (Jeff.Hastings@CGGVeritas.com)

Rick Trupp, CGG Veritas (Rick.Trupp@CGGVeritas.com)

Mike Garland (GARLANDMIKE@aol.com)

Martin Johnson

Lisanne Aerts, LGL Alaska Associates (laerts@LGL.com)

ATTACHMENT I

Request for Letter of Authorization
3D OBC Seismic Survey Activities

BP Exploration (Alaska) Inc. (BPXA), as operator of the Liberty Unit, plans to conduct a three-dimensional ocean bottom cable (OBC) seismic survey program for ~60 days in the period July/August 2008, with an "as needed" extension of additional days after the whaling season in September/October, given the uncertainties in ice conditions and other factors that can influence the survey. The seismic contractor will be CGGVeritas. The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay area, Beaufort Sea. This area includes portions of the Duck Island Unit, known as Endicott which comprises the Endicott causeway, Satellite Drilling Island (SDI) and Main Production Island (MPI), the full Liberty Unit and adjacent state land and waters and federal waters. Approximately 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft and 68% in water depths of 10-30 ft. The approximate boundaries of the total surface area are between 70^o11'N and 70^o23'N and between 147 ^{o}10'W and 148^o02'W (Figure 1).

Pursuant to 50 CFR 18, Subpart J and Section 101(a)(5) of the Marine Mammal Protection Act (MMPA), BPXA requests a Letter of Authorization (LOA) allowing the unintentional take of polar bears and walrus incidental to the 3D OBC seismic and bathymetry survey in the Alaskan Beaufort Sea. Under sections 109(h) and 112(c) of the Marine Mammal Protection Act, BPXA also requests authorization to take polar bears by harassment for the protection of both human life and polar bear while conducting seismic survey activities.

I. OPERATIONS TO BE CONDUCTED

A. <u>Description of Activity</u>

OBC seismic surveys in the Alaskan Arctic are used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. This type of seismic survey requires the use of multiple vessels for cable deployment/recovery, recording, shooting, and utility boats. The planned 3D OBC seismic survey in the Liberty area will be conducted by CGGVeritas. An overview of the activities of this survey is provided below, with focus on the mobilization procedure, seismic sound sources, the deployment and retrieval of receiver cables and the housing for crews.

Mobilization

The vessel fleet involved in the seismic survey activities will consist of approximately eleven vessels as listed below.

- Two source vessels, the *M/V Peregrine* (90 x 24 ft) and the *M/V Maxime* (55[1] x 16 ft).
- One recorder boat/barge, with *M/V Alaganik* barge (80 x 24 ft) and *Hook Point* boat (32 x 15 ft).
- Four small bow picker vessels to deploy and retrieve the receiver cables; these are the *F/V Canvasback* (32 x 14 ft), *F/V Cape Fear* (32 x 12 ft), *F/V Rumplemimz* (32 x 14 ft) and *F/V Sleep Robber* (32 x 14 ft). These vessels can operate in very shallow waters up to ~18 inch (0.5 m) water depth.

[1] For this specific survey it is planned to increase the length of the *M/V Maxime* from 40 to 55 ft.

- HSE vessel *Weather or Knot* (38 x 15 ft).
- Crew transport vessel *M/V Qayak Spirit* (42 x 14 ft) and (Northstar's) hovercraft *M/V Arctic Hawk* (42 x 20 ft).
- Crew housing and fuel vessel *M/V Arctic Wolf* (135 x 38 ft).

To deploy and retrieve cables in water depths less than those accessible by the bow pickers, equipment such as, swamp buggies and/or Jon boats will be used.

Most vessels will be transported by trucks to the North Slope in late May/early June, where they will be prepared at West Dock. The *Arctic Wolf* will sail around Barrow when ice conditions allow and the hovercraft will travel from West Dock. Vessel preparation will include assembly of navigation and source equipment, cable deployment and retrieval systems and safety equipment. The mobilization process will require about 35 days to complete with most activities occurring at West Dock. Once assembled, the deployment, retrieval, navigation and source systems will be tested prior to departure to the project site.

Seismic source

To limit the duration of the total survey, two source vessels will operate, alternating airgun shots. The source vessels will be the *M/V Peregrine* and *M/V Maxime* owned by Peregrine Marine. The sources used for seismic data acquisition will be sleeve airgun arrays with a total discharge volume of 880 cubic inch (in^3) divided over two arrays. Each source vessel will have two 440 in^3 arrays comprised of four guns in clusters of 2 x 70 in^3 and 2 x 150 in^3. The 880 in^3 array has an estimated source level of ~250 dB re 1 µPa. More detail of the 8-airgun array is specified in Table 1.

TABLE 1. Airgun array specification

Item	**Specification**
Energy Source	Eight 2000 psi Sleeve airguns; four 70 in^3 and four 150 in^3
Source output (downward)	0-peak is 6.6 bar-m (236.4 dB re µPa @ 1m 0-pk) Peak-peak is 13.9 bar-m (242.9 dB re µPa @ 1 m pk-pk)
Towing depth of energy source	Between 1-4 m
Air discharge volume	880 in^3.
Dominant frequency components	5-135 Hz

The arrays will be towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths varying from 1-4 m (3-13 ft), depending on the water depth. The vessel will travel along pre-determined lines with a total length of ~2,000 miles (~3220 km) in water depths varying from 3 to 30 ft (1 to 9.1 m). The speed of the vessel will vary between ~1 and 5 knots, mainly depending on the water depth. Each source vessel will fire shots every 8 seconds, resulting in 4 second shot intervals with two operating source vessels. The seismic data acquisition will occur over a 24-hr/day schedule.

Cable deployment and retrieval

Receiver cable lines consist of a hydrophone and a field digitizing unit (FDU) which will be placed on the seafloor according to a predefined configuration to record the reflected source signals from the airguns. Part of the receiver cables will be deployed on mudflats to pick up reflected source signals and allow for full interpretation of the data in the area of interest, i.e. well path (pink line in Figure 1). These cables may have marsh type geophones attached and are placed in a similar configuration as those deployed at the sea bottom. Total receiver line length will be ~490 miles (~788 km) of which ~10 miles (16 km) will be laid on mudflats.

The *M/V Peregrine*, *M/V Maxime* and 4 bow pickers (*Canvasback*, *Cape Fear*, *Rumplemimz and Sleep Robber*) will be used for the deployment and retrieval of the receiver cables. Each of the cable vessels will be powered with twin jet diesels and are rigged with hydraulically driven deployment and retrieval systems ("Squirters"). The *M/V Peregrine* and *M/V Maxime* function both as source and cable vessel and will be capable of carrying 120 hydrophone stations. The receiver cables that will be used are extremely small while still allowing a pull of 800 pounds. The smaller bow picker cable vessels will also carry 120 hydrophone stations and are capable of beach landings.   All cable vessels will maintain 24-hr operations.

The deployment of the receiver cables in the very shallow areas and mudflats will be conducted by other equipment that can operate in shallow waters and marshy conditions (such as swamp buggies, Jon boats). A bathymetry survey will be conducted in the winter (depending on ice conditions, this may be mid January 2008) to obtain more detailed information on the shallow water bathymetry in the seismic survey area. This bathymetry survey will be conducted in water depths of less than 6 ft.

Crew housing and transfer

The *M/V Peregrine* is able to house 10 crew including MMOs. The *M/V Maxime* can accommodate 6 people, including the MMOs. These source vessels will maintain 24-hr operations; crew transfers will take place by crew boats and/or hovercraft. The four bow pickers are too small to house their crew and they will be accommodated on shore. The seismic activity is a 24-hr operation to allow for efficient data acquisition in the short summer season, so crew change vessels will transfer crews approximately every 12 hours.

In addition to housing crew at existing Endicott facilities, there will be a mother ship mobilized, the *M/V Arctic Wolf*. This vessel will house up to 30 crew, store cable parts and fuel for the other vessels. The *M/V Arctic Wolf* is a propeller driven vessel. Because of its size, the vessel can not be transported by truck to Prudhoe Bay and will mobilize from either Homer or Anchorage and sail around Barrow to the survey area when ice conditions allow and in consultation with beluga whale hunters in the Chukchi Sea. Two marine mammal observers will conduct observations off of this vessel during the transits from and to Anchorage/Homer. Crew will be housed in other camps in Deadhorse or other operating areas if the *M/V Arctic Wolf* arrives after seismic acquisition begins.

Refueling of vessels at sea will be conducted following approved US Coast Guard procedures. Refuel of the boat storage will take place at West Dock, Endicott dock or by delivery from an approved Crowley vessel.

B. **Dates and Duration of Activity**

BP requests a Letter of Authorization for the period from January through November 2008. The bathymetry survey, to obtain more detailed information on the shallow water sections of the survey area (<6 ft), will be conducted in the winter on ice that is sufficient to support tracked vehicles and as soon as tundra travel is allowed. This can be as early as mid January 2008. Mobilization and cable deployment on the causeway may begin as early as June 1. Limited deployment of receiver cables might be possible on the mudflats in the Sagavanirktok River delta areas before the ice has cleared. Seismic data acquisition is planned to start on 1 July depending on the presence of ice. Open water seismic operations can only start when the project area is ice free (i.e. < 10% ice coverage), which in this area normally occurs around 20 July (+/- 14 days).

II. Plan of Cooperation

BPXA will communicate with representatives of the NSB communities to provide them information on this project and determine if there are any project concerns. Records of the communication that reflects the discussions with the Native Communities most likely affected by the activity will be submitted to USFWS. BPXA does not anticipate any potential conflicts with the subsistence hunt of polar bear and walrus.

III. Description of Monitoring / Interaction Plan

A. Mitigation and Monitoring

Mitigation measures that will minimize any impact from seismic sounds on polar bear and walrus in water and walrus hauled out on land or ice, will form an integral part of the survey in the form of specific procedures such as: i) speed and course alterations; ii) power-down, ramp up and shutdown procedures; and iii) provisions for poor visibility conditions. These procedures will follow international and NMFS best practice protocols. Measures specific for the species covered by this LOA and the proposed seismic survey are:

- Marine mammal observers on board the source vessels will monitor a safety radius and seismic operations will be shut down if:
  - Walruses are sighted within the 180-dB (Level A harassment according to MMPA) safety zone;
  - Polar bears are sighted within the 190-dB safety zone (adopted by the USFWS as referenced in the Draft Programmatic Environmental Impact Statement for Seismic Surveys in the Beaufort and Chukchi Seas, Alaska. OCS EIS/EA MMS 2007-001);
- Seismic-survey and associated vessels shall observe a 0.5-mile (~800 m) safety radius around walrus groups hauled out onto land or ice.

The main purpose of monitoring polar bear and walrus sightings is to assess whether the actual encounters and potential impacts are consistent with those expected. As described earlier, the main activities will take place in open water. Marine mammal observers (MMOs) will be present on the source vessels and they will report any polar bear and walrus sighting to the Health, Safety and Environment (HSE) Advisor, in cooperation with other field management. The MMOs will document the polar bear sightings, in general using the appropriate forms (Attachment II). All sightings will be immediately reported to the BPXA Security who will report to the appropriate agency personnel. Additionally, BPXA security at Endicott (BPXA facility within the Duck Island Unit) has been requested to communicate to the crew any sightings they may become aware of.

Prior to the open water seismic survey, during the ice-season, a bathymetry survey will be conducted to obtain more information on the water depths of the shallow water areas (< 6 ft). As these activities occur on the ice, there is a potential for impacts on and encounters with polar bears. A very limited portion of the seismic survey will take place on mudflats of the Sagavanirktok Delta, in very shallow waters close to the shore and along the Endicott causeway. There may be some ancillary operations, such as logistical support or emergency situations that require personnel to come on (or close to) land during the open water seismic survey. Prior to the start of the operations on ice and during the open water season but close to shore or on land, BPXA will confer with the USFWS or USGS on the locations of radio-collared bears, and any sightings made by the USFWS in the course of aerial surveys that may have been conducted during the year. Information on probable and historical den locations will also be reviewed and all known active polar bear dens will be avoided by 1 mile. The USFWS will be notified within 24 hours in case a polar bear den is located and the site will be avoided by 1 mile.

B. Intentional Takes: Hazing or Lethal Take

BPXA does not anticipate that any lethal takes of polar bear or walrus will result from the activities in the area covered by this request. Lethal take of polar bears in defense of life would be covered under Section 101 (c). BPXA requests authorization under Section 109 (h) and 112 (c) of the MMPA, to allow for the intentional harassment of polar bears in specific defined circumstances where the life of a person, or the bear is in immediate danger. However, hazing would continue to be provisions of last resort that would be undertaken in keeping with standard practices that have evolved in the North Slope oil fields. If unusual circumstances arise that require hazing, trained personnel will initiate prior discussions with the USFWS to the greatest practicable extent. Only those persons who have completed a USFWS approved hazing training course, and are authorized by the USFWS, would be permitted to take such intentional action.

C. Interaction Plan

A polar bear interaction plan, the "Field Operating Procedure Polar Bear Protocol", which has been developed for other LOA requests by BPXA will also be adhered to for this specific survey where relevant (Attachment IV).

D. Training

All personnel will be provided with a polar bear awareness instruction that will provide them with information on the law regarding polar bears, BPXA's polar bear policy and the design and maintenance of camp facilities and other survey specific aspects designed to increase bear safety. All personnel will undertake environmental awareness training and view a bear awareness video.

Selected personnel will have completed a USFWS approved hazing training program.

IV. Map of Area

A map of the proposed survey is provided as Figure 1.

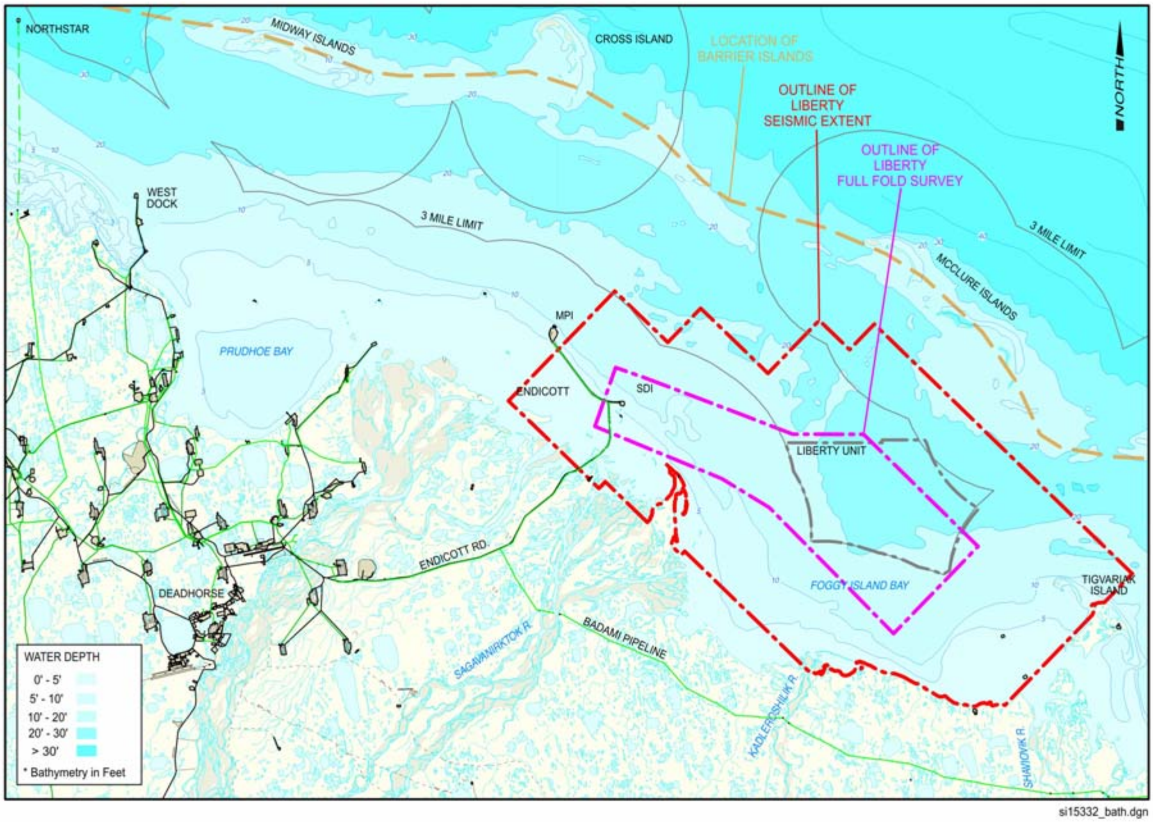


FIGURE 1. Liberty seismic survey area. The pink line represents the area were data needs to be acquired and the red dashed line shows the outline of the Liberty seismic extent, which is the area covered by the receiver and source lines.

V. END OF SEASON REPORT

BPXA will submit a report to the USFWS which will include:

(i) Dates and type of activities conducted

(ii) Dates and locations of polar bear and walrus sightings, including the number of polar bear and walrus, when and how they were encountered and their behavior during the encounter.

(iii) Description of the level of harassment of polar bear and walrus by the seismic survey activities.

This report will be submitted within 90 days after completion of the seismic survey activities.

ATTACHMENT II

Cover for fax

Polar Bears Sighting on Land
Polar Bear Sighting on Water
Walrus Sighting

VIA FAXSIMILE

Date: ________________

TO:

Craig Perham – USFWS
Fax: 786-3816

Dick Shideler – ADF&G
Fax: 459-7332

Steve Amstrup – USGS BRD
Fax: 786-3636

Dayne Haskell --BP
Fax: 564-5020

FROM: Name & Ext: ___________________________________

Facility/Department:________________________________

RE: Polar Bear Sighting Report

Comments:

Pages to Follow:__________

(Does not include cover sheet)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

ON LAND POLAR BEAR SIGHTING REPORT

Date:___________ Observer Name:_______________________________
Time:___________ Contact number/email:_________________________

Location____
____

Latitude:_________________ Longitude_______________ Datum _________________

Weather conditions: Fog_____ Snow_____ Rain____ Clear_____ Temperature____F/C

Wind speed______mph/kts Wind direction___________ Visibility: Poor
Fair
Good
Excellent

Number of bears:
_____ Adult M/F _________ Sow/cub(s)
_____ Sub-adult _________ Sow/yearling(s)
_____ Unknown _________ Sow/2YO(s)

Estimated distance of bear(s) from personnel_____ (meters) and facility:_ _ _ (meters)
closest point) (closest point)
Possible attractants present:____

Bear behavior: ____

Description of encounter:____
____
____
____

Duration of encounter:____

Deterrents used/distance: ______Vehicle ______Bean bag ______Other
______Crackershell ______Horn/siren
______Rubber bullet ______Spotlight/Headlight

Agency/Contacts:
USFWS_Craig Perham (786-3810) (FAX 786-3816)___ Time_______Date__________
ADF&G_Dick Shideler (459-7283) (FAX 459-7332)___ Time_______Date_________

For Additional Information Contact: Diane Sanzone , BPXA (907) 564-4857

United States Department of the Interior
FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

MARINE POLAR BEAR SIGHTING REPORT

Date:___________ Observer Name:_________________________________
Time:___________ Contact number/email:___________________________

Location____
____

Latitude:_________________ Longitude_______________ Datum ___________________

Weather conditions: Fog_____ Snow_____ Rain____ Clear_____ Temperature____F/C

Wind speed______mph/kts Wind direction___________ Visibility: Poor
Fair
Good
Excellent

Number of bears:
_____ Adult M/F _________ Sow/cub(s)
_____ Sub-adult _________ Sow/yearling(s)
_____ Unknown _________ Sow/2YO(s)

Estimated distance of bear(s) from vessel or location_____ (meters)

Bear behavior (Initial Contact): Curious_____ Swimming_____ Resting_____
Hunting ____ Walking______ Other______

Bear behavior (After Contact): Curious_____ Swimming_____ Resting_____
Hunting ____ Walking______ Other______

Description of encounter:____
____
____
____

Duration of encounter:________ **Possible attractants present:**____________________________

Agency/Contact:
USFWS-Craig Perham (786-3810) (FAX: 786-3816)________ Time_______Date__________
(craig_perham@fws.gov)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

PACIFIC WALRUS SIGHTING REPORT

Date:______
Time:______

Location: (include GPS coordinates)____
____

Observer name:____

Weather conditions: Fog_____ Snow_____ Rain_____ Clear_____ Approx. temperature______

Wind speed (kts)__________ Wind direction__________ Visibility _________mi

Total number of walrus: ____ Adult; _____Sub-adult; _____Unknown

Estimated distance (meters) of walrus(es) from location:____

Walrus behavior (initial contact): Resting (hauled out)_____ Swimming_____ Other__________

Walrus behavior (after contact): Resting (hauled out)_____ Swimming_____ Other__________

Duration of encounter: _________min or hour

Description of encounter:____
____
____
____

Agency contacts/ Time of Contact:
USFWS: Craig Perham (907)-786-3810 (phone); 786-3816 (FAX)

Time________ Date__________

ATTACHMENT III

Field Operating Procedure
Polar Bear Protocol

A. Purpose

To provide guidelines for assuring the prompt reporting, investigation, and documentation of polar bear sightings or incidents involving animals protected by the Marine Mammal Protection Act of 1972.

B. Scope

This procedure applies to all sightings or interaction with polar bear occurring during operations on the North Slope.

C. Responsibility

The crew Party Manager and HSE Advisor have overall responsibility. They are responsible for coordination and implementation of all surveillance or monitoring personnel who deal with wildlife/human encounters or sightings on the North Slope.

D. Procedure (Polar Bear Protocol)

1. When a polar bear is detected near any part of the operation, any employee (permanent, temporary or contract) or visitor, shall immediately notify the Party Manager or HSE Advisor.
2. The first priority is the protection of human life. The second priority is to avoid any situation in which a bear is seriously harmed.
3. If a bear is sighted all workers will leave the working area (beach/mud flats) and will return when the area is safe.
4. Transport operators will advise the personnel they are responsible for and have them seek shelter.
5. After all sightings or interactions with polar bears during operations on the North Slope, a Polar Bear Sighting Report shall be completed and forwarded to the appropriate parties.
6. If a polar bear is located within the vicinity of a facility, BPXA Security must be contacted to advise the appropriate parties.
7. Existing BPXA polar bear LOA procedures for land based activity in areas covered by the LOA's will be followed if a polar bear is sighted by personnel on land.
8. If a polar bear is sighted from a seismic source vessel (MV Peregrine and MV Maxime), the mitigation measures as outlined in Attachment I, Section III, A (of this document) will be followed. All vessel operators will be instructed to operate their equipment in such manner that no direct encounters with polar bears are likely.
9. If a polar bear den is sighted, work will cease immediately within 1 mile of the den, the HSE Advisor must report this information to BPXA Security immediately, and BPXA Security will report the information to USFWS and BP Environmental Studies within 24 hours. If a polar bear emerges from an unmapped den or if a den is identified all operations within the one mile area will cease immediately and USFWS will be contacted. USFWS will decide on a case-by-

case basis the appropriate action. There will be no activities, and vehicles and equipment will not pass within 1 mile of known polar bear dens.

This Field Operating Procedure Polar Bear Protocol document will be updated with any changes or additions noted in a Letter of Authorization.

ATTACHMENT IV

Polar Bear Awareness and Interaction Plan

A. Location and Layout

The survey location is in the Foggy Island Bay area. The majority of the OBC seismic survey will take place in open water, where swimming bears or walrus could be present. Activities that will be conducted on ice or close to the shore where bears could be encountered will be very limited and of short duration. Prior to commencing these activities, BPXA will consult with the U.S. Fish and Wildlife Service (USFWS) and the Alaska Department of Fish and Game (ADFG) regarding any known polar bear dens in the survey area.

As described in the Plan of Operations, this activity will be based from a fleet of up to 11 vessels. The seismic operation, as well as the majority of personnel housing, camp facilities, and waste handling will occur on board these vessels, with the potential of some very limited activity on land (e.g. deploying GPS shore stations to support vessel navigation systems). A visual inspection for signs of polar bears will be conducted prior to any activity on land or in any offshore area with extensive ice cover where risk of polar bear encounters is possible.

B. Waste Management

All solid waste generated aboard the vessels will be separated, stored securely and periodically transported to North Slope waste disposal facilities as needed. More details on the waste management procedures will be described in the Waste Management Plan specifically developed for this seismic operation.

Some personnel will be accommodated in existing camps at Endicott where they will comply with the site specific Waste Management Plan.

C. Personnel Control

Heightened awareness for possible bear encounters will form the basis of personnel control and safety. Polar bear awareness instructions will be provided to all field personnel to reduce the likelihood of polar bear encounters. This includes information on the law regarding polar bears, BPXA’s polar bear policy and other survey specific aspects designed to increase bear safety. All personnel will undertake environmental awareness training and view a bear awareness video.

During day-to-day activities, all personnel will be reminded to be constantly on the lookout for polar bears. In general the vessel heights will allow the operators a good vantage point to detect bears in the nearby vicinity. During high risk activities in areas (or periods) with higher ice cover, employees may be assigned as polar bear monitors while the activity is being completed. The combination of individual awareness and early detection monitoring will minimize the chance of a bear encounter.

Personnel will be aware of the restrictions regarding harassment of polar bears, and will be instructed that only designated personnel are authorized to act when a bear is sighted. If a bear is sighted, workers will be instructed to notify the vessel master immediately, who in turn will inform all other project workers on the bear’s presence. Approved on-site trained bear hazers will be summoned to the area to determine if any hazing actions are deemed necessary.

D. Bear Deterrence

The main strategy for avoiding bear/human interactions is to minimize the attractiveness of the site. Wastes are managed to reduce the attractiveness of the site and are discussed above. The continual presence of active machinery and vessel operations, as well as airgun discharges is expected to discourage bears from approaching the site.

Only personnel who have completed an U.S. Fish and Wildlife Service (USFWS) approved training program will be authorized to use deterrence equipment. BPXA has been issued hazing authorization under sections 109 (h)(1) and 112 (c) of the Marine Mammal Protection Act to intentionally take polar bears by hazing under certain circumstances. Designated hazing personnel trained in bear deterrence methods will be available on site. If a bear should remain on site for an extended period, the appropriate USFWS officials will be notified.

E. Record Keeping

Whenever a bear is observed, a sighting report including observations and any actions taken will be completed by the HSE Advisor or Party Manager and submitted to BPXA Security who will submit the report to the appropriate agency personnel.

F. Notification Contacts

If a polar bear is observed or sign identified, BPXA Security must be contacted immediately. Anchorage Health, Safety and Environment should be informed within 24 hours if the encounter is routine, and immediately in case of injury to personnel or the bear. It is the responsibility of Anchorage HSE to contact Federal and State Agencies, unless an emergency precludes those channels, in which case North Slope Environmental should make contact.

Wildlife Notification Contact Numbers

BP Exploration (Alaska) Inc.

Bill Streever (HSE, Anchorage)	907-564-4383 (work) 907-440-8324 (cell)
Stan Gates (HSE, Anchorage)	907-564-5210 (work)
Fax for HSE, Anchorage	907-564-5020
North Slope Security Captain	907-659-4435
Endicott Security	907-659-6800
BOC Security	907-659-4441
PBOC Security	907-659-5634
Greater Prudhoe Bay Environmental	907-659-5196
EOA Environmental Advisor	907-659-5999
WOA Environmental Advisor	907-659-4789
Endicott Environmental	907-659-6541
Milne Point Environmental	907-670-3473
Badami Environmental	907-659-1243
BPXA Security, Anchorage	907-564-5954

Federal and State Agency

Craig Perham (USFWS)	907-786-3810 (work) 907-786-3816 (fax)
Dick Shideler (ADF&G)	907-459-7289 (work) 907-456-3091 (fax) 907-455-6897 (home)
Steve Amstrup (USGS)	907-786-3424 (work) 907-786-3636 (fax)

RSLE ehkw

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

MAY 04 2007

Robert D. Mecum
Acting Administrator, Alaska Region
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Re: EFH Consultation for Liberty Development Project

Dear Mr. Mecum:

BP Exploration (Alaska) Inc. (BPXA) is planning to develop the offshore Liberty reservoir located southeast of the existing Endicott development using extended-reach drilling technology. The project would occur on a previously constructed pad (connected to the mainland with a causeway) rather than an offshore island as originally proposed.

The Minerals Management Service (MMS) designated BPXA as the non-federal representative for Essential Fish Habitat (EFH) consultation for the Liberty Development Project, pursuant to 50 CFR 600.920(c). BPXA has delivered the enclosed document to fulfill MMS's responsibilities under the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Act). We consider the enclosed document to generally serve as the EFH Assessment for the Liberty Development Project. Despite designating BPXA as the non-federal representative, the MMS remains ultimately responsible for meeting sections 305 (b) (2) and 305 (b) (4) (B) of the Act. Therefore, the MMS must provide a conclusion regarding the effects of the proposed action on EFH.

The MMS and US Army Corps of Engineers have determined that the proposed action may adversely affect EFH identified under the Act. The primary difference between an EFH Assessment prepared by MMS and BPXA is that the MMS does not challenge the presumption that the waters of the Beaufort Sea constitute EFH for Pacific salmon and we have consistently treated these areas as if they were EFH. This difference in interpretation is largely inconsequential because we believe the proposed project is consistent with the NOAA document entitled Non-Fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures (2003). As a result, the MMS believes that while there may be minor adverse effects on EFH, those effects have been reduced to the maximum extent practicable.

Please provide any Recommended Conservation Measures on the Liberty Development Project to us within the next 30 days so that we may incorporate those measures into the authorization process, as appropriate. Please contact Mark Schroeder at (907) 334-5247 or at mark.schroeder@mms.gov if you have any questions or require additional information on this consultation.

Sincerely,

John Goll
Regional Director

Enclosure

cc: Mike Holly
Matt Eagleton
Brad Smith

Leasing &
Environment Office

- [x] RSLE
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Author (Buechler)
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Chief, EAS

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cc:

Matthew Eagleton
National Marine Fisheries Service
222 West 7th Avenue, #43
Anchorage, Alaska 99513-7577

Brad Smith
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Anchorage, Alaska

REGIONAL SUPERVISOR
FIELD OPERATIONS
MINERALS MANAGEMENT SERVICE

BP Exploration (Alaska) Inc.
900 East Benson Boulevard
P.O. Box 196612
Anchorage, Alaska 99519-6612
(907) 561-5111

March 26, 2007

Mr. Jeffrey Walker
Regional Supervisor
U.S. Minerals Management Service
3801 Centerpoint Drive, Suite 500
Anchorage, AK 99503

Transmittal of Threatened and Endangered Species Essential Fish Habitat Brief for the National Marine Fisheries Service
Liberty Development Project

Dear Mr. Walker:

BP Exploration (Alaska) Inc. (BPXA) hereby transmits for your review and transmittal to the National Marine Fisheries Service (NMFS) *Threatened and Endangered Species Essential Fish Habitat Brief for the Liberty Development Project*. This Brief was prepared for BPXA by LGL Ecological Research Associates, Inc...

BP Exploration (Alaska) Inc. ((BPXA) is planning to develop the offshore Liberty reservoir located southeast of the existing Endicott development using extended-reach drilling technology from a shore-based pad rather than an offshore island as originally proposed. The location chosen for the drilling site is the Endicott Satellite Drilling Island (SDI) which is accessible by road from the Endicott causeway. SDI is located just offshore of the Sagavanirktok River delta. As you know, in a letter Dr. Balsiger, Regional Director, National Marine Fisheries Service (NMFS) dated February 17, 2006 pursuant to 50 CFR 402.08 and 600.920(c), the Minerals Management Service designated BPXA as the non-federal representative for Endangered Species Act (ESA) and Essential Fish Habitat (EFH) for the Liberty Development Project. BPXA is also the applicant in the proposed federal action. As the non-federal representative, BPXA has conducted informal consultations with the NMFS and has provided the information detailed in the attachment according those discussions with NMFS.

Please call me at 907-339-5024 if you have any questions or need more copies.

Sincerely,

Peter T. Hanley, Liberty HSE Manager

Attachment

cc: Mike Holley, U.S. Army Corps of Engineers

Liberty Development Project Proposed Endicott Satellite Drilling Island (SDI) Alternative

Threatened or Endangered Fish Species
Essential Fish Habitat

A Brief

by

Robert G. Fechhelm Ph.D.
LGL Ecological Research Associates, Inc.
1410 Cavitt St.
Bryan Texas 77845

for

BP Exploration (Alaska) Inc.
P.O. Box 196612
Anchorage, Alaska 99519–6612

March 2007

LGL Ecological Research Associates Inc. (LGL) has been requested by BP Exploration (Alaska) Inc. to prepare a Biological Brief regarding the Liberty Development Project Satellite Drilling Island (SDI) Alternative. This brief addresses the issues of 1) threatened and endangered fish species and 2) Essential Fish Habitat (EFH).

Threatened and Endangered Fish Species

Presently, there are no fish species in the State of Alaska that are 1) listed as either endangered or threatened, 2) candidate species for listing as either endangered or threatened, or 3) proposed for listing as either endangered or threatened (USFW 2006).

Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 established national standards for the conservation and management of exploited fish and shellfish stocks in U.S. Federal waters. Coastal waters extending 200 nautical miles seaward, but outside areas under State jurisdiction, were delineated as fisheries conservation zones for the U.S. and its possessions (later defined as the Exclusive Economic Zone [EEZ]). Fishery Management Councils were created to manage fish stocks within those conservation zones based upon the national standards. Councils were required to prepare Fishery Management Plans (FMPs) that would provide the basis for local administration and management of regional fisheries. FMP components generally address management objectives, alternatives and rationale; habitat issues; the benefits and adverse impacts of each alternative; and plans for the monitoring, review and possible amendments to any action.

The Fishery Conservation and Management Act was followed by the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (MSA), as amended by the Sustainable Fisheries Act of 1996, which required that FMPs further include the identification and description of Essential Fish Habitat (EFH). The MSA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA § 3(10)). The EFH Final Rule (50 CFR Part 600) further elaborates that "waters" include aquatic areas and their associated physical, chemical, and biological properties; "substrate" includes sediments underlying the waters; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. EFH pertains to only commercially-exploited fish and shellfish species under Federal management. EFH includes areas that are under either Federal (offshore) or State (freshwater and coastal) management jurisdiction. The Act also requires Federal agencies to consult and comment on any activities that may adversely affect EFH. Under the National Environmental Policy Act (50 CFR 600.920[e]), in conjunction with stipulations of the MSA, Environmental Impact Statements are required to address issues pertaining to EFH.

Pursuant to NOAA, NMFS (2005), the Preliminary Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska, it is the current position of NMFS that the only two species of fish found in the Beaufort Sea that are amenable to EFH regulation and consideration are the pink salmon (*Oncorhynchus gorbuscha*) and the chum salmon (*O. keta*) (Jon Kurland, Director, NMFS Habitat Conservation Division, Juneau, pers. comm.; Lawrence Peltz, NMFS Habitat Conservation Division, Anchorage, pers. comm.). This is also the position of MMS (Jeff Childs, pers. comm.). Although all five species of Pacific salmon have been reported from the Beaufort Sea, three of these, chinook (*O. tshawytscha*), sockeye (*O. nerka*) and coho (*O. kisutch*) salmon are extremely rare and no known spawning stocks have been identified in the region (Craig and Haldorson 1986, Fechhelm and Griffiths 2001, Stephenson 2006).

Chum Salmon (*Oncorhynchus keta*)

The chum salmon ranges from the Sacramento River in California (and stray as far south as Baja California) north to the Arctic and east to the Mackenzie and Anderson Rivers, west along the Arctic coast of Siberia to the Lena River (Laptev Sea), and south along the coast of Asia to Korea and Japan (Scott and Crossman 1983, Morrow 1989, Salo 2003). In Arctic Canada, small runs of chum salmon have been reported within the Mackenzie River watershed in Great Bear Lake, below Fort Smith in the Slave River, and in the upper Liard River (McPhail and Lindsey 1970, Scott and Crossman 1973; O'Neil et al. 1982; McLeod and O'Neil 1983). Isolated yet reliable reports of chum salmon taken throughout the Mackenzie River drainage date back to 1914 (Stephenson 2006). Chum salmon have been occasionally reported as far east of the Mackenzie River as the Hornaday River (Corkum and McCart 1981, Stephenson 2006). Runs within the Mackenzie River are likely quite small. Of the 30 major fishery surveys that have been conducted over the past 35 years in the Mackenzie River drainage, river drainages along the Canadian coast, and the coastal waters east, west, and within the Mackenzie River delta, almost all report taking no chum salmon (Fechhelm and Griffiths 2001). A 1979 escapement estimate in the Liard River was about 400 fish (Craig and Haldorson 1986).

In the Alaskan Beaufort Sea, small runs of chum salmon have been documented in the Colville River drainage Bendock (1979). In recent years, smolts have been caught in the lower delta (Moulton 2001). Although chum salmon are occasionally taken in the summer subsistence fishery that operates out of the village of Nuiqsut on the Colville River, they constitute only a minor portion of total catch (Moulton et al. 1986). Chum salmon are almost never taken in the fall subsistence fishery that operates from October to December (Moulton and Seavey 2005). There is no direct evidence that chum salmon spawn in the Sagavanirktok River or any other Alaskan River east of the Colville River (Craig and Haldorson 1986). Adult chum salmon are only occasionally taken in Alaskan coastal waters (Fechhelm and Griffiths 2001).

Small runs of chum salmon may also occur in rivers closer to Barrow. Although variable from year to year, substantial numbers of chum are taken in the Chipp River and in Elson Lagoon including adults in spawning condition (C. George, pers. comm., North Slope Borough, Department of Wildlife Management). However, multiple year surveys conducted in the Dease Inlet/Admiralty Bay area reported taking no chum salmon (Philo et al. 1993). Craig and Haldorson (1986) suggest that several rivers along the Chukchi Sea coast between Barrow and Point Hope may support small runs.

Pink Salmon (*Oncorhynchus gorbuscha*)

The pink salmon ranges from La Jolla, California, north to the Arctic and east to the Mackenzie River, west along the Arctic coast of Siberia to the Lena River (Laptev Sea), and south along the coast of Asia to Korea and Japan (Scott and Crossman 1983, Morrow 1989, Heard 2003). In Arctic Canada, rare takes of individual pink salmon have reported since 1936, but in almost all cases only single specimens have been captured (Craig and Haldorson 1986, Babaluk et al. 2000, Stephenson 2006). Most pink salmon have been caught in or near the Mackenzie River Delta. The farthest inland capture was made in the Peel River approximately 120 km from the coast (Hunter 1974 cited in Stephenson 2006). The extraordinarily low numbers of fish reported for Canadian waters suggest they are strays and that there are probably no spawning stocks in the Mackenzie Watershed (Craig and Haldorson 1986, Babaluk et al. 2000, Stephenson 2006). Small runs of pink salmon occur in several drainages along the Chukchi Sea coast (Craig and Haldorson 1986).

In the Alaskan Beaufort Sea, small runs of pink salmon occur in the Colville River. Bendock (1979) caught 64 pink salmon between the mouths of the Itkillik and Etivluk rivers during 1978 and noted fish spawning near the Itkillik River and at Umiat. In 1978, McElderry and Craig (1981) caught two males spawners near Ocean Point just above Nuiqsut. Small numbers of pink salmon are taken in the summer subsistence fishery that operates out of the village of Nuiqsut on the Colville River, but they constitute only a minor portion of total catch (Moulton et al. 1986). Pink salmon are almost never taken in the fall subsistence fishery that operates from October to December in the lower Colville Delta (Moulton and Seavey 2005), however, in recent years, "substantial numbers" of pink salmon have been taken farther inland near the Itkillik River as part of the fall fishery (C. George, pers. comm., North Slope Borough, Department of Wildlife Management). Pink salmon are also taken in the subsistence fisheries operating in the Chipp River and Elson Lagoon just to the east of Point Barrow (C. George, pers. comm., North Slope Borough, Department of Wildlife Management).

In the Sagavanirktok Delta/Prudhoe Bay region, pink salmon are regularly taken in summer fish surveys but numbers are quite low (Fechhelm et al. 2006). In 24 summers of sampling, only 375 pink salmon have been caught. All are adults in spawning condition. In 1982, Griffiths et al. (1983) reported taking eight pink salmon upriver in the west channel near the Sagavanirktok Bridge where several dead spawned-out adults were also observed. However no actual spawning sites or activities have ever been reported for the Sagavanirktok Watershed or any drainage east of the Colville River.

Arctic Expansion

In recent years, concern has been expressed that global warming could allow southern stocks of Pacific salmon from the Bering Sea to expand northward into Arctic waters where they might establish spawning populations (Babaluk et al. 2000, Stephenson 2006). Overall, evidence of climatic change in the Arctic continues to mount (Carmack and MacDonald 2002). Climate models predict a warming trend that could be quite intense at higher latitudes (Walsh and Crane 1992). Carmack and MacDonald (2002) note that the disproportionate influence of warming on Arctic physical systems will have profound effects on Arctic biota. Physical changes will include increased periods of open water, decreased ice cover, rising sea levels, increased storms, shifting water mass fronts, and more. Babaluk et al. (2000) note that changes in the distribution and abundance of salmon in Arctic waters may be useful proxies for monitoring the effects of climate change on the Beaufort Sea.

For 24 of the past 26 years, summer fish monitoring studies have been conducted in Beaufort Sea coastal waters in and around Prudhoe Bay (Fechhelm et al. 2006). Although the catch of pink salmon is relatively low, it is rather persistent through time. From 1981 through 2006, the summer catch rate for pink salmon exhibited no evidence of a protracted shift in abundance (Figure 1). Catch rates for 2003, 2004, and 2005 were significantly higher than all but one of the previous 20 years but CPUE dropped substantially in 2006 when only four pink salmon were taken.

The extension of chum and pink salmon into arctic waters is probably linked to a number of factors. Craig and Haldorson (1986) suggest that intolerance of cold temperatures, particularly in freshwater environments, may limit the establishment of coho and sockeye salmon in the Arctic. Pink and chum salmon are far more tolerant of cold temperatures (Craig and Haldorson 1986).

The predominantly marine life cycle of pink and chum salmon would also give them an advantage in establishing populations along the North Slope. Both species migrate to sea soon after emergence and do not rely on freshwater rearing and overwinting habitat (Heard 2003, Salo 2003). In contrast, sockeye and coho salmon spend one to several years in their natal watersheds before migrating to sea (Burgner 2003, Sandercock 2003). Some stocks of chinook salmon migrate to sea after only three months in freshwater, but most stay within their natal streams for their first year (Morrow 1980). Freshwater overwintering space is at a premium along the Arctic North Slope and the obligatory dependence of sockeye, coho, and possibly chinook salmon could severely limit their success. The ability of fish to exploit available overwintering habitat is considered by some to be the single most important factor limiting the success of amphidromous and freshwater species in the Arctic (Craig 1989).

The obligatory freshwater phase of sockeye and coho salmon would also leave them exposed for longer periods to the cold Arctic temperatures. Craig and Haldorson (1986) speculate that once they emerge into Beaufort Sea coastal waters, chum and pink salmon probably migrate southward toward the Bering Sea thereby avoiding cold Arctic waters during winter. The 1,200+ km summer journey would be well within the migratory capabilities of juvenile pink and chum salmon (Heard 2003, Salo 2003). Mature adults later migrate back to the Beaufort Sea to spawn. Excluding their egg phase, such a migratory cycle would mean that both species would only have to endure Arctic waters during the warmest part of the year.

The expansion of pink salmon into the Arctic may also be hampered by their fixed, two-year life span (Craig and Haldorson 1986). All pink salmon reproduce at age 2 and there is virtually no genetic overlap between alternate year spawning cohorts (Heard 2003). The reproductive output of either year class is confined to a single spawning event and if that spawning fails the bulk of the cohort gene pool could be forfeit. The other species of Pacific salmon are characterized by varying ages at which adults reach sexually maturity. The spawning success of a single cohort is spread out over several years and failure in any single year would not necessarily be catastrophic. Craig and Haldorson (1986) theorized that pink salmon populations in the Arctic probably undergo regular cycles of colonization and extinction due to their precise two-year spawning cycle coupled with the harsh climatic vagaries of the region.

The characteristics of egg deposition could also prevent pink and chum salmon from establishing major spawning stocks in North Slope rivers. Pink salmon from both Asian and North American populations typically spawn at depths of 30-100 cm (Heard 2003). Well-populated spawning grounds are mainly at depths of 20-25 cm , less often reaching depths of 100-150 cm. Redds themselves can be as deep as 46 cm (Scott and Crossman 1973). Chum salmon have adapted to spawning in waters of lesser depths than pink salmon (Salo 2003). In the State of Washington, maximum spawning depths have been reported to be 50 cm, and in Japan 110 cm (Salo 2003). Redd depths are typically less than 50 cm (Salo 2003). On the North Slope, all waterbodies freeze during winter and ice thickness can reach 200+ cm. Much of the substrate where salmon typically spawn would freeze thereby destroying the eggs. Greater survival would likely occur during milder winters when ice cover is less thick. Even during normal winters, much of the reproductive output of the spawning stock could be lost, a factor that could contribute to the relatively small runs that seem to occur in the few Arctic rivers that are populated.

In general, Pacific salmon do not possess the life-history characteristics that define anadromous species of the Arctic. Arctic anadromous fish possess unambiguous K-selective traits: longevity, delayed maturity, and repeat spawning in individuals (Craig 1989). Many species of Arctic anadromous fish have maximum life spans that range from 18-25 years (Craig

1989). In contrast, anadromous salmonids from temperature latitudes have maximum ages that range from 2 to 12 years (Scott and Crossman 1973, Groot and Margolis 2003). Arctic fishes reach sexually maturity in 7 to 11 years depending on species. Pacific salmon generally reach sexual maturity in 2-5 years. Arctic anadromous species are repeat spawners whereas all five species of Pacific salmon die after their first spawning. K-selective traits of Arctic anadromous fish undoubtedly reflective adaptation to the unique environment that they inhabit. K-selective populations are long-lived, have low population turnover rates, and have a relatively stable number of adults. Populations with many year classes of older repeat spawners are better able to withstand intermittent reproductive loss without jeopardizing the survival of the population (Craig 1989). These characteristics enable Arctic fish populations to remain generally stable in what otherwise might be considered a harsh and unstable environment (Johnson 1981, 1983). If these K-selective traits are prerequisites for a successful Arctic existence then they could determine the extent to which more R-selective Pacific salmon are able to expand their range into the Beaufort Sea.

Adverse Effects

The MSA requires federal agencies to consult with the NMFS on all actions or proposed actions permitted, funded, or undertaken by the agency that may adversely affect EFH. An adverse effect is any impact that reduces the quality and/or quality of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species, and their habitats, as well as other ecosystem components. Adverse effects may be site-specific of habitat-wide, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910[a]).

Pacific salmon fisheries in the Alaska are managed under a combination of domestic and international regulations and treaties (NOAA, NMFS 2004). Salmon fisheries are managed by the Alaska Department of Fish and Game (ADF&G) within state waters, where most of Alaska's commercial fishing occurs. Commercial fishing within the EEZ is limited to southeast Alaska and Federal management is deferred to ADF&G. Harvests of chinook, coho, and sockeye salmon in southeast Alaska are managed by agreement with Canada under the Pacific Salmon Treaty. Management of salmon fisheries in international waters of the North Pacific is under the auspices of the North Pacific Anadromous Fish Commission, which consists of four countries (Canada, Japan, Russia, and the U.S.). Federal management of salmon stocks is largely directed by FMPs designed to limit the bycatch of salmon in non-salmon directed fisheries within the EEZ

By definition, the coastal waters in and around the Liberty Development site should not be classified as EFH for chum and pink salmon despite their marginal presence in the Alaskan Beaufort Sea. EFH pertains to habitat "required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem" (50 CFR Part 600). There are no federally-managed commercial salmon fisheries in the Beaufort or Chukchi seas and it is highly doubtful that the low numbers of pink and chum salmon that regularly migrate to the Bering Sea constitute a meaningful component of the commercial fisheries there. There are also no federally-managed fisheries for other species within the Beaufort and Chukchi Seas thereby rendering the bycatch FMP issue moot. Again, it is highly unlikely that Beaufort Sea pink and chum salmon comprise a meaningful portion of bycatch within the North Pacific EEZ.

The MSA defines EFH as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA ' 3(10)). Current theory holds that, upon emergence into coastal waters, the small numbers of salmon that are spawned in the Colville River and rivers west migrate southeast to the warmer waters of the Bering Sea and do not return to the Beaufort Sea until time of spawning (Craig and Haldorson 1986). No juvenile salmon have ever been observed within the Prudhoe Bay area in over 26 years of study (Fechhelm et al. 2006). The few adults that have been caught in the Liberty Development area occur in late summer and are likely stray adult spawners returning to the Colville River. They have already grown to sexual maturity and are no longer feeding. Thus, there is no evidence that the waters in the vicinity of the proposed Liberty Development are used by salmon for any of the ecological requirements defined in the MSA.

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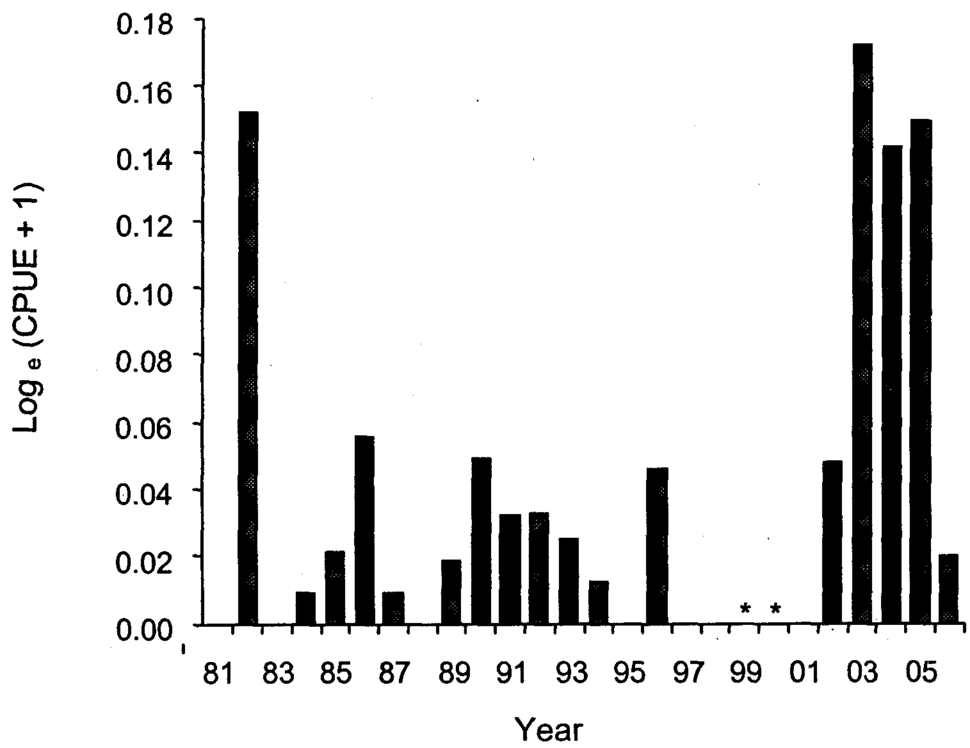

Figure 1. Loge (CPUE [fish/net/24 h]+1) for the 375 pink salmon collected in the Prudhoe Bay area by year. Asterisks indicate years in which no sampling took place. Catch rates for 1982, 2003, 2004, and 2005 were significantly ($P =$ 0.008, t-test, Ostle and Mensing 1972) higher than the remaining 20 summers. Source: Fechhelm et al. (2006).

United States Department of the Interior

U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

April 3, 2007

Memorandum

To: Regional Director, MMS – Alaska OCS Region

From: Ted Swem – Endangered Species Branch Chief

Subject: Seismic Surveys in Chukchi & Beaufort Sea – Revised Section 7 Consultation

Thank you for your memo regarding seismic survey activities in the Chukchi and Beaufort Seas. We understand that MMS is proposing to allow six seismic survey operations in this area in 2007 and an unknown number in future years. These surveys were described in your Biological Evaluation (BE) of Steller's eider (*Polysticta stelleri*), spectacled eider (*Somateria fischeri*), and Kittlitz's murrelet (*Brachyramphus brevirostris*) for Seismic Surveys in the Northeast Chukchi Sea and Western Beaufort Sea Planning Areas dated March 2006, and the BE of Steller's eider (*Polysticta stelleri*), spectacled eider (*Somateria fischeri*), and Kittlitz's murrelet (*Brachyramphus brevirostris*) for Chukchi Sea Lease Sale 193.

Seismic surveys in the Beaufort and Chukchi Seas have the potential to adversely affect listed Steller's and spectacled eiders, and the candidate species Kittlitz's murrelets through:

(a) Disturbance from the noise and visual presence of vessels, seismic arrays, and support aircraft;
(b) Collisions with vessels; and
(c) Direct and indirect effects resulting from spills of petroleum products and other toxic substances from vessels operating in the area.

However, as described in your memo, and in common with survey activities which took place in 2006, MMS is proposing the following mitigation to reduce impacts to listed eiders and Kittlitz's murrelets:

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

2. Survey support aircraft would avoid over flights across the Ledyard Bay Critical Habitat Unit below an altitude of 1,500 feet (450 meters) after July 1 of each year, unless human health or safety dictates otherwise.

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

4. All bird-vessel collisions (with vessels or aircraft) shall be documented and reported within three days to MMS. Minimum information will include species, date and time, location, weather, and if a vessel is involved its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Operators are advised that FWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

5. Operators must maintain a minimum spacing of 15 miles between the seismic-source vessels for separate operations.

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

The following stipulation developed and implemented under the Chukchi Sea Lease Sale 193 Biological Opinion is also in effect:

7. Whenever vessels are in the marine environment, there is a possibility of a fuel or toxic substance spill. If vessels transit through the spring lead system before June 10 they may encounter concentrations of listed eiders. The Service therefore requires that wildlife hazing equipment (including Breco buoys or similar equipment) be pre-staged, and readily accessible by personnel trained in their use, either on the vessel, at Point Lay or Wainwright, or on an on-site Oil Spill Response Vessel, in order to ensure rapid deployment in the event of a spill.

For the purposes of these stipulations, the spring lead system is defined as the area landward of a line drawn from Point Hope to the corner of the LBCHU at 69^{o}12’00”N x 166^{o}13’00”W, to the corner of the LBCHU at 70^{o}20’00”N x 164^{o}00’00”W to the corner of the Lease Sale 193 area at 71^{o}39’35”N x 156^{o}00’00”W (Figure 1).

After reviewing the proposed activities and considering the proposed mitigation measures, the Service concludes that the seismic survey work in the Chukchi and Beaufort Seas will not adversely affect Steller’s or spectacled eiders or Kittlitz’s murrelets and further consultation under the Endangered Species Act is not required.

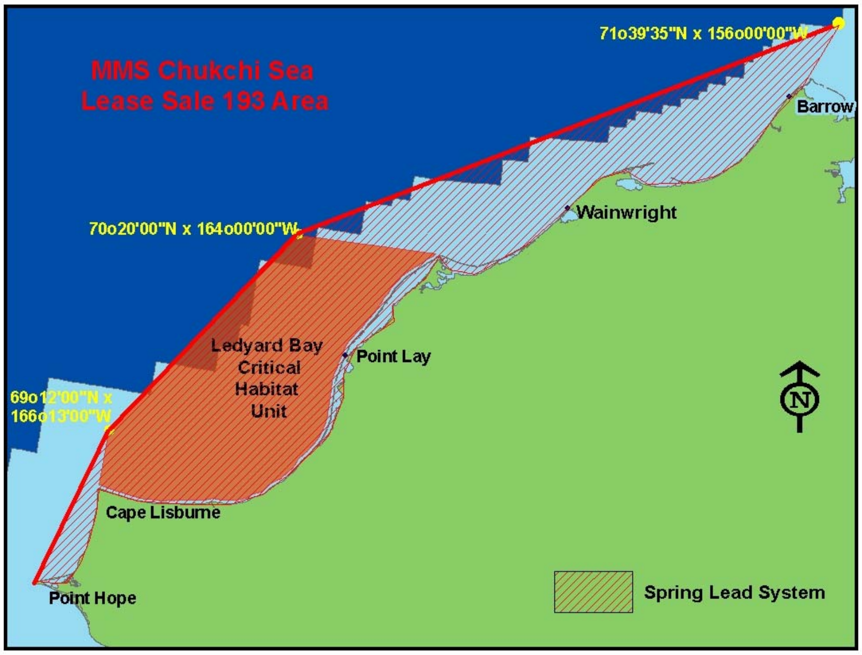

Figure 1- Spring Lead System for Information Needs and Terms and Conditions

However, the Service is aware of several incursions made by seismic survey vessels into the Ledyard Bay Critical Habitat Unit during 2006. We understand that these detours were necessary to ensure vessel safety during bad weather, or ice conditions. The Service is concerned that vessels and aircraft may disturb molting spectacled eiders in the area. In order to monitor the frequency of incursions, MMS should provide the following information to the Service as soon as practicable whenever a vessel enters the critical habitat unit or an airplane flies below an altitude of 1,500 feet over the area:

(i) Date, time, and, where possible, route of vessel entering the Ledyard Bay Critical Habitat Unit; and
(ii) Date, time, altitude, and route of any airplanes traveling below 1,500 feet above the Ledyard Bay Critical Habitat Unit.

If you have comments or concerns regarding this consultation please contact Sarah Conn at the Fairbanks Fish & Wildlife Field Office by phone at (907) 456-0499.

RSLE chron

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

MAY 04 2007

Robert D. Mecum
Acting Administrator, Alaska Region
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

Re: EFH Consultation for Liberty Development Project

Dear Mr. Mecum:

BP Exploration (Alaska) Inc. (BPXA) is planning to develop the offshore Liberty reservoir located southeast of the existing Endicott development using extended-reach drilling technology. The project would occur on a previously constructed pad (connected to the mainland with a causeway) rather than an offshore island as originally proposed.

The Minerals Management Service (MMS) designated BPXA as the non-federal representative for Essential Fish Habitat (EFH) consultation for the Liberty Development Project, pursuant to 50 CFR 600.920(c). BPXA has delivered the enclosed document to fulfill MMS's responsibilities under the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Act). We consider the enclosed document to generally serve as the EFH Assessment for the Liberty Development Project. Despite designating BPXA as the non-federal representative, the MMS remains ultimately responsible for meeting sections 305 (b) (2) and 305 (b) (4) (B) of the Act. Therefore, the MMS must provide a conclusion regarding the effects of the proposed action on EFH.

The MMS and US Army Corps of Engineers have determined that the proposed action may adversely affect EFH identified under the Act. The primary difference between an EFH Assessment prepared by MMS and BPXA is that the MMS does not challenge the presumption that the waters of the Beaufort Sea constitute EFH for Pacific salmon and we have consistently treated these areas as if they were EFH. This difference in interpretation is largely inconsequential because we believe the proposed project is consistent with the NOAA document entitled Non-Fishing Impacts to Essential Fish Habitat and Recommended Conservation Measures (2003). As a result, the MMS believes that while there may be minor adverse effects on EFH, those effects have been reduced to the maximum extent practicable.

Please provide any Recommended Conservation Measures on the Liberty Development Project to us within the next 30 days so that we may incorporate those measures into the authorization process, as appropriate. Please contact Mark Schroeder at (907) 334-5247 or at mark.schroeder@mms.gov if you have any questions or require additional information on this consultation.

Sincerely,

John Goll
Regional Director

Enclosure

cc: Mike Holly
Matt Eagleton
Brad Smith

Leasing &
Environment Office

- [x] RSLE
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cc:

Matthew Eagleton
National Marine Fisheries Service
222 West 7th Avenue, #43
Anchorage, Alaska 99513-7577

Brad Smith
National Marine Fisheries Service
222 West 7th Avenue, #43
Anchorage, Alaska 99513-7577

United States Department of the Interior
U.S. FISH AND WILDLIFE SERVICE
Fairbanks Fish and Wildlife Field Office
101 12th Avenue, Room 110
Fairbanks, Alaska 99701

January 15, 2008

Mr. Michiel Holley
U.S. Army Corps of Engineers
Regulatory Division
P.O. Box 6898
Elmendorf Air Force Base, AK 99506-0898

Re: BP Alaska Liberty Project
Seismic Survey
POA-1998-1109-2

Dear Mr. Holley:

The Service has reviewed an application to use the Nationwide Permit 6 by BP Exploration Alaska Inc. (BP Alaska). BP Alaska proposes to carry out 3-D seismic surveys to provide additional information for their Liberty Development Project. Alaska-breeding Steller's (*Polysticta stelleri*) and spectacled (*Somateria fischeri*) eiders may occur in the project area. Both these species are listed as threatened under the Endangered Species Act of 1973, as amended (Act). The Service conducted a formal section 7 consultation for the Liberty project culminating in a Biological Opinion signed on October 3, 2007. However, the seismic survey work now proposed was not considered in that consultation. This letter provides a section 7 consultation for the seismic activities that may be authorized by the U.S. Army Corps of Engineers (COE).

The seismic survey will take place in a 135.8 mi^2 area of Foggy Bay in the Beaufort Sea, with support activities, such as vessel refueling and material staging, occurring at West Dock. The project will begin in June and finish by November 1, 2008. An estimated eleven vessels will be used during the operation. In addition to marine vessels used in the deployment and retrieval of hydrophone and geophone receiver cables, a hovercraft, swamp buggies, and Jon boats may be used in shallow water (<2 feet deep) areas. Land based crews will assist in areas such as the Endicott causeway where cables are to be laid on land.

Once the receiver cables have been deployed by vessels and land based crews they will be connected to a stationary vessel which records the data. Two source vessels will then tow compressed air guns perpendicular to the receiver lines. The air gun arrays will provide the seismic energy source for the survey. Navigation will be aided by the placement of two Differential Global Positioning System base stations, one on Endicott Island and one on Tigvariak Island. Crews working on the project will be accommodated either on the vessels or at existing facilities at Endicott or Prudhoe Bay.

The proposed activities could adversely affect listed eiders through:

1. Disturbance of nesting females or broods and individuals in marine waters; and
2. Collisions with vessels.

Disturbance – Spectacled Eiders
Cable laying is planned for a small terrestrial area including the Endicott causeway and mudflat areas. These areas are not used by listed eiders, and as no on-tundra activities are planned, disturbance of nesting females or broods is not anticipated.

Listed eiders may be disturbed by vessel activity and airgun sounds during the survey. Satellite telemetry data (TERA 2002), suggests the majority of male spectacled eiders departing North Slope breeding grounds in late June move rapidly through the Beaufort Sea en route to the Chukchi Sea (average travel of 1.75 days). Of 14 transmittered males, only four spent an extended period of time (11 – 30 days) in the Beaufort Sea, and appeared to prefer large river deltas such as the Colville River where open water is more prevalent (TERA 2002). Females, which depart the nesting grounds later, remain in the Beaufort Sea longer than males. They may also migrate further offshore (outside the barrier islands, and hence the seismic survey area). Both the increased use of the Beaufort Sea and offshore migration routes used by females were attributed to the decrease in sea ice later in the summer (Peterson et al. 1999, TERA 2002). While satellite telemetry data indicates some use of the Beaufort Sea by spectacled eiders, we have no data to suggest the project area is occupied by large numbers of spectacled eiders or for long periods of time (Stehn and Platte 2000). Therefore, the Service concludes that while seismic survey activities may disturb spectacled eiders and displace them from the project area, similar marine habitat is not limited in the vicinity, and adverse effects are likely to be insignificant.

Collision – Spectacled Eiders
Migratory birds suffer substantial mortality from collisions with man-made structures (Manville 2004). Birds are particularly at risk of collision with objects in their path when visibility is impaired during darkness or inclement weather, such as rain, drizzle, or fog (Weir 1976). Day et al. (2005) suggested that eider species may be susceptible to collisions with offshore structures as they fly low and at relatively high speed (~ 45 mph) over water. Johnson and Richardson (1982), in their study of migratory behavior along the Beaufort Sea coast, reported that 88% of eiders flew below an altitude of 10 m and >50 % flew below 5 m.

There is a potential for spectacled eiders to collide with a vessel taking part in the seismic survey. However, the Service considers this risk to be low for the following reasons: Only an estimated 1.93% of the population, approximately 250 birds, nests east of the project area (Service data) and therefore may be at risk of colliding with the survey vessels while migrating past. The vessels are relatively small, and will be moving slowly, possibly allowing a bird encountering them to avoid a collision. Much of the survey will be taking place during summer when prolonged daylight increases visibility, presumably decreasing collision risk. This is particularly true when males move through the area in early summer. Later departing females often migrate further offshore than the project area, and are therefore, less likely to encounter seismic vessels.

Steller's Eiders
Little is known about Steller's eider use of this area of the Beaufort Sea. However, very few individuals are thought to nest as far east as the project area. Hence, the Service concludes that the risk of Steller's eiders encountering the project area and suffering adverse effects is extremely low.

Conclusion
While it is possible that spectacled eiders will encounter project vessels and activities adverse effects are expected to be limited to the displacement of a small number of individuals to other comparable areas of the Beaufort Sea, and are hence, considered to be insignificant. Therefore, consultation on the proposed seismic survey is concluded informally by this letter. If you need further assistance, please contact Sarah Conn at (907) 456-0499.

Sincerely,

Ted Swem

Ted Swem
Branch Chief,
Endangered Species

Literature Cited

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United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

FEB 11 2008

Memorandum

To: Regional Supervisor, Resource Evaluation

Through: Regional Supervisor, Leasing and Environment

Through: Chief, Environmental Assessment Section

From: Wildlife Biologist, EAS

Subject: Endangered Species Act finding of *May Effect* for Polar Bears and taking of marine mammals under the Marine Mammal Protection Act, incidental to on-ice and open water seismic operations in the Beaufort Sea by BP Exploration (Alaska) Inc. and CGG Veritas in winter and summer 2008.

BP Exploration (Alaska) Inc. (BPXA) plans to conduct a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea in the period July/August 2008, with an "as needed" extension of additional days at the end of September/October. Prior to the seismic survey a bathymetry survey is planned, to obtain more detailed information on the shallow water sections of the survey area (<6 ft). The intention is to conduct this bathymetry survey in the winter as soon as the ice has sufficient thickness, and the required authorizations are in place.

The project area encompasses 135.8 mi^2 (351.8 km^2) in Foggy Island Bay, Beaufort Sea. This area includes portions of the Duck Island Unit, known as Endicott which comprises the Endicott causeway, Satellite Drilling Island (SDI) and Main Production Island (MPI), the full Liberty Unit and adjacent state land and waters and federal waters. Approximately 1% is on mudflats, 18.5% in water depths of 1-5 ft, 12.5% in water depths of 5-10 ft and 68% in water depths of 10-30 ft. The approximate boundaries of the total surface area are between 70°11'N and 70°23'N and between 147°10'W and 148°02'W.

Polar bears, proposed for listing under the Endangered Species Act (ESA), den in coastal areas of the Beaufort Sea, and move through this area while hunting for the ringed seal, their principal prey. Dens have occurred on the barrier islands, along the Arctic coastal plain and occasionally on shore fast ice. Historically, the USGS polar bear den database indicates approximately 30 known dens in the Foggy Bay area. Mortality rates increase when polar bear cubs are forced to leave their dens prematurely, prior to reaching their optimum size and weight. Disturbance from oil industry activities has been documented to cause polar bear females with cubs to abandon their den sites early. Ringed, bearded and spotted seals, all protected from incidental taking by harassment or disturbance under the Marine Mammal Protection Act (MMPA), also occur in this area. Polar bears and their primary prey, the ringed seal, occur in the area during the proposed BPXA on ice seismic project. Polar bears may also occur on shore in this area during the summer months.

The Minerals Management Service (MMS) must comply with the ESA and evaluate the effects of authorizing the seismic program on ESA-listed species or species proposed for listing. Section 7 conferencing is only required if the action would jeopardize the continued existence of the polar bear. The MMS has determined that while the proposed action *may effect* polar bears, it would not jeopardize the continued existence of the species. However, if the polar bear is listed as threatened or endangered, MMS will need to formally consult with the FWS under the ESA.

The seismic program may also result in a taking of seals or polar bears under the MMPA. Discussions with U.S. Fish and Wildlife Service (USFWS) Marine Mammals Management personnel (2/01/08) indicate that USFWS believes that polar bears will be adequately protected from harmful effects as long as BPXA and their sub-contractors (CGG Veritas) abide by the terms of a Letter of Authorization (LOA) issued by USFWS.

Pursuant to 50 CFR 18, Subpart J and Section 101 (a) (5) of the Marine Mammal Protection Act (MMPA), BPXA has requested a Letter of Authorization (LOA) allowing unintentional take of polar bears and Pacific walrus incidental to the activities related to the seismic and bathymetry surveys in the Alaskan Beaufort Sea. Under sections 109(h) and 112(c) of the Marine Mammal Protection Act, BPXA has also requested authorization to take polar bears by harassment for the protection of human life as well as for the protection of polar bears while conducting survey activities.

BPXA is expected to apply for, receive, and adhere to the terms of an LOA from USFWS. As a LOA can only be issued if there will be no more than a negligible impact to polar bears, MMS concludes that BPXA activities are not likely to adversely effect polar bears in the project area.

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Casey Buechler
Author (M. Cody)

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C. Buechler

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Alaska Outer Continental Shelf Region
3801 Centerpoint Drive, Suite 500
Anchorage, Alaska 99503-5823

FEB - 4 2008

Ms. Judith Bittner
State Historic Preservation Officer
Office of History and Archaeology
550 West 7th Avenue, Suite 1310
Anchorage, Alaska 99501-3565

Dear Ms. Bittner:

The Minerals Management Service (MMS) is in receipt of the BP Exploration Alaska Inc.'s (BPXA) Liberty Ocean Bottom Cable (OBC) Seismic Survey application (08-05). The MMS was pleased to host a project overview meeting held on January 28, 2008, which was attended by various Federal and State agencies including two of your staff members (Margie Goatley and Dave McMahan). Since your staff has been fully briefed on the project, a full project description is not provided in this correspondence.

The survey area has been identified as having potential prehistoric archaeological resources. The MMS has reviewed the offshore area of potential effect for historic and archaeological resources by consulting our Alaska Shipwrecks Database, reviewing geophysical data, and the BPXA project description.

Based on our review of the MMS Alaska Shipwrecks Database, no historical archaeological resources were identified. The MMS staff reviewed available geophysical data and determined that sediment deposition has likely covered any relict prehistoric features that could be potentially contacted by OBC survey equipment. Those features not protected by sedimentation would have been subject to subaerial erosion and high-density ice gouging, lessening their likelihood for preservation. Therefore, based on MMS' review of available geophysical data, the light footprint of the OBC process, and its low potential for bottom disturbance, MMS believes no major impacts to prehistoric resources would occur.

According to the BPXA project description, there is one terrestrial archaeological site identified within the area of activity on Howe Island - additional archaeological sites lay outside the survey area adjacent to the perimeter of the survey. The project description indicated that BPXA will request approval of setbacks from archaeological sites from your office to ensure there is no access to these sites. Thus, we have concluded that there will be "*no effect*" upon the Howe Island site.

Also, it is our understanding that BPXA contracted with Reanier & Associates, Inc. to conduct a cultural resource reconnaissance survey and prepare a report. If any cultural resources are identified, we understand additional consultation could be required in order for these resources to be avoided by MMS permitted activities.

Given our procedures and the process outlined above, MMS concludes that the proposed undertaking will have "*no effect*" on submerged historic and/or prehistoric resources in the project area. The MMS requests your concurrence with our "*no effect*" determination for offshore historic and prehistoric resources for the Liberty Ocean Bottom Cable Seismic Survey.

If you have any questions, please contact Michael Burwell at (907) 334-5249 or Casey Buechler at (907) 334-5265.

Sincerely,

John Goll
Regional Director

Leasing &
Environment Office

- RSLE
- Chief EAS
- ~~Chief ESS~~
- ~~Chief, LAS~~
- DRD
- Casey Buechler
- M. Burwell

RD

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Authors(M. Burwell, C. Buechler)

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Finding of No Significant Impact (FONSI)

In accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, Minerals Management Service (MMS) prepared an Environmental Assessment on the British Petroleum Exploration (Alaska) Inc. (BPXA) proposed three-dimensional, ocean bottom cable, transitional zone seismic survey located offshore Alaska, in the Beaufort Sea OCS Planning Area on federal leases OCS-Y1585; Y1650; and Y1886. The EA is dated February 28, 2008.

Based upon the EA, MMS Alaska Region has concluded that the proposal will not have significant effects upon the quality of the human environment (40 CFR 1508.27). The impacts to biological resources will be minimal, and are further mitigated through stipulations outlined in BPXA's applications under the Marine Mammal Protection Act (MMPA) for take, which are anticipated to be included in the Letter of Authorization issued by US Fish and Wildlife Service, and Incidental Harassment Authorization issued by National Marine Fisheries Service.

Preparation of an environmental impact statement is not required.

Debra C. Ransom (signature) — 2/28/08

Chief, Environmental Assessment Section — Date

MMS, Alaska OCS Region

Fred R King, Actg (signature) — 2/28/08

Regional Supervisor, Leasing & Environment — Date

MMS, Alaska OCS Region