MARINE MAMMAL MONITORING AND MITIGATION DURING BP LIBERTY OBC SEISMIC SURVEY IN FOGGY ISLAND BAY, BEAUFORT SEA, JULY-AUGUST 2008

90-DAY REPORT

Prepared By

Alaska Research Associates, Inc.

Greeneridge Sciences Inc.

JASCO Research Ltd.

For

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

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by

Lisanne Aerts[a], Megan Blees[a], Susanna Blackwell[b], Charles Greene[b], Katherine Kim[b], David Hannay[c] and Melanie Austin[c]

[a] **LGL Alaska Research Associates, Inc.**
1101 East 76th Ave., Suite B, Anchorage, AK 99518, U.S.A.

[b] **Greeneridge Sciences Inc.**
4512 Via Huerto, Santa Barbara, CA 93110, U.S.A.

[c] **JASCO Research Ltd**
Suite 2101, 4464 Markham St., Victoria, BC V8Z 7X8, Canada

for

BPXA EXPLORATION (ALASKA) INC.
Dept. of Health, Safety & Environment
900 East Benson Blvd.
P.O. Box 196612
Anchorage, Alaska 99519-6612

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LIST OF ACRONYMS AND ABBREVIATIONS

AEWC	Alaska Eskimo Whaling Commission
ASAR	Autonomous Seafloor Acoustic Recorder
ASL	Above sea level
Bf	Beaufort; scale for wind force conditions
BPXA	BP Exploration (Alaska) Inc.
CAA	Conflict Avoidance Agreement
CFR	(U.S.) Code of Federal Regulations
cm	centimeter
CPA	Closest (observed) Point of Approach
DASAR	Directional Autonomous Seafloor Acoustic Recorder
dB	Decibel
ESA	Endangered Species Act
FR	Federal Registrar
ft	feet
GB	Gigabyte
GPS	Global Positioning System
h	hours
HSE	Health Safety and Environment
Hz	Hertz
IHA	Incidental Harassment Authorization (under U.S. MMPA)
in^3	cubic inches
IPI	Inter-pulse interval
IUCN	International Union for the Conservation of Nature
kHz	kilohertz
km	kilometer
km/h	kilometers per hour
km^2	square kilometers
kts	knots
LOA	Letter of Authorization
m	meter
mi	statute miles
mi^2	square miles
MMO	Marine Mammal Observer
MMPA	(U.S.) Marine Mammal Protection Act
n	sample size
NMFS	(U.S.) National Marine Fisheries Service
NSB	North Slope Borough
OBC	Ocean Bottom Cable
OBH	Ocean Bottom Hydrophone
OCS	Outer continental shelf
RL	Received Level in units of dB re1 µPa
rms	root-mean-square: an average, in the present context over the duration of a sound pulse
SDI	Endicott Satellite Drilling Island
SPL	Sound Pressure Level
SSV	Sound Source Verification
USFWS	United States Fish and Wildlife Service
µPa	Micro Pascal
~	Approximately
>, <	greater than, less than
≥, ≤	greater than or equal to, less than or equal to
@	at

EXECUTIVE SUMMARY

Background and Introduction

BP Exploration Alaska Inc. (BPXA) conducted a 3D, ocean bottom cable (OBC) seismic survey in the Liberty field during July and August 2008. The Liberty field is located in federal waters of Foggy Island Bay, Beaufort Sea about 8.9 km (5.5 mi) offshore in 6.1 m (20 ft) of water and approximately 8 to 13 km (5 to 8 mi) east of the existing Endicott Satellite Drilling Island (SDI).

Marine seismic surveys emit sound energy into the water and have the potential to affect marine mammals given the reported auditory and behavioral sensitivity of many such species to underwater sounds. Either behavioral, distributional or (if they occur) auditory effects could constitute a "take" under the provisions of the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA). The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share jurisdiction over the marine mammal species that were likely to be encountered during the project and each provided authorization to conduct the seismic survey through an Incidental Harassment Authorization (IHA, NMFS) and Letter of Authorization (LOA, USFWS). The IHA and LOA included provisions to minimize the possibility of exposure of potentially harmful seismic sounds to marine mammals and to reduce behavioral disturbances that could be considered as a "take" under the MMPA.

In addition, regulations in the MMPA require IHA applicants that plan activities in Arctic waters to provide a plan of cooperation that identifies measures to minimize adverse effects on the availability of marine mammals for subsistence purposes. BPXA met with representatives of the community of Nuiqsut, the Alaska Eskimo Whaling Commission (AEWC), the North Slope Borough (NSB), and others to discuss appropriate measures to be implemented during the 2008 shallow water Liberty seismic survey with the purpose of avoiding conflicts with the subsistence hunt. These measures were included in the Conflict Avoidance Agreement (CAA) that was signed on 4 June 2008.

A marine mammal monitoring and mitigation program was conducted in compliance with the IHA and LOA to avoid or minimize potential effects of BPXA's seismic survey on marine mammals, as well as to communicate with local subsistence communities. This required that shipboard personnel detect marine mammals within or about to enter the designated safety radii (190 dB for pinnipeds and 180 dB for cetaceans), and in such cases initiate an immediate power-down or shut-down of the airguns.

This 90-day report describes the methods and results for the marine mammal mitigation and monitoring program specifically required to meet the primary objectives, which were:

- To provide real-time sighting data needed to implement the mitigation requirements;
- To estimate the numbers of marine mammals potentially exposed to seismic pulses exceeding sound levels of 160 dB; and
- To determine the reactions (if any) of marine mammals potentially exposed to seismic sounds.

Seismic Survey Described

An OBC seismic survey involves the lowering of seismic cables from dedicated cable vessels for placement on the ocean bottom within the targeted seismic acquisition area. Attached

to the cables are sensors (hydrophones/geophones) which detect seismic energy data reflected from underground rock strata. The collected seismic data is transmitted through the cables to the recorder vessel for data storage. The energy sources used during this survey are airguns towed by seismic source vessels traveling orthogonally over the patch of cabled hydrophones.

The geographic region where BPXA's Liberty OBC seismic survey occurred was located in Foggy Island Bay, Beaufort Sea in water depths between a few inches and 7.6 m (25 ft). The project area encompassed about 351.8 km2 (135.8 mi2). The OBC seismic survey was conducted by two seismic source vessels (*Peregrine* and *Miss Diane*), four cable vessels (*Canvasback*, *Cape Fear*, *Rumple Minze* and *Sleep Robber*), a recorder vessel/barge combination (*Alaganik*/*Hook Point*), two crew/support vessels (*Qayaq Spirit* and *Mariah B*), and a housing vessel (*Arctic Wolf*). One additional vessel, the ACS vessel *Gwydyr Bay*, substituted for a crew vessel for several days when crew vessel repairs were required.

The *Peregrine* was mainly used for the deeper parts of the survey area (mostly >3 m or 10 ft) and the *Miss Diane* for the shallower areas (<3 m or 10 ft). Both source vessels were equipped to tow two arrays. The *Peregrine* towed two 440 in^3 (total of 880 in^3) arrays comprised of four airguns in clusters of 2 x 70 in^3 and 2 x 150 in^3. Although the Liberty survey was planned and permitted for use of an 880 in^3 array, initial test results indicated that a 440 in^3 array would be adequate. The *Miss Diane* towed two 220 in^3 arrays, comprised of two guns of 1 x 70 in^3 and 1 x 150 in^3. The maximum volume used by both vessels during seismic data production was 440 in^3. The arrays were towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths of 1.8 m (6 ft) on the *Peregrine* and 1.1 m (3.5 ft) on the *Miss Diane*.

The *Arctic Wolf* mobilized from the Port of Anchorage on 26 June, with a planned 2 week travel to West Dock. Due to ice conditions in the Chukchi Sea and around Barrow, the total transit time took about 3 weeks and the vessel arrived at West Dock on 20 July. The seismic survey in the Liberty area started 15 July with the lay-out of the first cable. Seismic data acquisition started 24 July and ended on 25 August in accordance with the CAA, with the final cables retrieved 26 August. Minor follow-up operations were completed by 1 September 2008.

Acoustic Monitoring

Three different acoustic measurements were conducted during the Liberty seismic survey: (1) sound source verification of the airgun arrays, (2) sound measurements of all vessels involved in the survey and measurements of received airgun sound levels, and (3) of combined vessel sounds in relation to the presence or absence of the barrier islands.

The primary objective of the airgun sound source verification measurements was to verify the estimated marine mammal safety radii by measuring the received sound pressure levels of various airgun volumes as a function of distance. The measured safety radii for the airgun arrays of the *Peregrine* and *Miss Diane* were analyzed in the field and results were provided to the MMOs as soon as they became available, prior to the start of data acquisition (24 July). The results were presented in reports and submitted by BPXA to the NMFS and USFWS as stipulated in the IHA and LOA. The same SSV reports were provided to the AEWC and NSB Department of Wildlife Management (NSB-DWM) in accordance with the CAA.

Sound measurements of vessels were conducted to obtain knowledge on each vessel's radiated source level (at 1m from the source) in the area of operation. A total of 11 vessels were involved in the Liberty seismic survey, including the ACS vessel *Gwydyr Bay*. Source level measurements were obtained for all vessels and where possible for different speeds.

Three acoustic recorders (DASARs) were deployed at three locations outside but near the Liberty seismic survey area. These locations were selected such that it allowed for determination of propagation loss of underwater sounds from airguns and vessels in relation to the presence or absence of barrier islands. Most received rms sound pressure levels on the DASAR closest to the survey area were in the range between 120 and 140 dB (90.1%). The received sound levels at the other two DASAR locations were much lower, with only 25.3% exceeding 120 dB for the location that was placed outside but beyond a gap between two barrier islands, and 0.5% for the location outside but directly behind a barrier island. These sound levels could include airgun pulses from sources other than the Liberty survey.

Results of Marine Mammal Monitoring

***Arctic Wolf* Transit** – Two MMOs aboard the housing vessel, *Arctic Wolf*, conducted a total of 369 observation hours during the transit from Anchorage to West Dock, Prudhoe Bay. All observations were conducted during daylight hours, with a total of 206 hours during actual transit, and 151 hours while the vessel was on anchor or idle. There were 11 hours for which the speed and activity of the vessel was not clearly determined.

Thirteen marine mammal species were observed during the transit including, Dall's porpoise, gray whale, harbor porpoise, humpback whale, killer whale, Risso's dolphin, bearded seal, harbor seal, ringed seal, spotted seal, Steller's sea lion, Pacific walrus, and polar bear. A total of 56 cetacean and pinniped sightings were made, of which 29 cetacean sightings of 73 animals and 27 pinniped sightings of 34 animals, excluding walrus. Most sightings were made when the vessel was actually traveling. This was most apparent for cetaceans; for which the sighting rate (number of sightings per hour) was ~4.5 times higher when the vessel was traveling than when it was on anchor or idle.

A total of 22 walrus sightings of 11335 individuals and 2 polar bear sightings of 2 individuals were made during the *Arctic Wolf* transit. In addition, while transiting in waters around south Alaska, 50 sea otters were observed in one sighting. Walruses were observed in the Chukchi Sea, mainly near Icy Cape, both on ice and in the water. The distance of these walrus sightings to the vessel ranged between 9 and 668 m, with the exception of three sightings at 1187 m and two at 2975 m. On one occasion, walruses were observed on ice floes everywhere around the vessel, while it was traveling north through some ice leads. Due to the large number of animals spread out over a distance of ~6.5 km (~4 mi), this was recorded as one sighting with an estimated 10000 individuals. Both polar bear sightings were observed on ice at 668 m from the vessel, also near Icy Cape.

The MMOs on the *Arctic Wolf* regularly contacted representatives of the local subsistence villages, when traveling in nearby waters. They provided them with the current position of the *Arctic Wolf* and its travel plans in order to avoid potential conflicts with the subsistence hunt.

Seismic Survey – Seismic data acquisition was conducted mainly during daylight, i.e. more than 90% of the time that airguns were operating. MMOs conducted observations during all daylight hours when airguns were operating and during many hours when the source vessel was not operating its airguns. Observations during night time were not required. Daylight MMO observer effort on the *Peregrine* was 353 hours with airguns operating, 20 hours during post-seismic (up to one hour after airguns were shut down), and 67 hours during non-seismic activity (period one hour after airguns were turned off). MMO observer effort on the *Miss Diane* was 244 hours during airgun operations, 29 hours during post-seismic, and 220 during non-seismic. The ability to detect marine mammals depends largely on the environmental conditions, such as Beaufort (Bf) wind force and visibility. About 76% of the total observer effort on the *Peregrine*

and 91% on the *Miss Diane* took place during wind force conditions of Bf 1 to 3, which corresponds to wind speeds between 2 to 19 km/h or 1 to 10 kts. During the entire daylight observation effort, visibility conditions were favorable for detecting marine mammals. Visibility conditions less than 1 km (0.6 mi), which result in less effective monitoring of the 180 dB safety radii (550 m for the 440 in^3 array of the *Peregrine* and 300 m for the *Miss Diane*), occurred only 33 hours (9%) and 4 hours (2%) of the total observer effort with airguns operating for *Peregrine* and *Miss Diane*, respectively

Eight marine mammal species were observed during the entire seismic survey period, i.e. from 15 July to 25 August. These species include beluga whale, bowhead whale, gray whale, ringed seal, spotted seal, bearded seal, and polar bear. While on watch the MMOs on both source vessels observed 16 individual cetaceans in four sightings and 13 pinniped sightings of one individual each. In addition, one cetacean sighting (two individuals) and five pinniped sightings (five individuals) were made during periods when no airguns were operating and no MMO watch was required (opportunistic off-watch sightings). This occurred for example when operations were halted due to bad weather.

During the Liberty seismic survey a total of three shut-downs and one power-down were implemented for marine mammals. Two shut-downs were implemented for carcasses, observed while airguns were operating and one shut-down for a seal, entering the 190 dB safety radii of the mitigation source. A power-down was implemented for a seal that was entering the 190 dB safety zone of the 440 in^3 airgun array (250 m or 820 ft), and remained outside the 190 dB safety zone of the mitigation source. No shut-down was required as the seal was observed to leave the 440 in^3 safety radius.

There was one polar bear sighted during the MMO watch period on the *Miss Diane* when seismic airguns were operating. This bear was swimming at 1.1 km (0.7 mi) distance, far outside the 190 dB safety radius for the 440 in^3 airgun array (150 m or 492 ft). During off-watch periods, mainly when the vessels were hiding from bad weather close to the barrier islands or behind Endicott Satellite Drilling Island (SDI), a total of 10 polar bears were observed in 9 sightings. Observations made by crew on vessels without MMOs were reported to the lead MMO on the *Peregrine*, to avoid duplicate reporting. No Pacific walrus were sighting during the seismic survey.

The minimum and maximum numbers of potential pinniped and cetacean exposures to ≥160 dB were calculated to compare with the estimates from the IHA application. The minimum numbers comprised of the actual number of pinnipeds and cetaceans sighted within the 160 dB safety radius around the operating airguns. Sighting rates (number of sightings per hour), calculated from sightings conducted one hour and more after airguns were turned off, were used to estimate the maximum number of pinnipeds and cetaceans potentially exposed to ≥160 dB rms. The assumption was that the non-seismic sighting rate was representative for a non-disturbed presence of marine mammals. This resulted in 0 to 10 potential exposures for cetaceans and 3 to 30 for pinnipeds, compared to the IHA estimates of 28 and 250, respectively.

ACKNOWLEDGEMENTS

We like to thank the captains and crew of all vessels that were involved in the seismic survey. Special thanks are extended to the captains and crew of the *Arctic Wolf*, *Peregrine* and *Miss Diane* for their hospitality and the *Sleep Robber* for their excellent assistance in deploying and retrieving the acoustic recorders used for the sound source verification measurements.

Additionally, we appreciate the cooperation and support that we received from the on-site Liberty team of BPXA, CGGVeritas, and HAFTA. Particularly, we thank Larry Wyman, Howie Claiborne, Jay Friberg, Ron Gervason, Joe Pagliero, Rick Stolz and Brad Cutler. Additionally, we are very thankful for the valuable advice and support of Bill Streever of BP's Environmental Studies group, who was deeply involved in all aspects of this program. We also thank representatives of the National Marine Fisheries Service, U.S. Fish and Wildlife Service, North Slope Borough, Alaska Eskimo Whaling Commission and Minerals Management Service for their advice and comments during the open-water meeting convened by NMFS in April 2008.

Appreciation is extended to Steve Chronic and Charles Hopson from LCMF, for their assistance in developing an excellent MMO team. A special thanks goes to all marine mammal observers (MMOs) who participated on this project. This project could not have been a success without the determination and professionalism of all MMOs.

William Aguvluk
Jonas Ahsoak
Richard Bodfish
Patrick Easterday
Kelsey Hall
Charles Hopson
David Lee Hopson
Ralph Kaleak
David Mann
Brian McNamara
Crystal Shaw

1 BACKGROUND AND INTRODUCTION

BP Exploration Alaska Inc. (BPXA) conducted a 3D, ocean bottom cable (OBC) seismic survey in the Liberty field during July/August 2008. The Liberty field is located in federal waters of Foggy Island Bay, Beaufort Sea about 8.9 km (5.5 mi) offshore in 6.1 m (20 ft) of water and approximately 8 to 13 km (5 to 8 mi) east of the existing Endicott Satellite Drilling Island (SDI) (Figure 1.1).

A total of three cetacean species, four species of pinnipeds, and one marine fissiped (polar bear—*Ursus maritimus*) are known to occur in the Beaufort Sea in or near the Liberty area. Five additional cetacean species – narwhal (*Monodon monoceros*), killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), minke whale (*Balaenoptera acutorostrata*), and fin whale (*Balaenoptera physalus*) – could occur in the Beaufort Sea, but each of these species is rare or extralimital to the Liberty area. The marine mammal species that occurs most frequently throughout the seismic survey in the Liberty area is the ringed seal (*Phoca hispida*[1]*)*. One can also observe the bearded and spotted seal (*Erignathus barbatus* and *Phoca larga),* but to a far lesser extent than the ringed seal. Due to its distribution, encounters with the walrus (*Odobenus rosmarus*) are possible but not expected. However, anecdotal reports suggest that walruses may be occurring more frequently in the project area than they have in the past. Presence of beluga whales (*Delphinapterus leucas*), bowhead whales (*Balaena mysticetus*) and gray whales (*Eschrichtius robustus)* in the shallow water environment within the barrier islands is possible but expected to be very limited. Of these species, only the bowhead whale is listed as "endangered" under the Endangered Species Act (ESA). The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share jurisdiction over the marine mammal species that can be encountered during the project. USFWS manages two species, walrus and polar bear; NMFS manages all cetacean and pinniped species except walrus.

Marine seismic surveys emit sound energy into the water and have the potential to affect marine mammals given the reported auditory and behavioral sensitivity of many such species to underwater sounds (Richardson et al. 1995; Gordon et al. 2004). Potential effects consist of behavioral or distributional changes, and perhaps (for animals close to the sound source) temporary or permanent reduction in hearing sensitivity. Either behavioral/distributional effects or (if they occur) auditory effects could constitute a "take" under the provisions of the U.S. Marine Mammal Protection Act (MMPA) and the ESA, at least if the effects are considered to be biologically significant[2].

During the planning and design phase of the 2008 Liberty OBC seismic survey, BPXA worked with LGL Alaska Research Associates, Inc. (LGL) to develop a marine mammal and acoustic monitoring program as part of the Incidental Harassment Authorization (IHA) application to NMFS and the application for a Letter of Authorization (LOA) to USFWS. The applications and associated mitigation and monitoring program address potential impacts to marine mammals from the proposed Liberty shallow water seismic survey and identify mitigation and monitoring measures to minimize those impacts. More details of these authorizations are provided in Section 1.1 and 1.2 below.

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[1] Also referred to as *Pusa hispida.*

[2] Biologically significant means here, "in a manner that might have deleterious effects to the well-being of individual marine mammals or their populations."

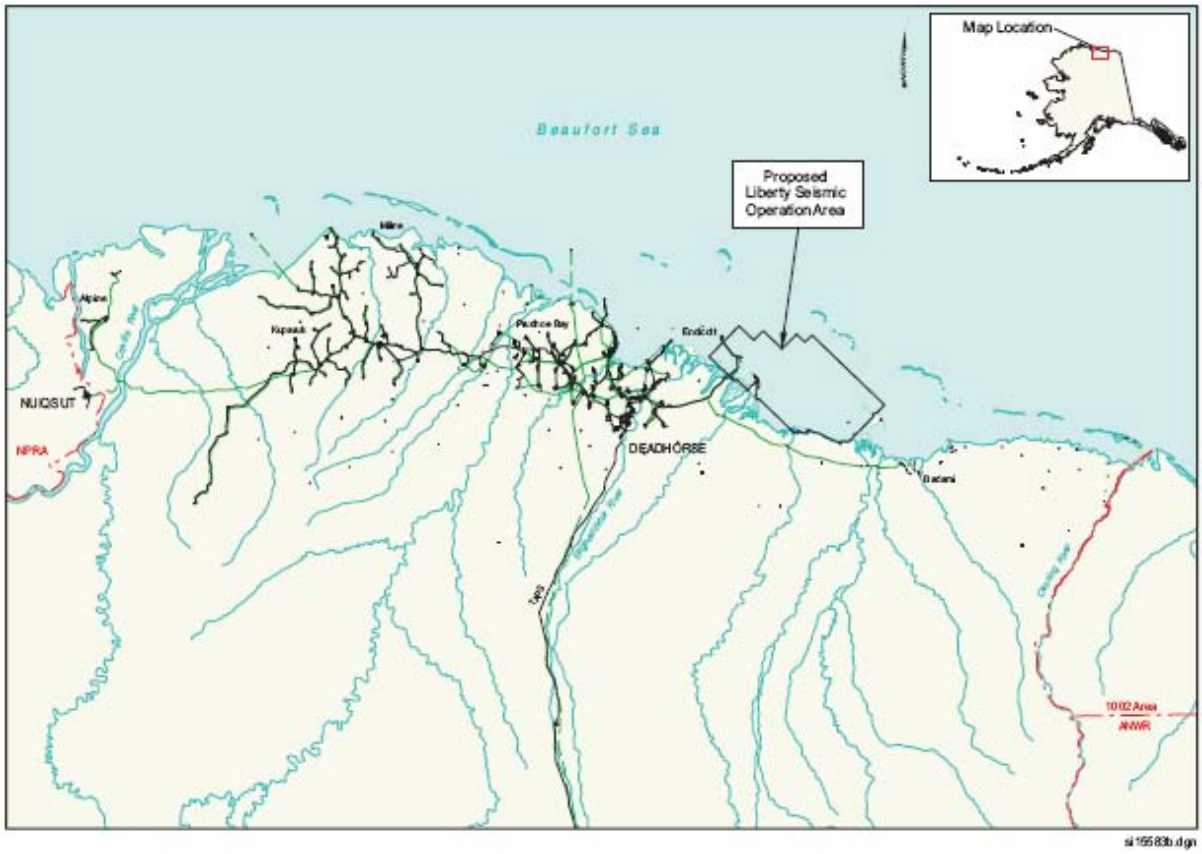

FIGURE 1.1 OVERVIEW OF THE LIBERTY SEISMIC SURVEY LOCATION.

This document serves to meet reporting requirements specified in the IHA and LOA. The primary purposes of this report are to describe BPXA's seismic activities in Foggy Island Bay, to describe the associated marine mammal monitoring and mitigation program and their results, and to estimate the numbers of marine mammals potentially exposed to seismic sounds at or above presumed effects levels.

1.1 Incidental Harassment Authorization (NMFS)

On 15 November 2007, BPXA submitted an IHA application to NMFS for an IHA allowing non-lethal harassment of marine mammals incidental to the 3D OBC seismic survey in the Liberty Prospect, Beaufort Sea. A notice regarding the proposed issuance of this IHA was published by NMFS in the Federal Register on 2 May 2008 and public comments were invited (NMFS 2008). The IHA was issued to BPXA by NMFS to cover the period from 8 July 2008 through 25 Aug 2008 (Appendix A).

The IHA issued by NMFS authorized level B harassment of the ESA-listed bowhead whale (*Balaena mysticetus*), as well as several non-listed species including gray whale (*Eschrichtius robustus*), beluga whale (*Delphinapterus leucas*), ringed seal (*Phoca hispida*), spotted seal (*Phoca largha*), and bearded seal (*Erignathus barbatus*). The IHA required BPXA, among other, to have dedicated marine mammal observers (MMOs) on board of their seismic source vessels to

observe a ≥190 dB[3] safety radius for pinnipeds (not including walruses) and a ≥180 dB safety radius for cetaceans.

NMFS granted the IHA to BPXA on the assumptions that:

- The numbers of whales and seals potentially harassed (as defined by NMFS criteria) during seismic operations would be "small";
- The effects of such harassment on marine mammal populations would be negligible;
- No marine mammals would be seriously injured or killed;
- There would be no unmitigated adverse effects on the availability of marine mammals for subsistence hunting in Alaska; and
- The agreed upon monitoring and mitigation measures would be implemented.

On 18 July 18 2008, BPXA submitted to NMFS a request for clarification regarding emergency shutdown procedures for injured or dead marine mammals sighted in the area of operation as mentioned under condition 6(b)(iv)(C) of the IHA issued 8 July 2008. Upon review, NMFS determined that wording in this condition should be altered and issued an amendment to the IHA, effective starting 28 July 2008 (Appendix A).

1.2 Letter of Authorization (USFWS)

BPXA submitted a LOA application to USFWS on 14 December 2007, to allow unintentional take of polar bears and Pacific walrus incidental to the OBC seismic activities (including a bathymetry survey) and to allow take of polar bears by harassment for the protection of human life and polar bears while conducting survey activities. A LOA specific to the bathymetry program was issued to BPXA on 6 March 2008 (Appendix B) in accordance with the USFWS regulations listed at 71 FR 43926, dated 2 August 2006 (USFWS 2006). Authorizations covering the seismic survey activities during the open-water season were not added initially, to allow the USFWS a more thorough review of that part of the seismic program. An amendment to the LOA of 6 March 2008, to include the open-water seismic activities, was issued to BPXA on 2 July 2008 (Appendix B). The LOA and amendment issued to BPXA by USFWS continued to be effective until 30 November 2008. The LOA required BPXA, among others, to observe a ≥190 dB safety radius for polar bears and a ≥180 dB safety radius for walruses. Other monitoring and mitigation requirements for the open-water seismic survey activities are similar or equal to the IHA issued by NMFS and are briefly discussed in Section 1.4 and in more detail in Section 4.2.

1.3 CAA

Regulations in the Marine Mammal Protection Act (50 CFR 216.104(a)(12)) require IHA applicants that plan activities in Arctic waters to provide a plan of cooperation that identifies what measures have been taken or will be taken to minimize adverse effects on the availability of marine mammals for subsistence purposes. BPXA met with representatives of the community of

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[3] Unless otherwise noted, all sound levels quoted in this report are referenced to 1 μPa and expressed as rms or "root mean square", levels, which represent a form of average across the duration of the sound pulse. There are several other measures of pulsed sounds, such as "zero-to-peak", "peak-to-peak" and SEL (sound exposure level). It is currently thought that SEL (energy) and peak level measures may be more relevant to marine mammals than are rms values (Southall et al. 2007), but the current regulatory requirements are based on rms values.

Nuiqsut, the AEWC, and the North Slope Borough (NSB) to discuss appropriate measures to be implemented during the 2008 shallow water Liberty seismic survey with the purpose of avoiding conflicts with the subsistence hunt. These agreements were included in the Conflict Avoidance Agreement (CAA) that was signed on 4 June 2008 (Appendix C).

1.4 Mitigation and Monitoring Objectives

The objectives of the marine mammal mitigation and monitoring program were described in detail in BPXA's IHA application (BPXA 2007) and in the IHA issued by NMFS to BPXA (Appendix A). Explanatory material about the monitoring and mitigation requirements was published by NMFS in the Federal Register (NMFS 2008).

The main purpose of the mitigation program was to avoid or minimize potential effects of BPXA's seismic survey on marine mammals. This required that shipboard personnel detect marine mammals within or about to enter the designated safety radii (190 dB for pinnipeds other than walrus and 180 dB for cetaceans and walrus), and in such cases initiate an immediate power-down or shut-down of the airguns. A power-down involves reducing the sound level of the operating airguns, in this case by reducing the air volume. A shut-down involves temporarily terminating the operation of all airguns. An additional mitigation objective was to detect marine mammals within or near the safety radii prior to starting the airguns, or during ramp-up toward full power. In these cases, the start of airguns was to be delayed or ramp-up discontinued until the safety radius was free of marine mammals, insofar as this can be determined visually, for a period of 30 minutes.

For the BPXA shallow water seismic survey, a specific dedicated vessel monitoring program to detect aggregations of 12 or more baleen whales within the 160 dB zone, or 4 or more bowhead whale cow-calf pairs within the 120 dB zone, was not considered applicable and hence not included in the IHA although it has been included as a requirement in some offshore Beaufort and Chukchi Sea IHAs in recent years.

The primary objectives of the marine mammal monitoring program were:

- To provide real-time sighting data needed to implement the mitigation requirements;
- To estimate the numbers of marine mammals potentially exposed to seismic pulses exceeding sound levels of 190 or 180 dB; and
- To determine the reactions (if any) of marine mammals potentially exposed to seismic sounds.

The marine mammal mitigation and monitoring objectives identified in the IHA (NMFS) and LOA (USFWS) are included in Appendices A and B. The marine mammal mitigation and monitoring measures that were implemented during the shallow water seismic activities in the Liberty area based on the IHA and LOA are described in detail in Section 4.2.

1.5 Report Structure

The main purpose of this 90-day report is to satisfy the IHA (NMFS) and LOA (USFWS) requirements to submit a final report within 90 days after the completion of operations on 1 September 2008 and to provide BP with a permanent record regarding marine mammal encounters during the Liberty seismic operations. It describes the methods and results of the marine mammal mitigation and monitoring program designed to meet the primary objectives and as required by the IHA and LOA. The report consists of a total of five chapters:

1. Background and introduction (this chapter);
2. Summary of BPXA's seismic survey activities (Chapter 2);
3. Description of the acoustic measurements conducted during the field season, including the methodology and results (Chapter 3);
4. Description of the marine mammal monitoring and mitigation program, which includes details of mitigation measures as communicated to the seismic crew and marine mammal observers (MMOs), and a summary of the MMO observation protocol (Chapter 4);
5. Results of the marine mammal monitoring and mitigation program, including a summary of the situations that required implementation of the mitigation measures, and estimated numbers of marine mammals potentially exposed to sound levels of ≥190 or ≥180 dB as required by the IHA (Chapter 5) and LOA.

In addition, there are seven Appendices that provide copies of relevant permit documentation and details of the marine mammal monitoring and mitigation. The Appendices include:

A. Copy of the Incidental Harassment Authorization (IHA) and the amendment issued by NMFS to BPXA for the shallow water seismic survey;

B. Copy of the Letter of Authorization (LOA) and the amendment issued by USFWS to BPXA for the shallow water seismic survey;

C. Copy of the Conflict Avoidance Agreement (CAA) between BPXA, the Alaska Eskimo Whaling Commission, and the Whaling Captains Associations;

D. Vessel descriptions;

E. Marine mammal status in Beaufort Sea;

F. Beaufort Wind Force Scale.

G. Call log to Communication centers of the *Arctic Wolf.*

H. Environmental monitoring and mitigation end-of-survey report (Aerts & Blees 2008).

Figures 1.2 to 1.4 show impressions from the survey area and the open water survival field practice.

FIGURE 1.2 HOUSING VESSEL *ARCTIC WOLF* ON SITE.

FIGURE 1.3 *ALAGANIK/HOOK POINT* ON SITE. IN THE BACKGROUND THE BROOKS RANGE MOUNTAINS ARE VISIBLE.

FIGURE 1.4 OPEN WATER SURVIVAL FIELD PRACTICE AT WEST DOCK ON 13 JULY 2008.

2 SEISMIC SURVEY DESCRIBED

An OBC seismic survey involves the lowering of seismic cables from dedicated cable vessels for placement on the ocean bottom within the targeted seismic acquisition area. Attached to the cable are sensors (hydrophones/geophones) which detect seismic energy data reflected from underground rock strata. The collected seismic data is transmitted through the cables to the recorder vessel for data storage. The energy sources used during this survey are airguns towed by seismic source vessels traveling orthogonally over the patch of cabled hydrophones.

The OBC seismic survey conducted by BPXA in the Liberty prospect area was conducted by two seismic source vessels (*Peregrine* and *Miss Diane*), four cable vessels (*Canvasback*, *Cape Fear*, *Rumple Minze*, and *Sleep Robber*), a recorder vessel/barge combination (*Alaganik/Hook Point*), two crew/support vessels (*Qayaq Spirit* and *Mariah B*), and a housing vessel (*Arctic Wolf*). The ACS vessel *Gwydyr Bay* substituted for a crew vessel for several days when crew vessel repairs were required. All vessels operated in accordance with the provisions of the permits.

2.1 Operating Areas, Dates and Navigation

The geographic region where the OBC seismic survey occurred was located in Foggy Island Bay, Beaufort Sea in water depths between a few inches and 7.6 m (25 ft). The project area encompassed about 351.8 km^2 (135.8 mi^2), with the approximate boundaries between N70°11' and N70°23' and W147°10' and W148°02' (Figure 2.1).

All vessels, except the housing vessel *Arctic Wolf*, were trucked to the North Slope during the week of 23 June. The vessels were rigged and equipment was loaded at West Dock and the West Dock Staging Pad. The *Gwydyr Bay* permanently resides in Prudhoe Bay. The *Arctic Wolf* mobilized from the Port of Anchorage on 26 June, with a planned 2 week travel to West Dock. Due to ice conditions in the Chukchi Sea and around Barrow, the total transit time took about 3 weeks and the *Arctic Wolf* arrived at West Dock on 20 July. At West Dock she took on new provisions, water, and fuel before proceeding to the project area on 22 July.

The seismic survey in the Liberty area started 15 July with the lay-out of the first cable. A delay in the seismic effort was caused by a combination of bad weather and technical problems with the receiver cables. Seismic data acquisition started 24 July and ended at 0340 hours on 25 August in accordance with the CAA. The two source vessels and crew vessels transited to West Dock for demobilization on 25 August. The cable vessels, the housing vessel, and the recorder operated in the survey area for another day, until 26 August, to retrieve the last cables. The *Peregrine* was released to another operator after 25 August and the *Arctic Wolf* was released from duty on the project and picked up another contract effective 26 August 2008. All remaining vessels demobilized at West Dock and were trucked south. On 29 August, a vessel with divers transited to and from the survey area and recovered a sealed battery-pack that had been accidentally dropped overboard. Operations were completed 1 September 2008.

2.2 Airgun Description

Two source vessels were used during this seismic survey, the *Peregrine* and the *Miss Diane.* The *Peregrine* was mainly used for the deeper parts of the survey area (mostly >3 m or 10 ft) and the *Miss Diane* for the shallower areas (<3 m or 10 ft). Both source vessels were towing two arrays. The *Peregrine* towed two 440 in^3 arrays comprised of four airguns in clusters

of 2 x 70 in³ and 2 x 150 in³. The *Miss Diane* towed two 220 in^3 arrays, comprised of two guns of 1 x 70 in³ and 1 x 150 in³. Aside from some test runs with the two 440 in^3 array (= 880 in^3) of the *Peregrine*, the maximum volume used by both vessels during seismic data production was 440 in³. By reducing the operating array volume on the *Peregrine* from 880 in^3 to 440 in^3, the safety zones and hence the potential impact on marine mammals decreased.

The arrays were towed at a distance of ~8-10 m (~26-32 ft) from the source vessel at depths of 1.8 m (6 ft) on the *Peregrine* and 1.1 m (3.5 ft) on the *Miss Diane*. Both vessels traveled along pre-determined lines at an average speed of 5.6 km/h (3 kts). Each source vessel fired shots every 12 seconds, resulting in 6-second shot intervals in situations when both vessels were operating simultaneously (ping-pong). When weather and operational conditions allowed, seismic data acquisition operated 24 hours per day.

2.3 Short Summary of Work Performed

Seismic data were acquired on Patches 4 to 17 and on Patch 18 in only a small portion in the center (Figure 2.1). On Patch 4 to 6, seismic data were only acquired in water depths greater than 0.6 m (2 ft). Geophones were used to collect some shallow water portions of patches 7, 8 and 9. No seismic data were acquired in the remaining patches 1 to 3 and 19 to 22.

Approximately 237.8 km^2 (91.8 mi^2) of data acquisition was completed or approximately 70% of the originally permitted survey area. A total of 107,469 source shot points were taken with seismic data acquired for 93,104 shots. Approximately 580 km (360 mi) of cable were deployed and retrieved. Approximately 158.2 km^2 (61.1 mi^2) or 66.5% of the data was collected in state waters with approximately 79.5 km^2 (30.7 mi^2) or 33.5% of the data collected in federal OCS waters. Figure 2.2 shows some project vessels on site, Figure 2.3 is of the receiver cables, and Figure 2.4 shows the Miss Diane operating during the seismic survey.

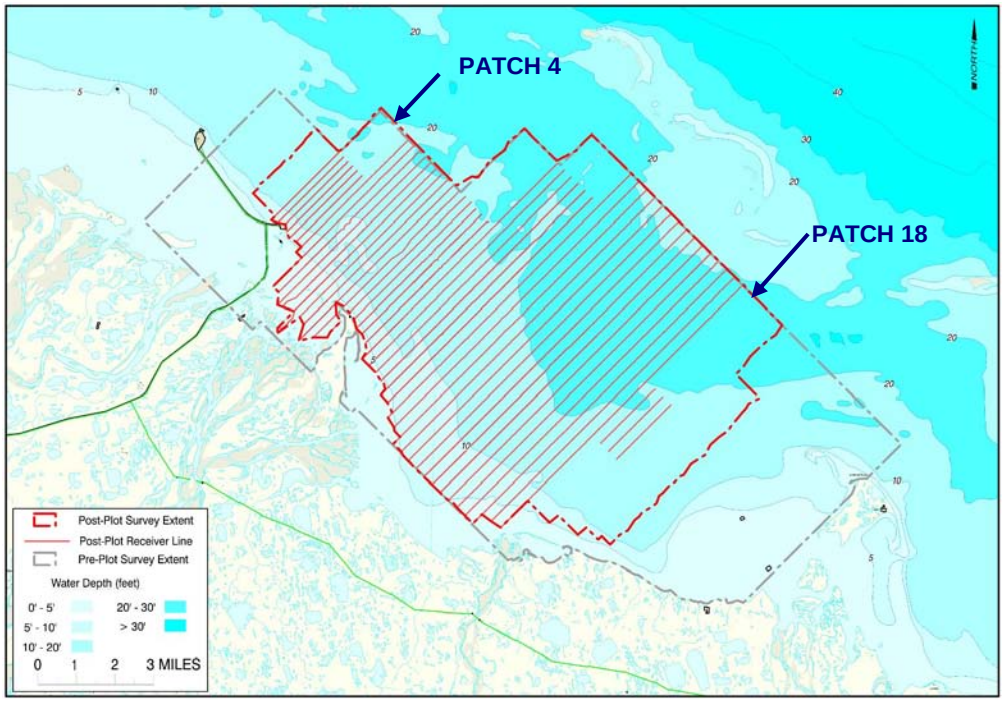


FIGURE 2.1 LIBERTY SEISMIC SURVEY AREA WITH PRE-SURVEY RECEIVER AND SOURCE LINES. SEISMIC DATA WERE ACQUIRED FROM PATCH 4 TO 17 AND IN ONLY A VERY SMALL PORTION OF PATCH 18.

2.4 Environmental Monitoring and Mitigation

Dedicated MMOs conducted vessel-based marine mammal monitoring and mitigation from the seismic source vessels *Peregrine* and *Miss Diane* throughout the seismic operations. MMOs were also present on the *Arctic Wolf* during its 3-week transit to the project area from the Port of Anchorage. Directly after the *Arctic Wolf* was released from duty on this project, it started on another contract and so no BPXA MMOs were needed for the return transit. This report provides detailed descriptions of the methods, equipment used, and results of the marine mammal related monitoring and mitigation during the seismic surveys.

In addition to the marine mammal mitigation and monitoring program, several other environmental monitoring surveys were conducted in accordance with relevant permit stipulations. These surveys included: *i*) a search for bird nests in areas where cable deployment and retrieval activities were planned on or in close proximity to land; *ii*) fish monitoring to identify potential for immediate fish injury or mortality due to proximity to seismic sounds; and *iii*) monitoring of potential damage to Boulder Patch biota (mainly kelp) from cable deployment and retrieval activities. The objective of these environmental surveys was to minimize potential impacts and increase understanding of potential impacts identified. The results of the bird, fish, and Boulder Patch surveys are described in the environmental monitoring and mitigation end-of-survey report (Aerts & Blees 2008) as part of the permit requirements (Appendix H).

FIGURE 2.2 THE RECORDER BOAT/BARGE COMBINATION *ALAGANIK/HOOK POINT* AND THREE OF THE FOUR BOWPICKERS LOADING CABLES.

FIGURE 2.3 RECEIVER CABLES (ORANGE) WITH LEAD LINE, HYDROPHONE AND RECORDING UNIT USED DURING THE LIBERTY SURVEY.

FIGURE 2.4 *MISS DIANE* TOWING THE TWO 220 IN^3 AIRGUN ARRAY.

3 ACOUSTIC MONITORING

This chapter presents the results of the acoustic measurements conducted for BPXA's 2008 Liberty seismic survey in Foggy Island Bay, Beaufort Sea during July/August 2008. The acoustic measurements and monitoring activities were conducted for three different purposes as summarized below. Details of each of these objectives are described in separate sections of this chapter.

- To measure and verify marine mammal safety zones. Sound source verification (SSV) measurements of the received sound pressure levels from the airguns were conducted to determine the distances from the airguns to received sound levels of 190, 180, 160 and 120 dB re 1 µPa (rms);
- To measure radiated noise of all vessels that were operated during the seismic survey, with the main objective as determining the effective source levels (dB re 1 µPa at 1 m rms) for each vessel;
- To measure the received sound levels of the airguns and of the combined vessel sounds in relation to the presence or absence of the barrier islands.

3.1 Airgun Sound Source Verification

This section presents the results of the airgun sound source verification (SSV) measurements from the two seismic source vessels *Peregrine* and *Miss Diane*. The objective was to verify the established safety radii by measuring the received sound pressure levels of various airgun volumes as a function of distance. This allows calculation of distances from the airguns to received sound levels of 190, 180, 160, and 120 dB. These measured distances were compared with the estimated distances as provided in the IHA application. The new measured distances to 190 dB and 180 dB were used as safety zones for marine mammal mitigation purposes and were provided to the MMOs as soon as they became available (24 July).

All airgun SSV measurements were performed by Greeneridge Sciences, Inc. under subcontract to LGL Alaska Research Associates, Inc. The acoustic data recorded were analyzed in the field immediately following each of the SSV measurements and the measured safety radii for the airgun arrays of the *Peregrine* and *Miss Diane* were provided to the MMOs as soon as they became available, prior to the start of data acquisition (24 July). The results were presented in reports and submitted by BPXA to the NMFS and USFWS as stipulated in the IHA and LOA. The same SSV reports were provided to the AEWC and NSB Department of Wildlife Management (NSB-DWM) in accordance with the CAA.

Equipment used

Recordings were made using two Autonomous Seafloor Acoustic Recorders model B or ASAR-Bs, hereafter referred to as ASARs (Figure 3.1). The ASARs included two omnidirectional hydrophones. One was a calibrated ITC model 1032 hydrophone without a preamplifier and was used to record high sound pressures from strong sources at close range. The

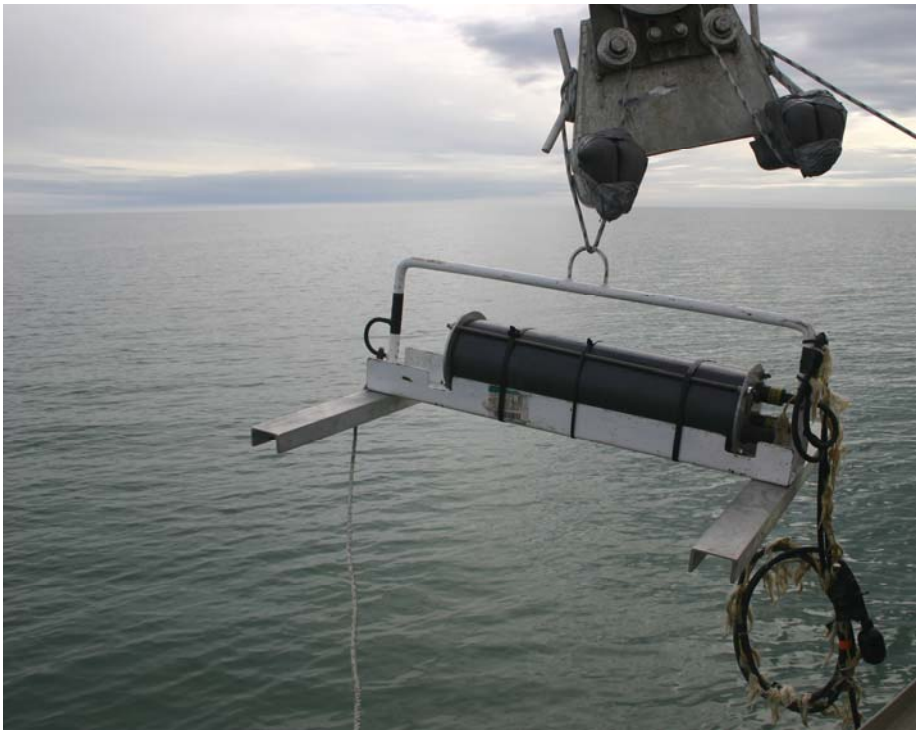


FIGURE 3.1 ASAR SYSTEM BEING DEPLOYED FROM THE BOWPICKER *SLEEP ROBBER*.

second was a calibrated ITC model 8212 hydrophone with a preamplifier, and was used to record lower level sounds from greater distances. Together, the two hydrophones provided an extended dynamic range for linear recording of strong and weak sounds, free of distortion. The ASAR pressure housing contained the recording electronics and a rechargeable gel cell battery. The recorder included a two-channel signal digitizer with 16-bit quantization and a sampling rate of 44.1 kHz for each channel, providing a usable frequency range of 5 to 20,000 Hz. Data were written to an 8 GB solid state memory card providing approximately 13 hours of continuous recording. All ASAR hydrophones had been calibrated at the ITC calibration facility in Goleta, California, which employs standards traceable to the national standards for underwater sound measurements. Thorough calibration of the hydrophones and recording equipment allowed all results to be referred to the standard acoustic pressure of one micropascal (1 µPa).

Field operations

SSV measurements of the airgun arrays on the *Peregrine* and *Miss Diane* were conducted prior to the start of seismic data acquisition with those specific arrays. The SSV measurements were conducted along a 12 km (7.5 mi) trackline located in the deepest part of the seismic survey area. In addition to measurements of bow and stern aspects of the airgun sounds, the trackline included a transverse line of ~1 km (~0.6 mi) long and at a distance of ~1 km (~0.6 mi) from the recorders to measure the broadside aspects of the airgun sounds (Figure 3.2). The water depth at the ASAR locations was 7.0 m (~23 ft) and remained approximately range-independent over the entire 12 km (7.5 mi) vessel track. The airgun arrays of the *Peregrine* were towed at a depth of 1.8 m (6 ft) and 1.1 m (3.5 ft) for the *Miss Diane.* SSV measurements were conducted for each airgun volume separately, with those of the *Peregrine* on 15 July 2008 and of the *Miss Diane* on 18 July 2008.

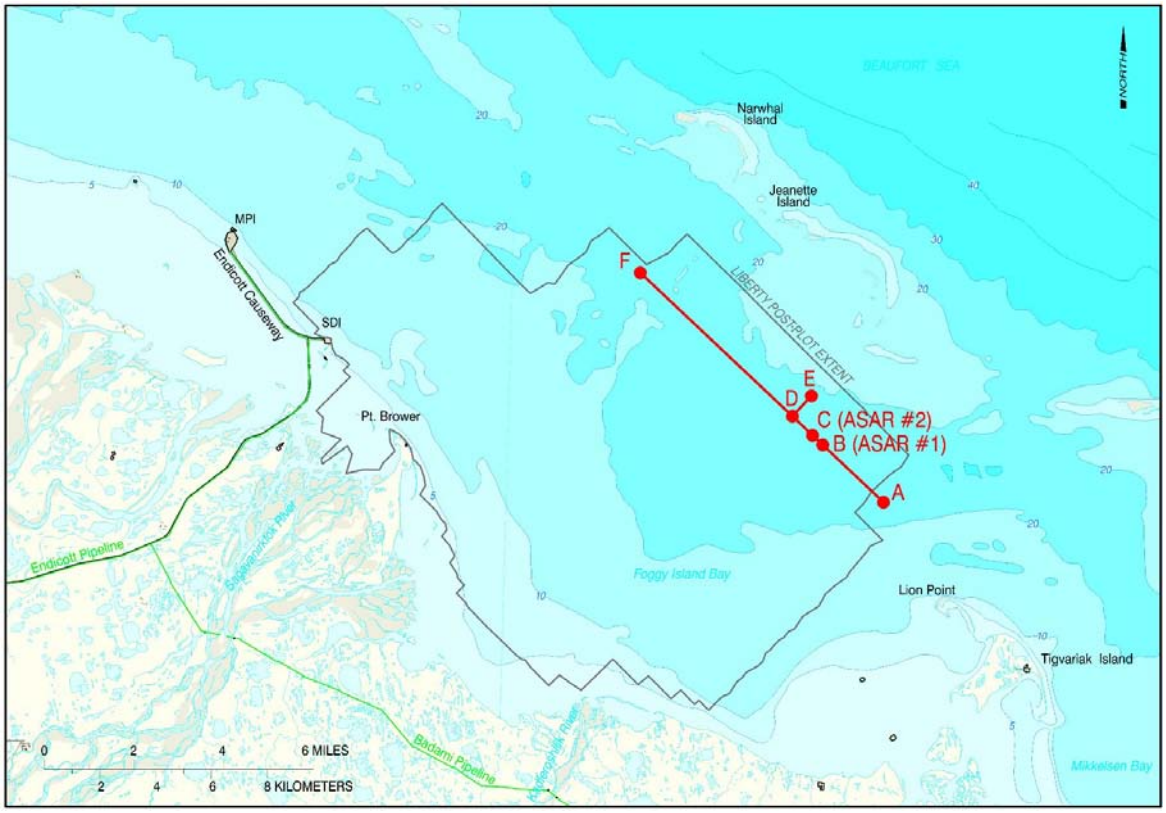


FIGURE 3.2 LOCATION OF AIRGUN SSV TRACK WITHIN THE POST-SURVEY SEISMIC SURVEY AREA. REDUNDANT ASAR-B RECORDERS WERE DEPLOYED AT ~0.3 MI (0. 5 M) FROM EACH OTHER AT WAYPOINTS B AND C. A TRANSVERSE LINE WITH HAIRPIN TURN AT WAYPOINT E PROVIDED BROADSIDE ASPECTS OF THE AIRGUN SOUNDS.

Shortly after completion of the ASAR deployments at locations B and C on 15 July, the *Peregrine* started shooting both 440 in^3 airgun arrays (= 880 in^3) at a nominal speed of ~4 to 6 km/h (2 to 3 kts) while following the SSV trackline, starting at point F. A transverse line, running from point D to E and with a hairpin turn at point E back to D provided broadside aspects of the airgun sounds. The sound of all aspects was measured to ensure that the safety radii would be calculated based on the aspect with the greatest radiated sound. The symmetry of the airgun arrays strongly suggested that the port and starboard aspects would not differ. However, because of the presence of the tow boat in the bow direction, the bow and stern aspect were expected to be different. The vessel used for the ASAR deployments, the bowpicker and cable vessel *Sleep Robber*, remained in the area at a safe distance from the track to avoid noise contamination of the recordings. All other seismic survey vessels in the area were also instructed to remain at a distance while the SSV measurements were conducted.

The *Peregrine* completed three runs along the SSV track over the ASARs (Figure 3.2) with different array volumes:

- From point F to A operating two 440 in^3 airgun arrays, hereafter referred to as 880 in^3 array;
- From point A to F with one 440 in^3 array, hereafter referred to as 440 in^3 array;
- From point F to A with a total of 70 in^3, the smallest gun of the array and also the mitigation source.

The same protocol was repeated for the *Miss Diane* on 18 July, with the two 220 in^3 airgun arrays, hereafter referred to as the 440 in^3 array. There were two main reasons for conducting a separate measurement with the *Miss Diane* instead of using the results from the *Peregrine's* 440 in^3: *i*) the 440 in^3 airgun configuration on the *Miss Diane* was slightly different, with two airgun arrays of 220 in^3 in stead of one airgun array of 440 in^3; and *ii*) the tow depth of the airgun array on the *Miss Diane* was shallower, which would result in higher propagation loss and thus smaller safety radii. No SSV measurements of the 70 in^3 gun on the *Miss Diane* were conducted because it was identical to the *Peregrine* 70 in^3 gun but at shallower tow depth. The decision was made to use the recommended safety radii obtained with the *Peregrine's* 70 in^3 mitigation source for both seismic source vessels.

After the recorded data were obtained, broadband sound pressure levels (SPL) were calculated for a subset of pulses, chosen to create a sufficient number of points of received level versus range from which to make a reliable fit. The pulse duration was defined as the time interval between the arrival of 5% and 95% of the total pulse energy, and the pulse SPL was averaged over the pulse duration (Burgess and Greene 1999, McCauley et al. 1998, 2000). The SPL obtained is equivalent to the rms levels as used by NMFS for mitigation purposes. SPL values were then fitted to a sound propagation equation of the form:

$$RL = A - B*\log(R) - C*R \qquad \text{(Eq 1)}$$

where RL is the received level in dB re 1 µPa and R is the source-to-receiver range in meters. The constant term (A) is the hypothetical level 1 m (3.3 ft) from the source, extrapolated back to 1 m range based on the above measurements. This hypothetical value would equal the actual level at 1 m only if the source were a point source and if transmission loss were consistent at all distances from 1 m to the maximum measurement distance, neither of which is the case in practice. The equation permits calculating the distances to specified received levels, such as 190, 180, and 160 dB, relevant for marine mammal mitigation. It also permits extrapolation to determine an expected distance to a received level of 120 dB. For the Liberty seismic survey only the distances associated with received levels of 190 and 180 dB were used for mitigation purposes (see Section 3.2).

The initial least-squares fit of the data to the model equation resulted in the coefficients for the 50th percentile fit with approximately half the measured points above the equation and half below—whatever resulted in the minimum mean square error. Adjusting the constant value in the equation permitted raising the equation line until it covered all the measurement points, 100%, but maintaining the shape of the least-squares equation. This 100th percentile equation was used as the basis for establishing marine mammal safety radii because it included all variability observed in the measurements and as such provided some margin for the inevitable variability in propagation conditions from one site to another.

The sections below describe the results of the SSV measurements of various airgun volumes that were conducted with the *Peregrine* (880 in^3, 440 in^3 and 70 in^3) and the *Miss Diane* (440 in^3). For each airgun volume the bow, stern and broadside (port and starboard) aspects were analyzed. The port and starboard aspects were analyzed together with the bow aspect in cases where the vessel run along the track was conducted from point F to A and with the stern aspect when the track was run in the opposite direction.

SSV Results Peregrine: 880 in^3 Airgun Array

Figure 3.3 below shows received levels for 44 samples at distances of ~0.04 to 10 km (~0.02 to 6.2 mi) for the bow aspect and its associated model fit for the 880 in^3 array of the

Peregrine. Also shown are broadside (port and starboard) aspects measured at ~1.75 km (~ 1.1 mi) range. These samples were not included in the model fit calculations.

The model that satisfies the bow aspect measurements is shown in Figure 3.3, where N is the number of observations and R^2 is the coefficient of determination representing the goodness of fit of the model. Because the model equation utilizes a standard least-squares fit to the measured data, about 50% of the measurements fall above and 50% fall below the fitted curve. The equation that predicts distances to received levels encompassing all measurements (100th percentile) has a higher constant term, in this case 275.0 in stead of 264.0. The dashed curve in Figure 3.3 corresponds to the adjusted equation with this constant term of 275.0. This 100th percentile equation is used as the basis for setting marine mammal safety radii as it includes all the variability observed in the measurements and as such provides some margin for the inevitable variability in propagation conditions from one site to another.

Figure 3.4 shows received levels for 68 samples at distances of 0.04 to 3 km (0.02 to 1.9 mi) for the stern aspect. It shows a partitioning of the received levels into two segments with a break at approximately 1.5 km (0.9 mi). This partitioning seems to be the result of a marked change in the bottom stratigraphy and composition between the source and the receiver. This geologic break occurred at the same geographic location during all airgun SSV runs over this track. Similar features were also present in some of the seismic acquisition data as shown by a geophysicist working on the seismic survey. The model fit was, therefore, applied to the two segments separately to derive at two different regression equations as shown in Figure 3.4. The "C" coefficient in Eq. 1, which corresponds to an absorption or scattering loss, could not be included in equation RL_2 for the longer ranges because of the relatively small change in distance.

Table 3.1 summarizes the radii calculated from the combined equations for both the 50th and 100th percentile model fit. The "Modeling Determined Radii" column shows the values predicted prior to the field season by Greeneridge Sciences based on measurements of a 56 in^3 airgun obtained in Foggy Island Bay in 1997 (Greene, 1998). The IHA application submitted to NMFS by BPXA in November 2007 provides more details on these modeled radii.

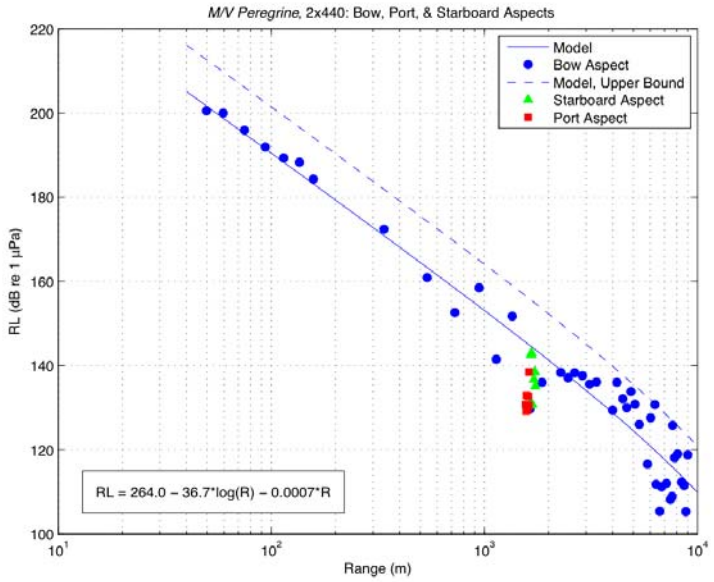


FIGURE 3.3 BOW AND BROADSIDE MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE ($40 \le R \le 9000$ M) FOR THE *PEREGRINE*'S 880 IN^3 AIRGUN ARRAY ($N = 44$, $R^2 = 0.9531$). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FIT (EQUATION IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FIT (RL=275.0 -36.7*LOG(R) – 0.0007*R).

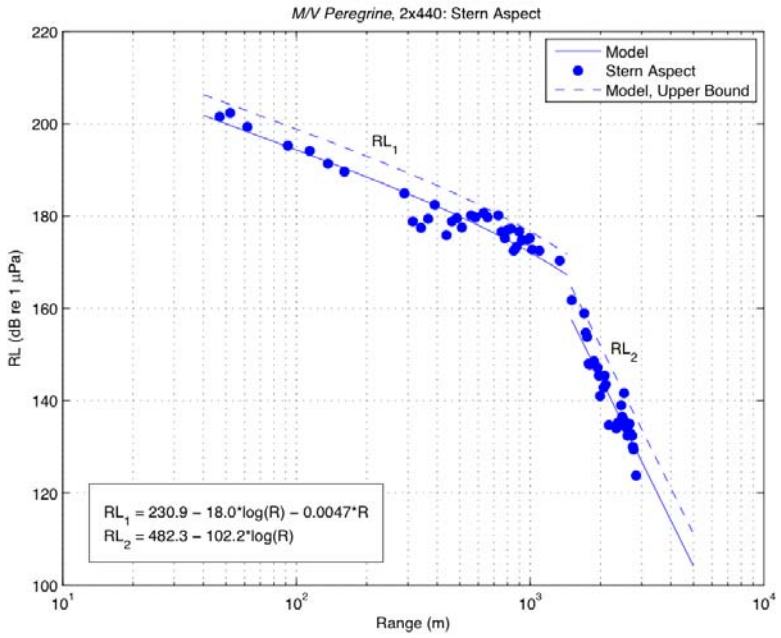


FIGURE 3.4 STERN MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (40<R<1500 M FOR RL_1, 1500 <R<3000 M FOR RL_2) FOR THE *PEREGRINE*'S 880 IN^3 AIRGUN ARRAY (N_1 = 37, R_1^2 = 0.9158, N_2 = 31, R_2^2 = 0.8596). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FITS (EQUATIONS IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FITS (RL_1=235.4 -18.0*LOG(R) – 0.0047*R, RL_2=489.3 -102.2*LOG(R)).

TABLE 3.1 PREDICTED MODELED RADII, AND MEASURED RADII FOR BOW AND STERN ASPECT (50TH AND 100TH PERCENTILES) OF THE 880 IN^3 AIRGUN ARRAY ON *PEREGRINE*. 1000 M = 3300 FT = 0.6 MI. NOTE THAT THE LARGER EMPIRICALLY DETERMINED RADII ASSUME HOMOGENUOUS CONDITIONS, I.E. DON'T TAKE INTO ACCOUNT POTENTIAL EFFECT OF BARRIER ISLANDS.

Received Level [dB re 1 µPa]	Modeling-Determined Radii[a] [m]	Empirically-Determined Radii	
		, Bow Aspect (50th/100th Percentile)[b] [m]	Stern Aspect (50th/100th Percentile)[b] [m]
190	390	103/204	167/278
180	880	192/379	494/752
170	1830	356/699	1178/1614
160	3430	657/1274	1500/1664
120	16000	6264/10372	3498/4096

[a] Radii predicted by Greeneridge Sciences prior to the field season, assuming the 880 in^3 array was operating at a depth of 13 ft (4 m).

[b] From best-fit equation of empirical data.

SSV Results Peregrine: single 440 in³ Airgun Array

The analyses for the 440 in³ array on the *Peregrine* were the same as those reported above for the 880 in³ array. Figure 3.5 shows received levels for 39 samples at distances of 0.10 to 8 km (0.06 to 5 mi) for the stern and broadside aspects. Received levels for 21 bow aspect samples at distances of 1.5 to 3 km (0.9 to 2 mi) are shown in Figure 3.6. Again, a partitioning of the received levels versus range into two segments was apparent, with a break at approximately 01.5 km (9 mi), but this time for the bow aspect as the vessel ran the trackline in the opposite direction. Differences in broadside aspect between the 440 in³ and 880 in³ are likely due to differences in geometry of both airgun clusters. Table 3.2 summarizes the predicted modeled radii, and measured radii for bow and stern aspect (50th and 100th percentiles) of the single 440 in³ airgun array on *Peregrine*.

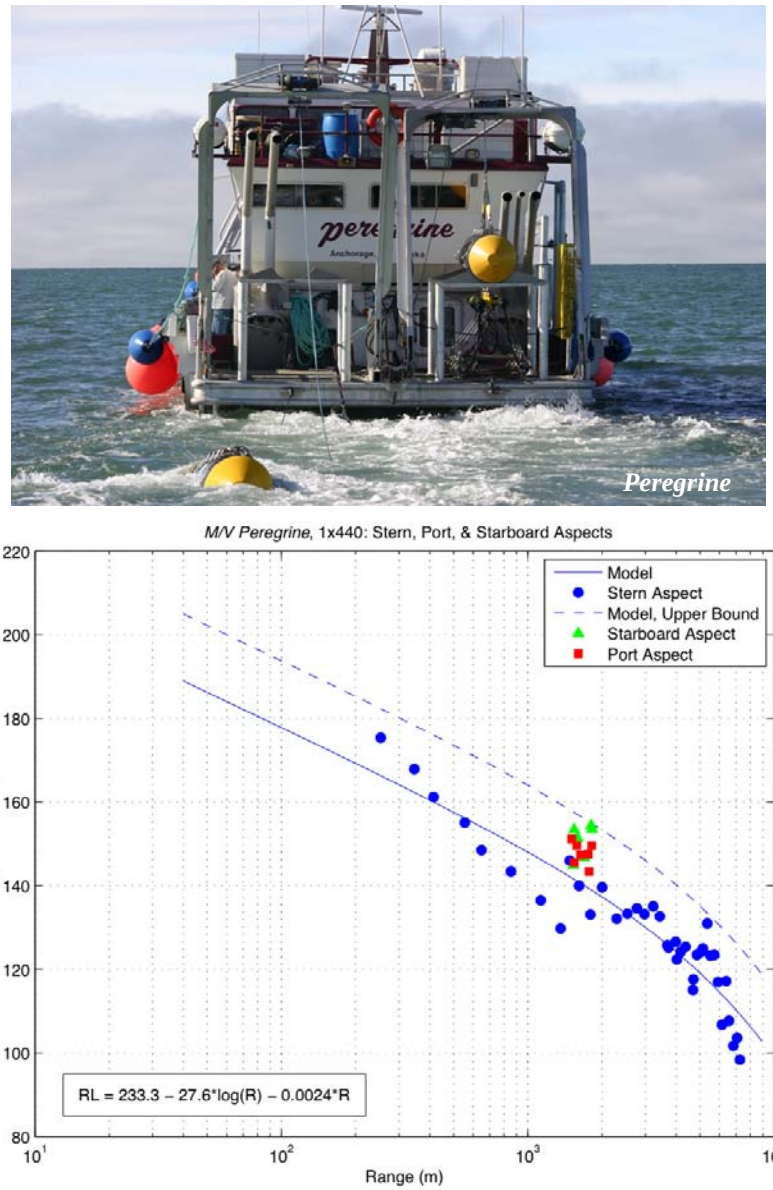


FIGURE 3.5 STERN AND BROADSIDE MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (100<R<8000 M) FOR THE *PEREGRINE*'S 440 IN³ AIRGUN ARRAY (N = 39, R^2 = 0.8703). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FIT (EQUATION IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FIT (RL=249.3 -27.6*LOG(R) – 0.0024*R). THE *PEREGRINE*, OPERATING ITS 440 IN³ AIRGUN ARRAY, IS SHOWN IN THE PICTURE ABOVE.

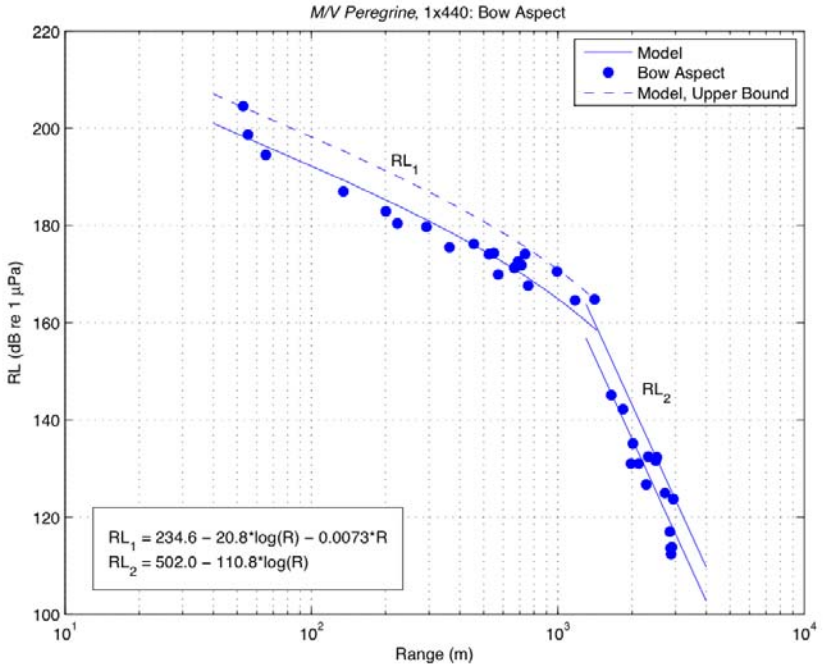


FIGURE 3.6 BOW MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (40<R<1500 M FOR RL_1, 1500 <R<3000 M FOR RL_2) FOR THE *PEREGRINE*'S 440 IN^3 AIRGUN ARRAY (N_1 = 21, R_1^2 = 0.9079, N_2 = 14, R_2^2 = 0.7301). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FITS (EQUATIONS IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FITS (RL_1=240.6 -20.8*LOG(R) – 0.0073*R, RL_2=509.0-110.8*LOG(R)).

TABLE 3.2 PREDICTED MODELED RADII, AND MEASURED RADII FOR BOW AND STERN ASPECT (50TH AND 100TH PERCENTILES) OF THE SINGLE 440 IN^3 AIRGUN ARRAY ON *PEREGRINE*. 1000 M = 3300 FT = 0.6 MI. NOTE THAT THE LARGER EMPIRICALLY DETERMINED RADII ASSUME HOMOGENUOUS CONDITIONS, I.E. DON'T TAKE INTO ACCOUNT POTENTIAL EFFECT OF BARRIER ISLANDS.

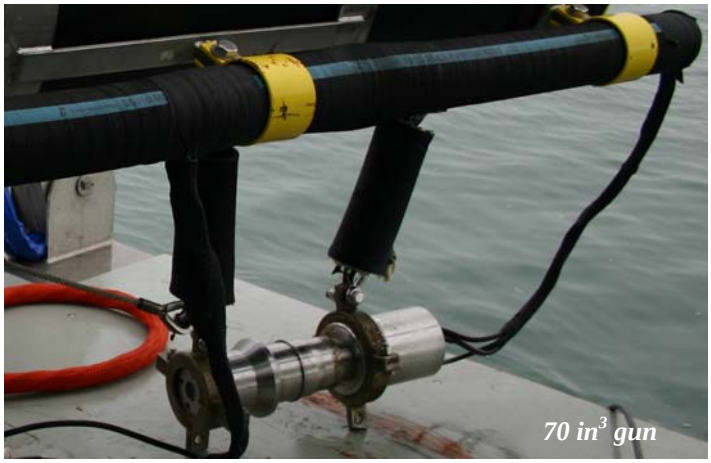
Received Level [dB re 1 µPa]	Modeling-Determined Radii[a] [m]	Empirically-Determined Radii	
		Bow Aspect (50th/100th Percentile)[b] [m]	Stern Aspect (50th/100th Percentile)[b] [m]
190	200	126 / 226	40 / 136
180	462	325 / 533	84 / 304
170	1030	716 / 1056	188 / 652
160	2090	1324 /1408	415 / 1314
120	12900	2794 /3232	4820 /8595

[a] Radii predicted by Greeneridge Sciences prior to the field season, assuming the 440 in^3 array was operating at a depth of 13 ft (4 m).

[b] From best-fit equation of empirical data.

SSV Results Peregrine: 70 in³ Airgun

Data collected with the *Peregrine's* 70 in^3 array were analyzed in the same way as those reported earlier. Figure 3.7 shows received levels for 35 samples at distances of 0.02 to 8 km (0.01 to 5 mi) for the bow and broadside aspects. Received levels for 47 stern aspect samples are shown in Figure 3.8. Once again a partitioning of the received levels versus range into two segments was apparent, with a break at approximately 1.5 km (0.9 mi). Table 3.3 summarizes the predicted modeled radii, and measured radii for bow and stern aspect (50th and 100th percentiles) of the 70 in^3 airgun array on *Peregrine.*



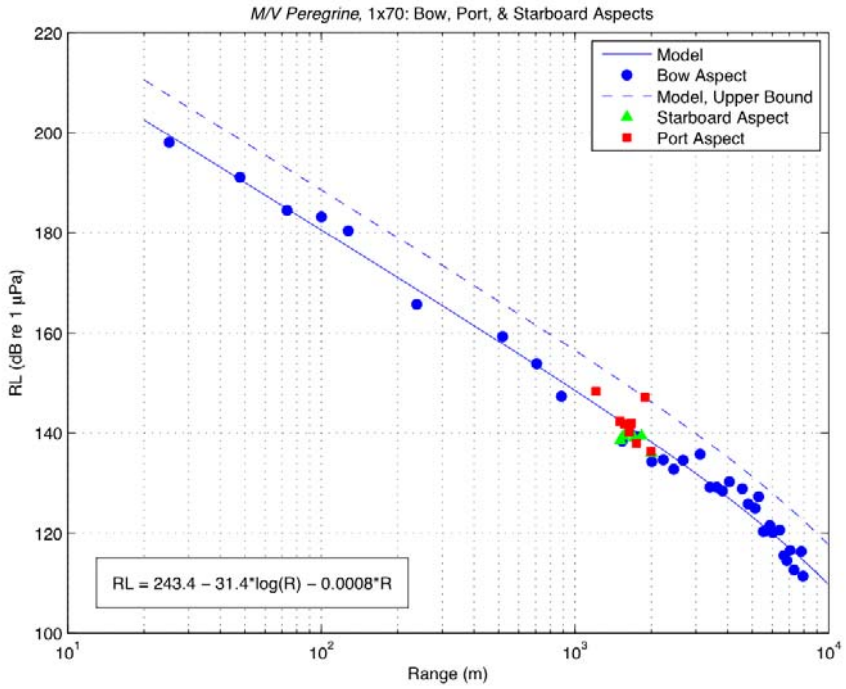


FIGURE 3.7 BOW AND BROADSIDE MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (20<R<8000 M) FOR THE *PEREGRINE*'S 70 IN^3 AIRGUN ARRAY (N = 35, R2 = 0.9895). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FIT (EQUATION IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FIT (RL=251.4 -31.4*LOG(R) – 0.0008*R). THE *70* IN^3 AIRGUN OF THE *PEREGRINE* IS SHOWN IN THE PICTURE ABOVE.

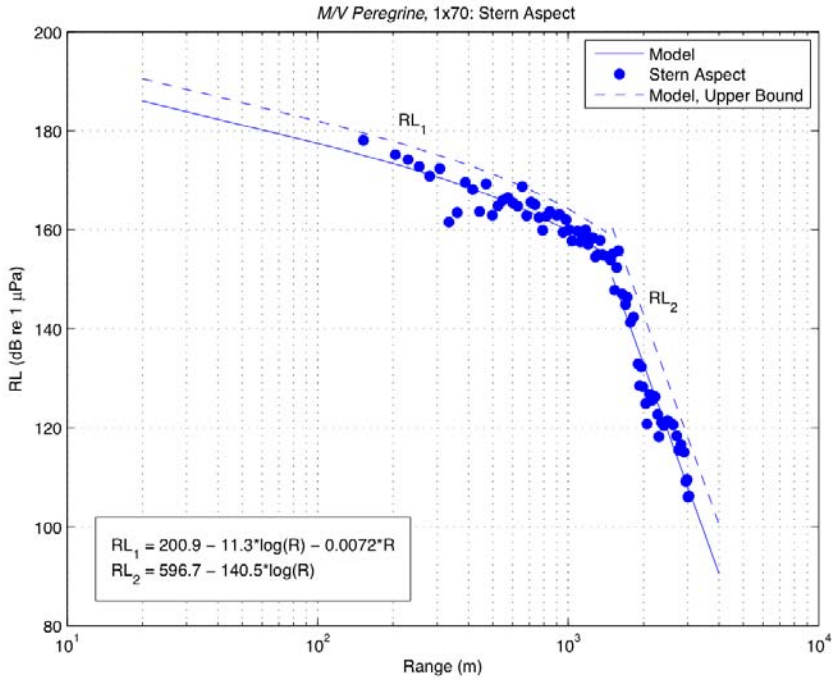


FIGURE 3.8 STERN MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE FOR THE *PEREGRINE*'S 70 IN^3 AIRGUN ARRAY (N_1 = 47, R_1^2 = 0.8455, N_2 = 31, R_2^2 = 0.8999). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FITS (EQUATIONS IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FITS (RL_1=205.4 -11.3*LOG(R) – 0.0072*R, RL_2= 606.7 -140.5*LOG(R)).

TABLE 3.3 PREDICTED MODELED RADII, AND MEASURED RADII FOR BOW AND STERN ASPECT (50TH AND 100TH PERCENTILES) OF THE 70 IN^3 AIRGUN ARRAY ON *PEREGRINE*. 1000 M = 3300 FT = 0.6 MI. NOTE THAT THE LARGER EMPIRICALLY DETERMINED RADII ASSUME HOMOGENUOUS CONDITIONS, I.E. DON'T TAKE INTO ACCOUNT POTENTIAL EFFECT OF BARRIER ISLANDS.

Received Level [dB re 1 µPa]	Modeling-Determined Radii[a] [m]	Empirically-Determined Radii	
		Bow Aspect (50th/100th Percentile)[b] [m]	Stern Aspect (50th/100th Percentile)[b] [m]
190	44	50 / 90	9 / 22
180	105	104 / 187	64 / 143
170	249	216 / 384	332 / 577
160	571	443 / 781	980 / 1374
120	7030	5976 / 8968	2470 / 2910

[a] Radii predicted by Greeneridge Sciences prior to the field season, assuming the 70 in^3 array was operating at a depth of 13 ft (4 m).

[b] From best-fit equation of empirical data.

SSV Results Miss Diane: 440 in³ Airgun Array

The SSV measurements of the 440 in³ airgun array on the *Miss Diane* were conducted with the same acoustic equipment and along the same track as for the *Peregrine*, i.e., traveling between points A and F in Figure 3.2. The airgun arrays were towed at a depth of 3.5 ft (1.1 m). Figure 3.9 shows received levels for 68 samples at distances of 0.02 to 8 km (0.01 to 5 mi) for the stern and broadside aspects. Figure 3.10 shows received levels versus distance for 138 bow aspect samples. Consistent with measurements made with the *Peregrine*, a partitioning into two segments of the received level versus range was apparent, with a break at the same geographical position at approximately 1.5 km (0.9 mi). Table 3.4 summarizes the predicted modeled radii, and measured radii for bow and stern aspect (50th and 100th percentiles) of the 440 in³ airgun array on *Miss Diane.*

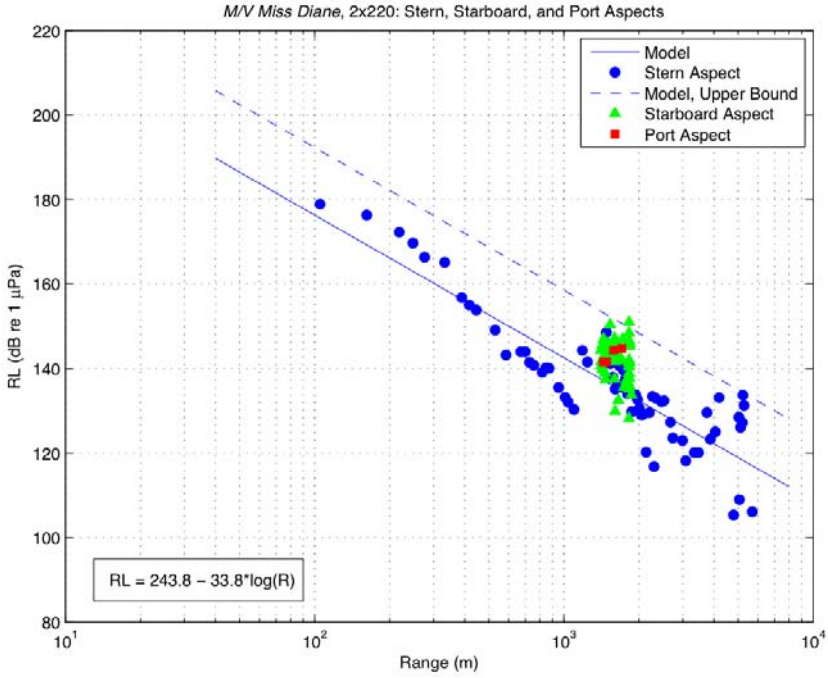


FIGURE 3.9 STERN, STARBOARD, AND PORT MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (100<R<6000 M) FOR THE *MISS DIANE*'S 440 IN³ AIRGUN ARRAY (*N* = 68). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FIT (EQUATION IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FIT (RL=259.8 -35.0*LOG(R)). THE *MISS DIANE*, WITH ITS TWO 220 IN³ AIRGUN ARRAYS, IS SHOWN IN THE PICTURE ABOVE.

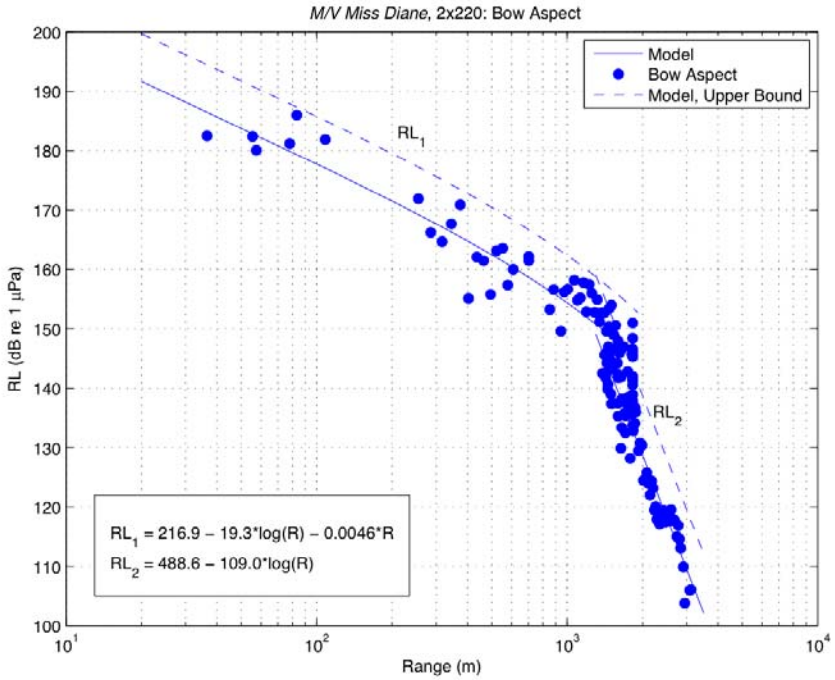


FIGURE 3.10 BOW MEASUREMENTS OF RECEIVED LEVELS AS A FUNCTION OF RANGE (20<R<1500 M FOR RL_1, 1500 <R<3000 M FOR RL_2) FOR THE *MISS DIANE*'S 440 IN^3 AIRGUN ARRAY (N_1 = 42, N_2 = 96). THE SOLID LINE REPRESENTS THE 50TH PRECENTILE MODEL FITS (EQUATIONS IN FIGURE) AND THE DASHED LINE THE 100TH PERCENTILE MODEL FITS (RL_1=224.9 - 18.2*LOG(R) – 0.0021*R, RL_2=498.6 -108.8*LOG(R)).

TABLE 3.4 PREDICTED MODELED RADII, AND MEASURED RADII FOR BOW AND STERN ASPECT (50TH AND 100TH PERCENTILES) OF THE 440 IN^3 AIRGUN ARRAY ON *MISS DIANE*. 1000 M = 3300 FT = 0.6 MI

Received Level [dB re 1 µPa]	Modeling-Determined Radii[a] [m]	Empirically-Determined Radii	
		Bow Aspect (50th/100th Percentile)[b] [m]	Stern Aspect (50th/100th Percentile)[b] [m]
190	200	24 / 62	40 / 117
180	462	78 / 190	78 / 231
170	1030	236 / 523	154 / 458
160	2090	627 / 1195	304 / 905
120	12900	2405 / 2970	4652 / 13856

[a] Radii predicted by Greeneridge Sciences prior to the field season, assuming the 440 in^3 array was operating at a depth of 13 ft (4 m).

[b] From best-fit equation of empirical data.

3.2 New Safety Radii

Under current NMFS guidelines (e.g. NMFS 2000), "safety radii" for marine mammals around airgun arrays are customarily defined as the distances within which received pulse levels are ≥180 dB re 1 μPa for cetaceans and ≥190 dB for pinnipeds. These guidelines were also employed by the USFWS in its LOA issued to BPXA, with a ≥180 dB safety radius for walrus and ≥190 dB radius for polar bears in water. These safety criteria are based on an assumption that seismic pulses at lower received levels will not injure these animals or impair their hearing ability, but that higher received levels might have such effects. Marine mammals exposed to ≥160 dB are assumed by NMFS to be potentially subject to behavioral disturbance. However, no specific dedicated monitoring programs 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 were required for the Liberty shallow water seismic survey, as none of these situations were expected to occur based on the estimated and measured safety radii. The recommended safety radii for received levels of ≥190 dB and ≥180 dB are provided in Table 3.5, together with the modeled radii and the measured radii (100th percentile) from either bow or stern aspect, whichever resulted in the largest radius. These recommended radii were provided to the MMOs on 24 July and implemented during the seismic survey as of that date.

TABLE 3.5 SUMMARY OF RECOMMENDED, MODELED AND EMPIRICALLY DETERMINED (MEASURED) SAFETY RADII FOR RECEIVED LEVELS OF 190 DB AND 180 DB. THE RECOMMENDED RADII WERE BASED ON THE LARGEST 100TH PERCENTILE DISTANCE FOR EACH AIRGUN ARRAY AND WERE IMPLEMETED BY THE MMOS ON THE SOURCE VESSEL AS SOON AS THEY BECAME AVAILABLE (24 JULY). 1000 M = 3300 FT = 0.6 MI

Airgun Array [in^3]	Received Level [dB re 1 μPa]	Recommended Radii [m]	Modeling-Determined Radii [m]	Empirically-Determined Radii [m]
880 ***Peregrine***	190	300	390	278
	180	800	880	752
440 ***Peregrine***	190	250	200	226
	180	550	462	533
70 ***Peregrine***	190	100	44	90
	180	200	105	187
440 ***Miss Diane***	190	150	200	117
	180	300	462	231

3.3 Vessel Sound Measurements

This section presents the results of the acoustic measurements of vessel sounds. The objective was to obtain knowledge on each vessel's radiated source level (1m from the source) in the area of operation. A total of 10 vessels were involved in the Liberty survey. One additional vessel, the ACS vessel *Gwydyr Bay*, substituted for a crew vessel for several days when crew vessel repairs were required. Source level measurements were also obtained for this vessel. Figure 3.11 shows some of the vessels that were involved in the seismic survey.

The vessel sound measurements were performed by Greeneridge Sciences Inc. and JASCO Research under subcontract to LGL Alaska Research Associates Inc.

Equipment used: ASARs

The ASAR-B's used by Greeneridge are the same units described under the SSV measurements (Section 3.1).

Equipment used: OBHs

The underwater acoustic recording equipment used by JASCO is referred to as the Ocean Bottom Hydrophone (OBH) system. Two OBH recorders were deployed on the sea bottom with a 30 m (98 ft) sinking line attached to a Danforth anchor. A surface buoy was attached to the Danforth anchor to facilitate retrieval of the OBHs (Figure 3.12). The separation of anchor and OBH isolated the recorder from noise produced by movements of the float and surface line. A frame was attached to the OBH prior to deployment to hold the OBH hydrophones approximately 20 cm (0.65 ft) off the seabed.

FIGURE 3.11 SUBSET OF VESSELS INVOLVED IN THE SEISMIC SURVEY. FROM LEFT TO RIGHT: *QAYAQ SPIRIT, MARIAH B, CAPE FEAR, RUMPLE MINZE, CANVASBACK, AND SLEEP ROBBER*.

Each OBH used two calibrated Reson hydrophones: a model TC4043 (nominal sensitivity -201 dB re V/µPa) and a model TC4032 (nominal sensitivity -170 dB reV/µPa). Digital recordings were obtained with Sound Devices model 722, 24-bit audio hard-drive recorders set to sampling rate 48 kHz. The recorders had 40 GB hard drives that could store up to 37 hours of continuous acoustic data on a single deployment. The hydrophone pressure sensitivities were calibrated by the manufacturer (Reson) at 250 Hz and between 5 kHz and 80 kHz. The Sound Devices digital recorders were calibrated in JASCO's lab prior to being sent into the field. Field calibrations were performed immediately prior to deployment and immediately after retrieval of the OBHs, using a GRAS 42AC pistonphone calibrator. For the pistonphone calibrations, a Reson TL8089 adapter was used with the Reson TC4032 hydrophone and a GRAS RA0043 adapter was used with the TC4043 hydrophone. The combinations of pistonphones, adapters, and hydrophones were pre-calibrated.

One minute pistonphone calibration signals at 250 Hz, with 0.1 dB accuracy, were recorded on each deployment. The calibration signals were processed following the deployments to obtain overall system gain values. The pre-deployment and post-deployment calibration gains obtained this way differed by 0.3 dB. We expect accuracy conservatively to less than 1 decibel for frequencies below 5 kHz, which is in the flattest frequency response region of both hydrophones. This accuracy is based on the low-frequency spectral variation of calibration curves provided by Reson for these hydrophones.

Field operations

Vessels traveled along a predetermined 2 km (1.2 mi) length track which roughly followed a 6 m (20 ft) isobath, as illustrated in Figure 3.13 where track endpoints are denoted by Stations A and C. Two acoustic recorders (either ASARs or OBHs) were deployed near the midpoint of the track at Station B. Different load conditions and traveling speeds were measured for each vessel to assess variability in source levels.

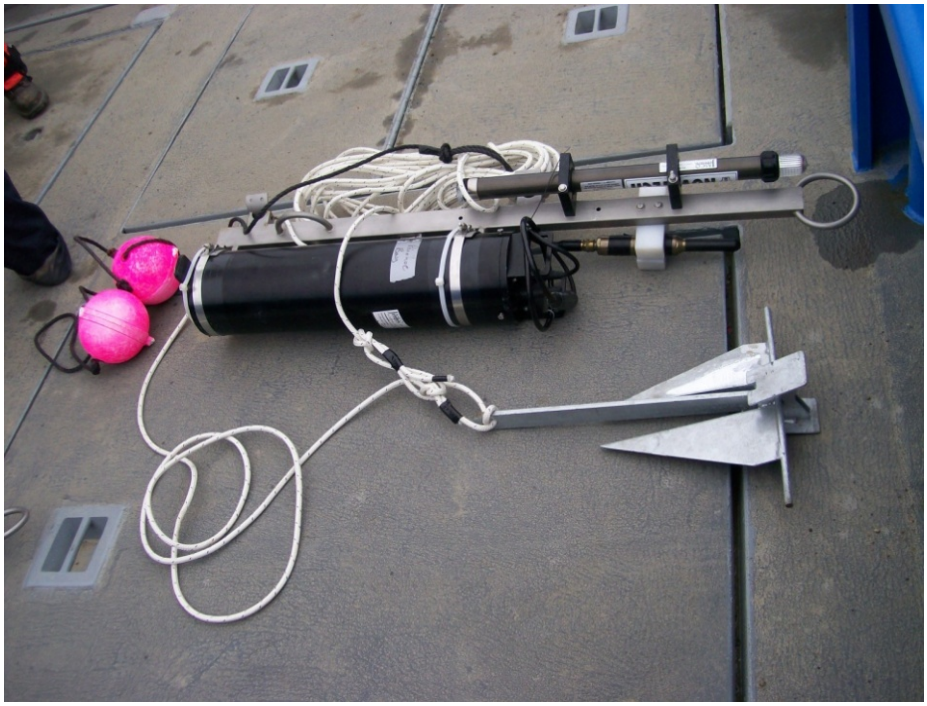


FIGURE 3.12 AN OBH SYSTEM READY TO BE DEPLOYED.

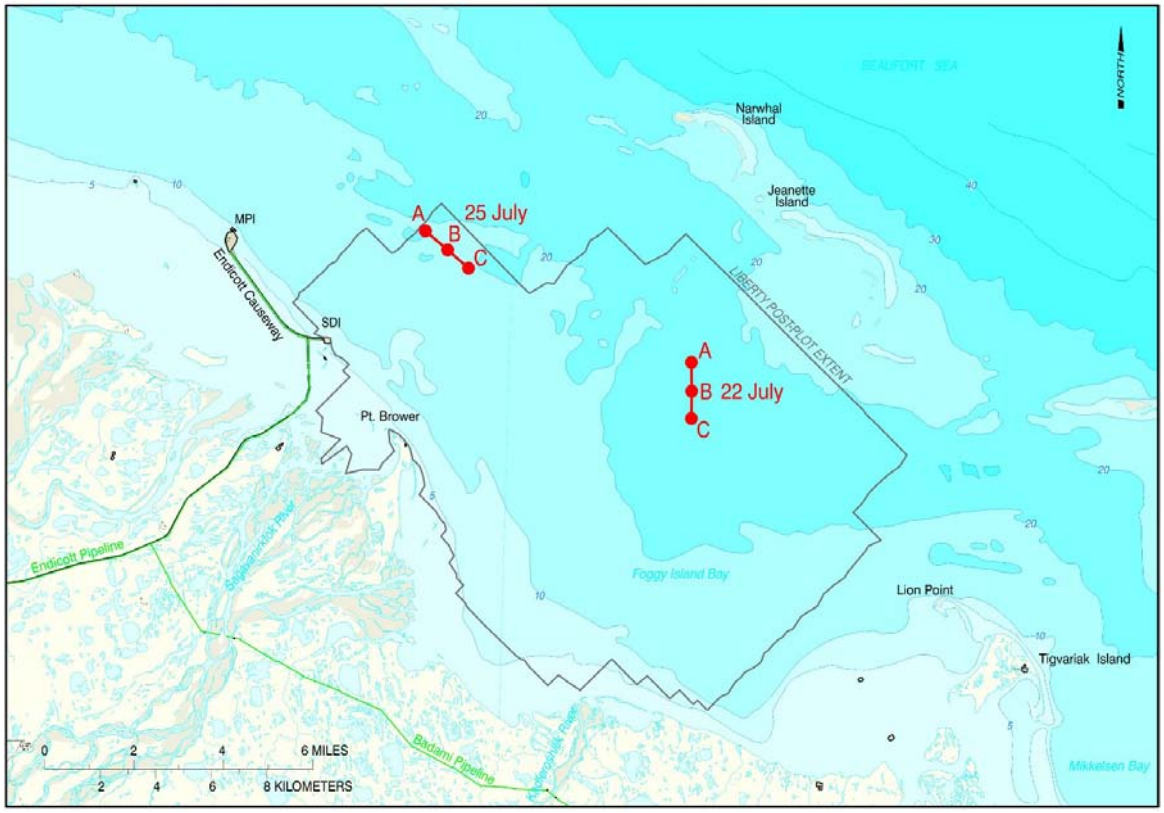


FIGURE 3.13 TRACKS FOR VESSEL MEASUREMENTS RELATIVE TO THE POST-SURVEY SEISMIC SURVEY AREA. RECORDERS WERE DEPLOYED AT THE MIDPOINT OF THE TRACK, STATION B.

Source level measurements of the four bowpickers (*Cape Fear, Canvasback, Rumple Minze* and *Sleep Robber*) were made at their normal operating or working speed (slow run) and transiting speed (fast run). For the crew boat, the *Qayaq Spirit*, measurements were made for a slow run and its normal operating or transiting speed (fast run). For the two seismic source vessels, *Peregrine* and *Miss Diane*, "slow run" measurements were made at a traveling speed of approximately 5.5 km/h (3 kts) and under loaded conditions with compressors running. The data for these measurements were obtained from the SSV data, utilizing the received signals between seismic pulses to characterize the cumulative sounds generated by the vessel. In addition, the airgun boats ran the track for vessel measurements, traveling at typical transiting speeds without airguns and compressors in operation (fast run).

During the ASAR deployment for the vessel source level measurements on 22 July, the two recorders were programmed to provide simultaneous measurements of sound levels. For this deployment, the two ASARs, as expected, exhibited redundant data and, therefore, only acoustic data from the first ASAR's high-sensitivity hydrophone (ITC-8212) were employed to estimate source levels. However, for the ASARs' final deployment on 25 July, the two recorders were programmed to record sequentially for 26 hours in an effort to maximize time available for the vessels to complete their runs. Unfortunately, a battery failure during this final deployment on one of the two ASARs resulted in loss of data for at least three vessels (*Mariah B, Arctic Wolf, and Sleep Robber*) and for the fast runs of the *Cape Fear* and *Peregrine*.

Source level measurements of the vessels for which data was lost and of the remaining vessels (the ACS vessel *Gwydyr Bay* and the recorder vessel-barge combination *Alaganik/Hook Point*) were conducted on 11 and 12 August, using the OBH systems. The bowpicker *Rumple*

Minze also ran the source level track on these dates, thus providing an additional set of measurements for this vessel.

Source Level Analyses: ASARs

For the vessel sound measurements, non-overlapping data segments of 0.5 to 2 seconds in duration, dependent upon the contiguous data available for a given run, were used to calculate a broadband sound pressure level for each segment. Examples for each vessel and run type are shown in the upper panels of Figures 3.14 through 3.23 where each triangular symbol represents a single data segment. Broadband levels above background noise levels were then used to characterize the vessel sounds by fitting them via the method of least squares to a propagation model based upon logarithmic spreading loss:

$$RL = A + B \cdot \log(R)$$

where RL is the received level in units of dB re 1 µPa and R is the range to the source in m. The constant term (A) is the hypothetical level 1 m (3.3 ft) from the source, extrapolated back to 1 m range based on the above measurements. This hypothetical value would equal the actual level at 1 m only if the source were a point source and if transmission loss were consistent at all distances from 1 m to the maximum measurement distance, neither of which is the case in practice. The spreading loss term (B), which is negative, varies with the frequency content of the source as well as waveguide characteristics such as water depth and seafloor composition.

Sea state during instrument deployments and recording periods was typically no greater than sea state 2, with wind speeds less than 18.5 km/h (10 kts), significant wave heights less than 0.6 m (2 ft), and sea conditions ranging from calm to scattered whitecaps. Because the measurements used in the linear regression analyses were well differentiated above background noise levels, changes in ambient noise levels due to sea state would have no impact on estimated vessel source levels.

The analyses incorporated only those measurements well above background noise levels that better characterize vessel-generated sounds and also utilize additional nearfield measurements for an improved regression fit.

Source Level Analyses: OBHs

The vessels GPS track log positions, interpolated to a higher resolution timescale, were used to compute the distance from the vessel to the OBH location as a function of time for each vessel run. Broadband rms sound pressure levels (SPL) were computed in 1-second time windows. The sound recordings were time synchronized with a GPS time reading prior to deployment and this allowed referencing of sound level directly to the corresponding vessel-to-OBH distance.

Nominal relationships between SPL and distance were determined by fitting an empirical sound pressure level curve to the data:

$$SPL = A + B \, \mathrm{Log}(r) \qquad \text{(Eq. 2)}$$

where the A term in this type of fit is sometimes considered to represent the source level of the vessel because it is the extrapolated level at the reference distance of 1 m from the source. There are other similar approaches, such as back-propagating the closest distance measurement by 20 log (R), which is referred to as spherical spreading back-propagation. Both of these approaches have limited accuracy in the shallow 6 m (20 ft) water depth at the measurement location. While source level measurements should normally be made in deeper water, good higher frequency

(>100 Hz) source levels can still be obtained in shallow water by back-propagating narrow frequency band levels with computer acoustic propagation models. That has not been performed for these measurements, and the value A from the empirical fits is reported as the respective vessel source level.

More conservative estimates of vessel sound levels at distance have been calculated by applying a shift to the best empirical fits so the resulting curves exceed 90 percent of the data values. The shifted curves (dashed lines in the plots of the OBH results section) are referred to as 90th percentile fits.

Results Source Level Measurements: ASARs

For each vessel run recorded with the ASARs, broadband received sound levels (RL) are plotted as a function of time, showing the peak RLs corresponding to the closest point of approach (CPA). In addition, the RLs are shown as a function of distance from the vessel, for which best fit regressions are computed separately for bow and stern aspect (Figures 3.14 to 3.23). Mean and standard deviation vessel speeds for all runs recorded with the ASARs, and a summary of effective source levels, are detailed in Table 3.6.

TABLE 3.6 SUMMARY OF ESTIMATED VESSEL SOURCE LEVELS. VESSEL SPEEDS ARE MEAN VALUES ± ONE STANDARD DEVIATION (S.D.). EFFECTIVE SOURCE LEVELS (SL) ARE SHOWN FOR BOTH BOW AND STERN ASPECTS, BASED ON BEST FIT MODELS. APPENDIX D CONTAINS VESSEL SPECIFICATIONS.

	Slow Run		Fast Run	
	Mean speed ± S.D. [kts] [a]	Effective SL of bow / stern aspects [dB re 1 µPa@1m]	Mean speed ± S.D. [kts] [a]	Effective SL of bow / stern aspects [dB re 1 µPa@1m]
Bowpickers				
Rumple Minze	2.2 ± 0.7	141.4 / 136.3	5.8 ± 1.0	142.4 / 142.3
Canvasback	1.9 ± 0.4	129.2 / 131.8	6.0 ± 1.4	145.3 / 143.2
Cape Fear	1.6 ± 0.5	131.1 / 138.2	— [b]	— [b]
Crew Vessel				
Qayaq Spirit	7.3 ± 0.7	151.0 / 148.8	20.7 ± 4.3	184.7 / 184.3
Seiscmic source vessels				
Miss Diane	2.4 ± 0.7	158.1 / 155.1 [c]	6.1 ± 0.9	165.7 / 163.1 [d]
Peregrine	3.3 ± 1.0	172.5 / 173.8 [c]	— [b]	— [b]

[a] 1 kts = 1.85 km/h

[b] Recording ceased prior to the *F/V Cape Fear*'s and *Peregrine's* fast runs.

[c] Airgun boat source levels for slow runs represent the normal operating conditions for seismic surveying; these were estimated from between-airgun-pulse sound source verification measurements and, thus, include compressor noise.

[d] Airgun boat source levels for fast runs represent the unloaded transiting case and does not include compressor noise.

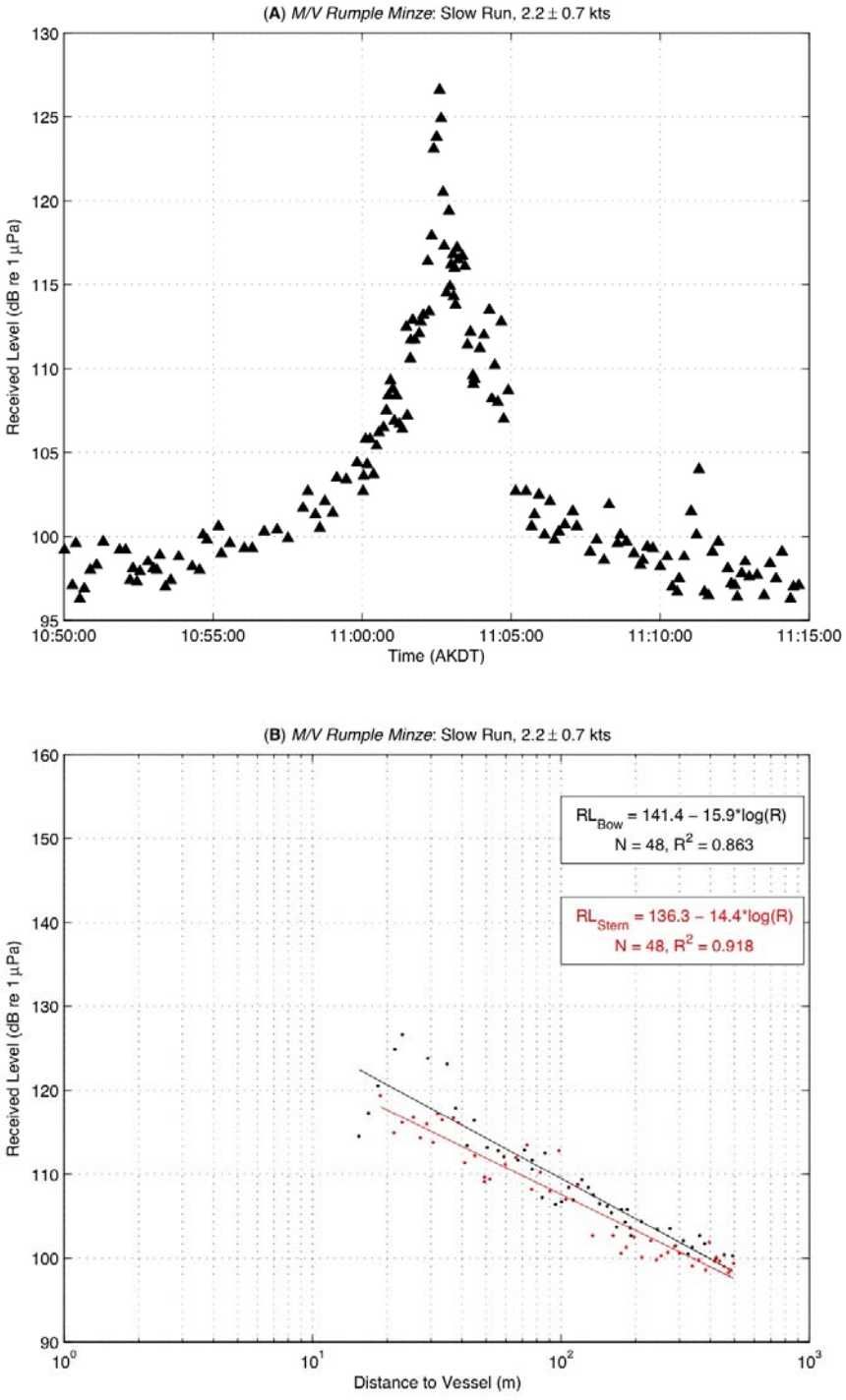


FIGURE 3.14 BROADBAND RECEIVED LEVELS (RLS) OF THE BOWPICKER *F/V RUMPLE MINZE* DURING ITS SLOW RUN, RECORDED ON 22 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

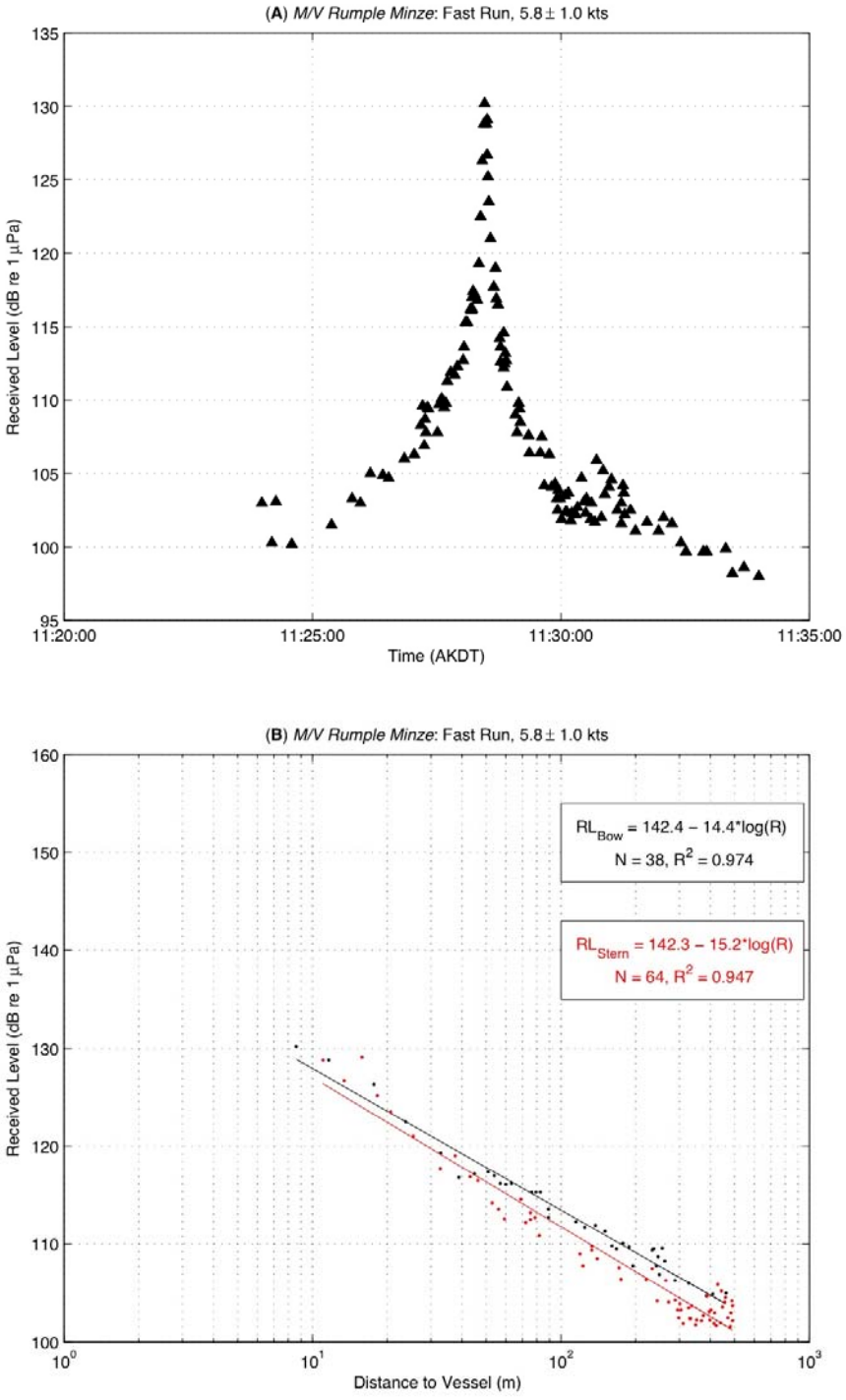


FIGURE 3.15 BROADBAND RECEIVED LEVELS (RLS) OF THE BOWPICKER F/V *RUMPLE MINZE* DURING ITS FAST RUN, RECORDED ON 22 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

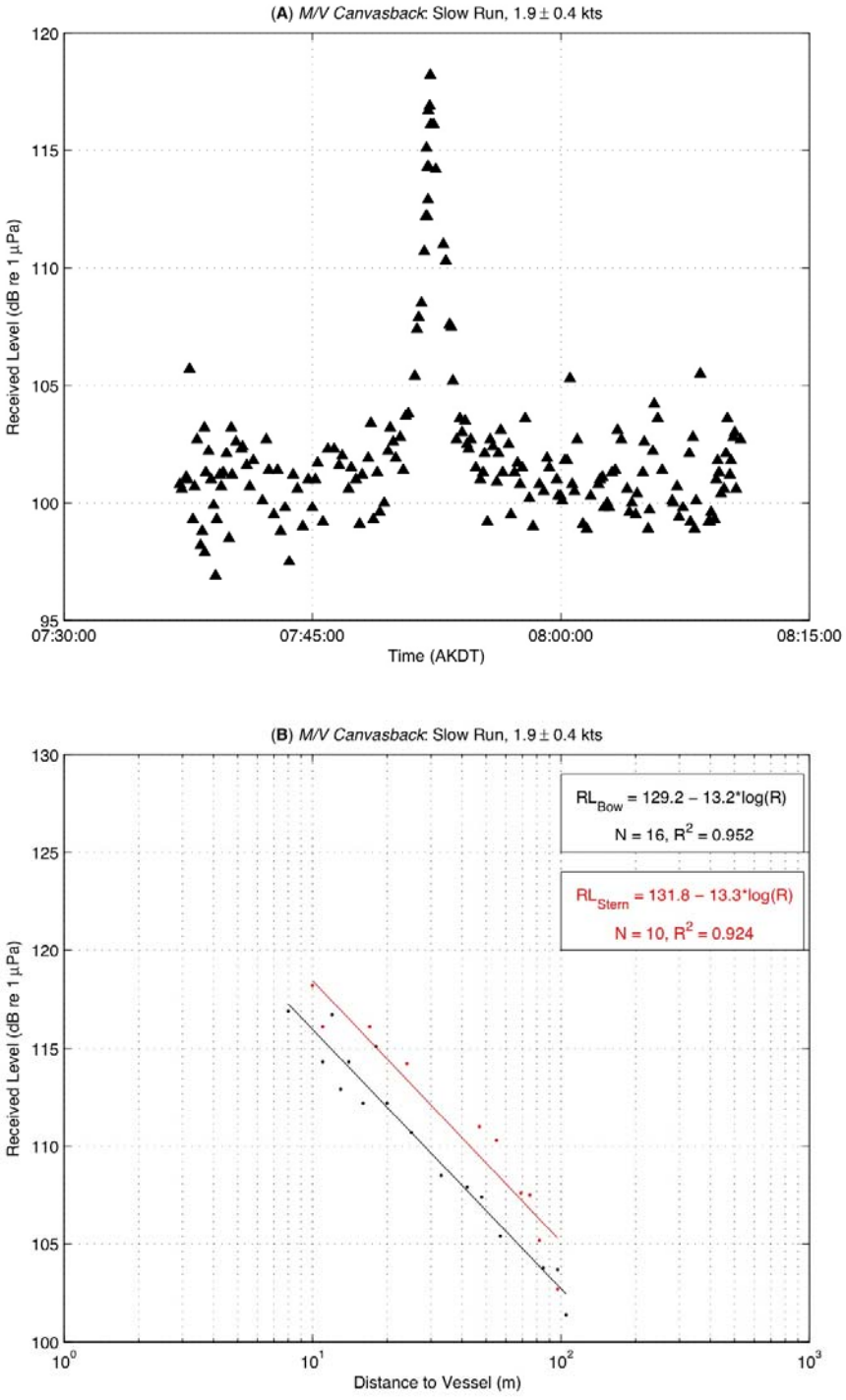


FIGURE 3.16 BROADBAND RECEIVED LEVELS (RLS) OF THE BOWPICKER F/V *CANVASBACK* DURING ITS SLOW RUN, RECORDED ON 25 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

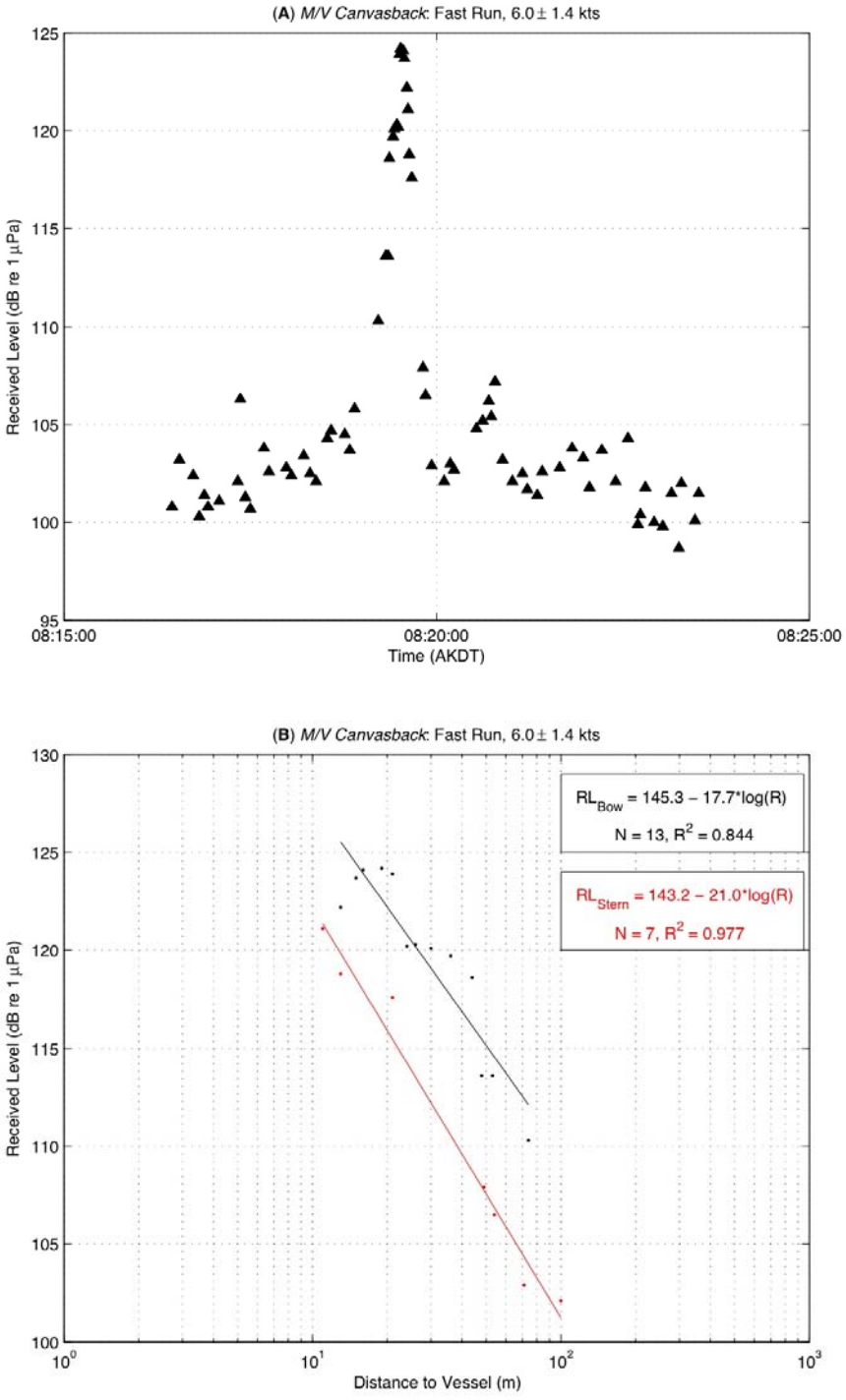


FIGURE 3.17 BROADBAND RECEIVED LEVELS (RLS) OF THE BOWPICKER *F/V CANVASBACK* DURING ITS FAST RUN, RECORDED ON 25 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

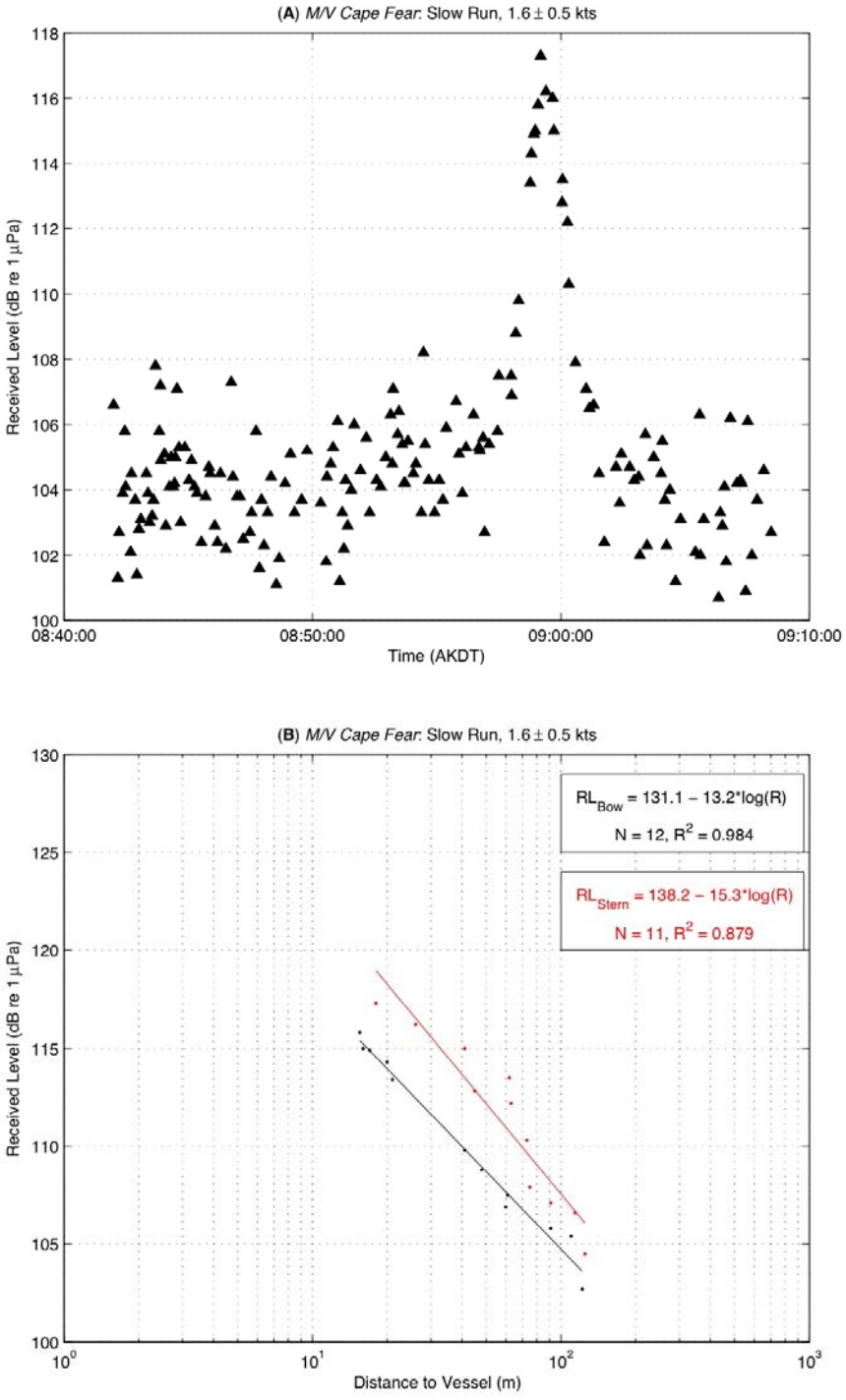


FIGURE 3.18 BROADBAND RECEIVED LEVELS (RLS) OF THE BOWPICKER *F/V CAPE FEAR* DURING ITS SLOW RUN, RECORDED ON 25 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

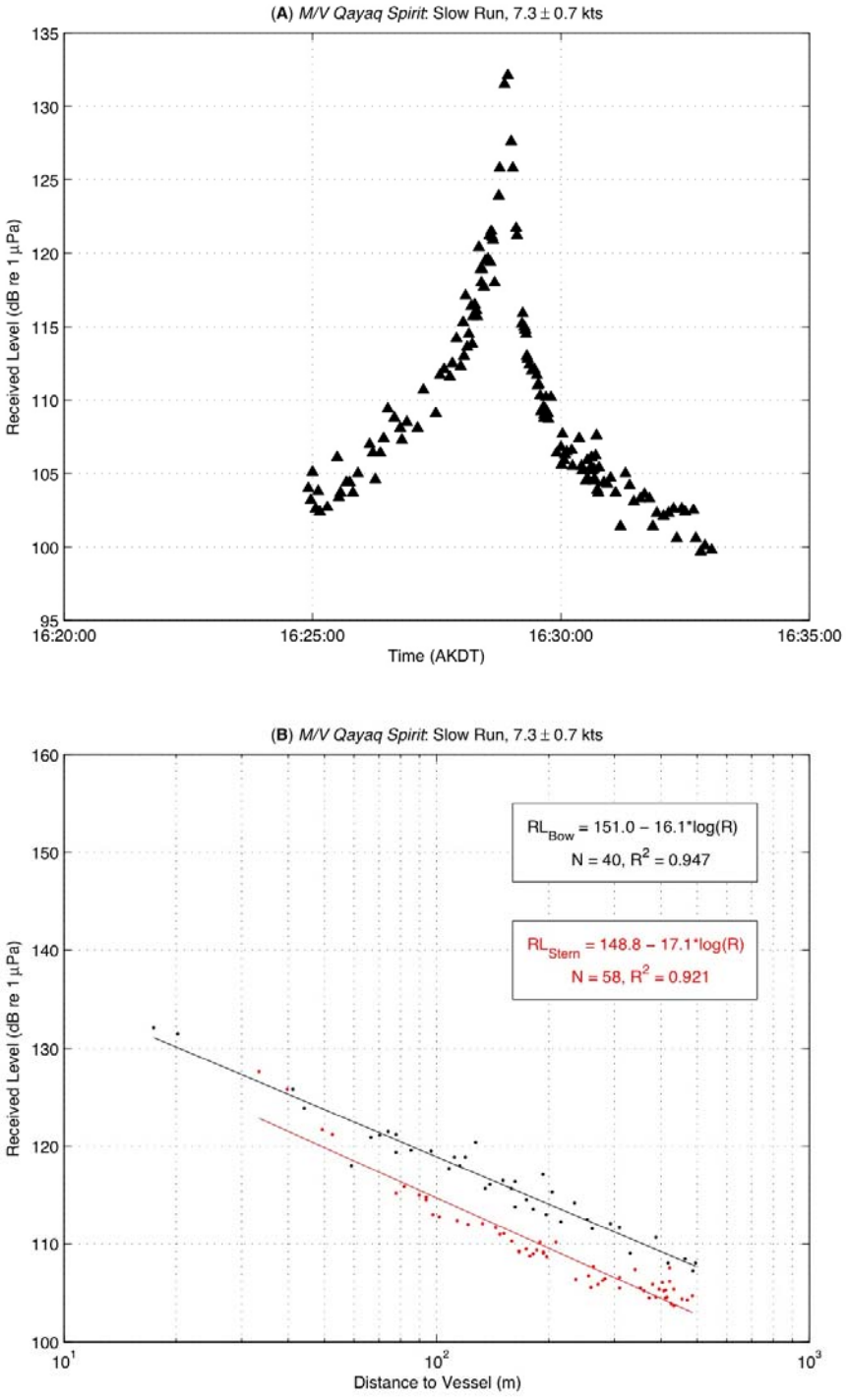


FIGURE 3.19 BROADBAND RECEIVED LEVELS (RLS) OF THE CREW VESSEL *QAYAQ SPIRIT* DURING ITS SLOW RUN, RECORDED ON 22 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

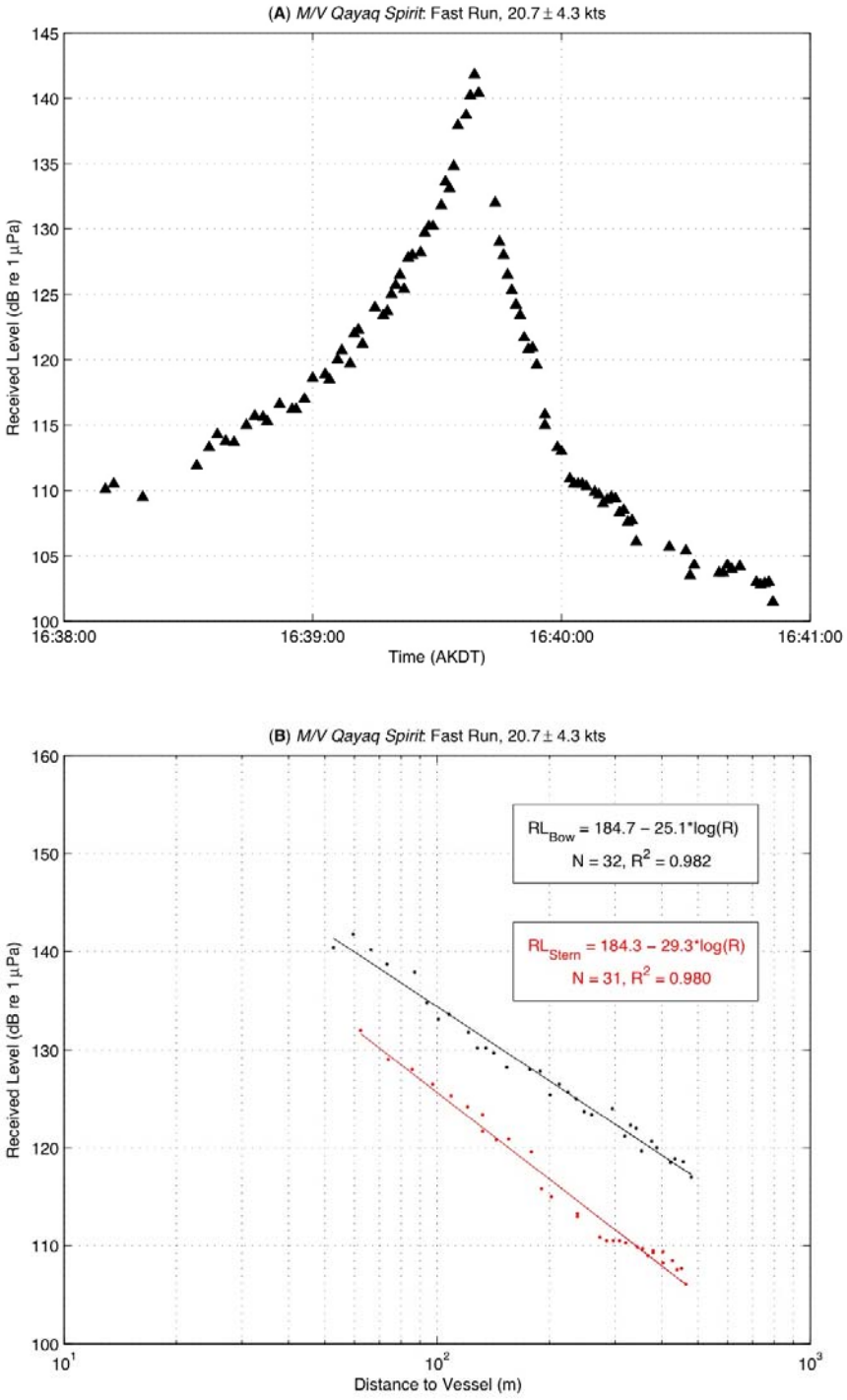


FIGURE 3.20 BROADBAND RECEIVED LEVELS (RLS) OF THE CREW VESSEL *QAYAQ SPIRIT* DURING ITS FAST RUN, RECORDED ON 22 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

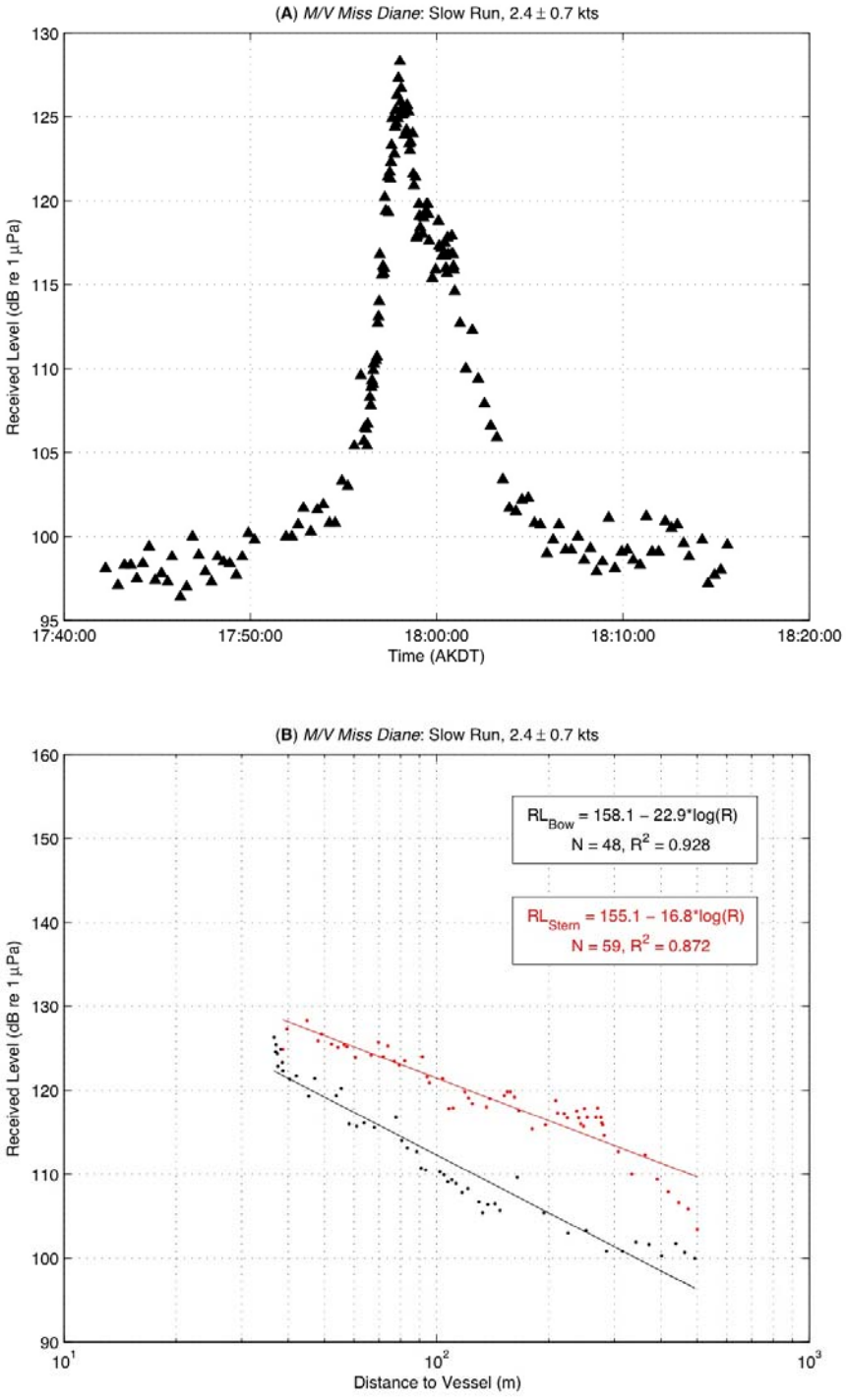


FIGURE 3.21 BROADBAND RECEIVED LEVELS (RLS) OF THE SEISMIC SOURCE VESSEL *MISS DIANE* DURING ITS SLOW RUN, RECORDED ON 18 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

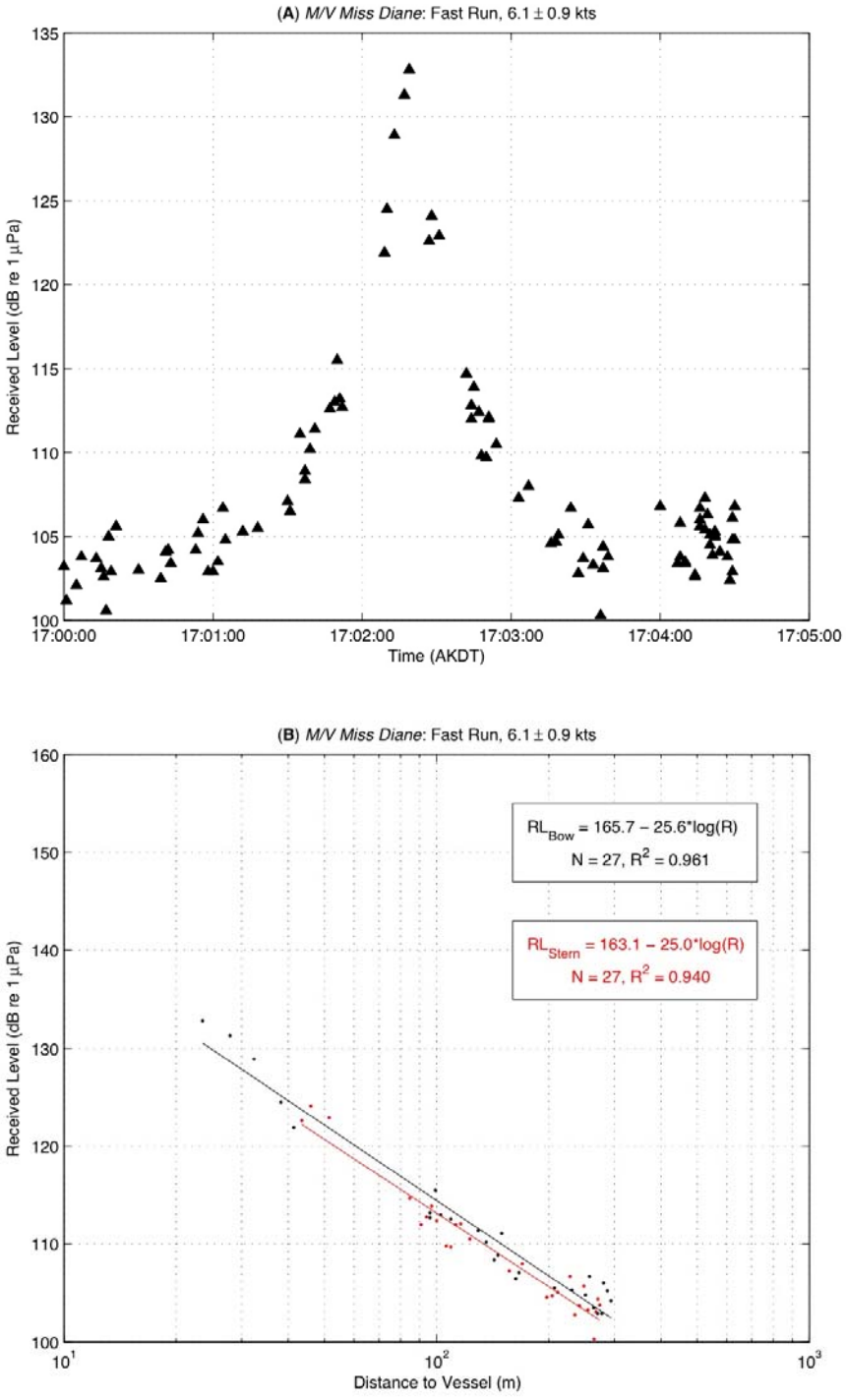


FIGURE 3.22 BROADBAND RECEIVED LEVELS (RLS) OF THE SEISMIC SOURCE VESSEL *MISS DIANE* DURING ITS FAST RUN, RECORDED ON 25 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

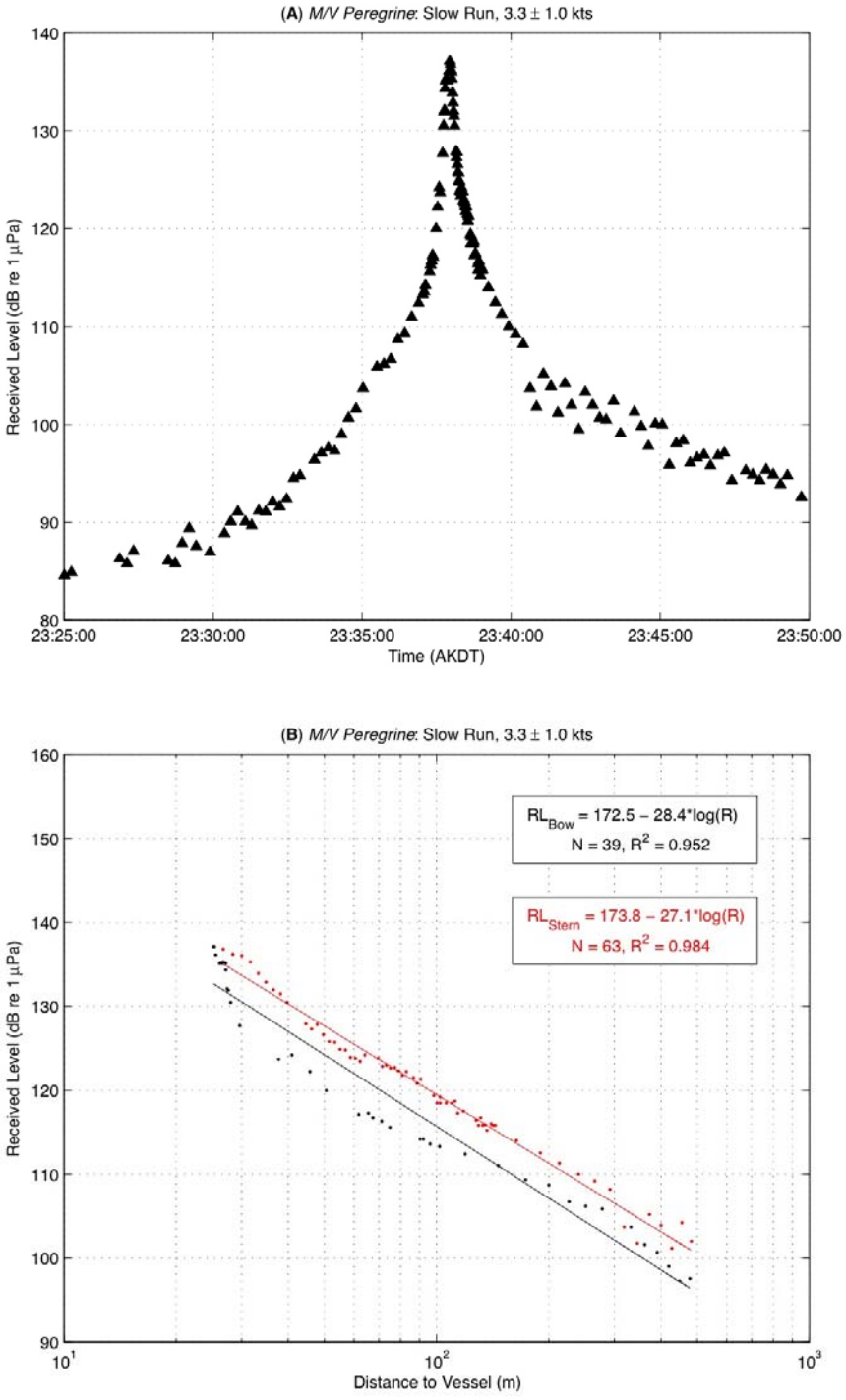


FIGURE 3.23 BROADBAND RECEIVED LEVELS OF THE SEISMIC SOURCE VESSELS *PEREGRINE* DURING ITS SLOW RUN, RECORDED ON 15 JULY 2008, FOGGY ISLAND BAY. (A) RL AS A FUNCTION OF TIME, WITH PEAK RLS CORRESPONDING TO THE CPA. (B) RLS AS A FUNCTION OF DISTANCE TO THE VESSEL. BEST FIT REGRESSIONS ARE COMPUTED SEPARATELY FOR BOW- AND STERN-ASPECT DATA.

Results Source Level Measurements: OBHs

Nearly all 1-second sound level data points measured were used in the fits. A very few data values were manually removed. Those data were identified by their anomalously high values relative to adjacent data values. The sounds responsible for those values were manually reviewed by listening to the corresponding sound recording. In all cases they were due to bumping noise on the recorder, likely from small movements of the bottom-deployed OBHs. The maximum range used for the fits was truncated at the distance corresponding to vessel sound levels reaching the upper range of background sound levels. Background levels varied from approximately 88 dB re uPa to 103 dB re uPa broadband, and likely were influenced by other vessel activities occurring nearby. If greater ranges had been included then the fits would have been incorrectly influenced by the background levels. All measurements showed a clear correlation of decreasing SPL with increasing distance between vessel and OBH. A summary of the source levels based on best-fit and 90th percentile fits for each vessel recorded are provided in Table 3.7. The 90th percentile fit addresses the variable nature of measurement data and also the influences of non-vessel sounds. Vessel sounds have inherent variability that occurs mainly because vessels operate in waves and swells. Best-fits to measured data would underestimate the higher range of resulting sound level variability.

TABLE 3.7 VESSEL SOURCE LEVELS FROM SOUND PRESSURE LEVEL MEASUREMENTS IN 20 FT (6 M) WATER DEPTH. APPENDIX D CONTAINS VESSEL SPECIFICATIONS.

Vessel Name	Speed	CPA	Source Level Bow (Best-fit/90th % fit)	Source Level Stern (Best-fit/90th % fit)
Bowpickers				
F/V Sleep Robber	3.2	40.1	150.0 / 152.1	150.0 / 152.1
	7.5	44.0	171.8 / 174.3	171.8 / 174.3
F/V Cape Fear	7.2	39.4	161.3 / 164.5	161.3 / 164.5
	4.1	57.5	158.3 / 160.4	158.3 / 160.4
F/V Rumple Minze	3.2	38.4	140.9/142.8	160.2/162.3
Crew/Support vessel				
Gwydyr Bay	7.1	12.8	171.2 / 172.5	166.4 / 168.1
	20.5	10.1	182.7 / 184.1	191.8 / 194.8
Mariah B	22.5	36.5	176.4 / 179.0	176.4 / 179.0
	8.0	35.4	163.8 / 166.4	163.8 / 166.4
Recorder vessel				
Alaganik/Hook Point	3.6	77.4	165.3 / 167.6	165.3 / 167.6
Housing vessel				
Arctic Wolf	7.3	46.5	200.1 / 203.6	200.1 / 203.6
Seismic source vessel				
Peregrine	8.1	40.7	179.0 / 181.3	179.0 / 181.3

Graphs of SPL versus time and SPL versus distance from the OBHs are plotted for each vessel monitored (Figure 3.24 to 3.39). Only two vessels, the ACS vessel *Gwydyr Bay* and the *Rumple Minze*, were found to produce meaningfully different levels in the bow and stern directions. The *Gwydyr Bay* produced higher levels in the bow direction while the *Rumple Minze* produced higher levels in the stern direction. Separate analyses of the sound levels in these two directions were performed only for those two vessels (Figures 3.29 and 3.37). Measured sound levels from the other vessels were similar in the bow and stern directions so the analyses for those vessels did not separate the data by direction.

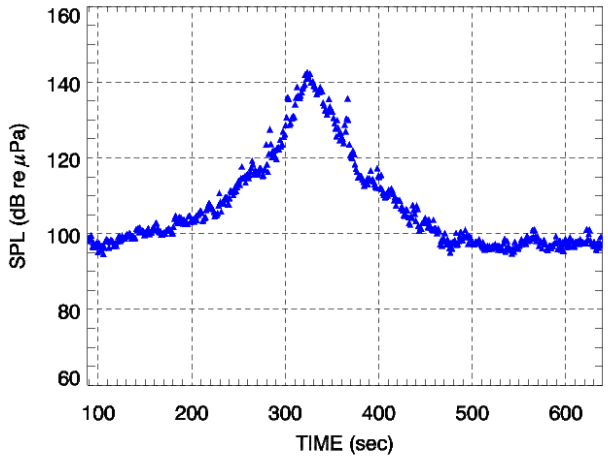


FIGURE 3.24 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME FOR THE HOUSING VESSEL *ARCTIC WOLF* TRANSITING AT 7.3 KTS, MEASURED 12 AUGUST 2008 AT 0152 HOURS AKDT.

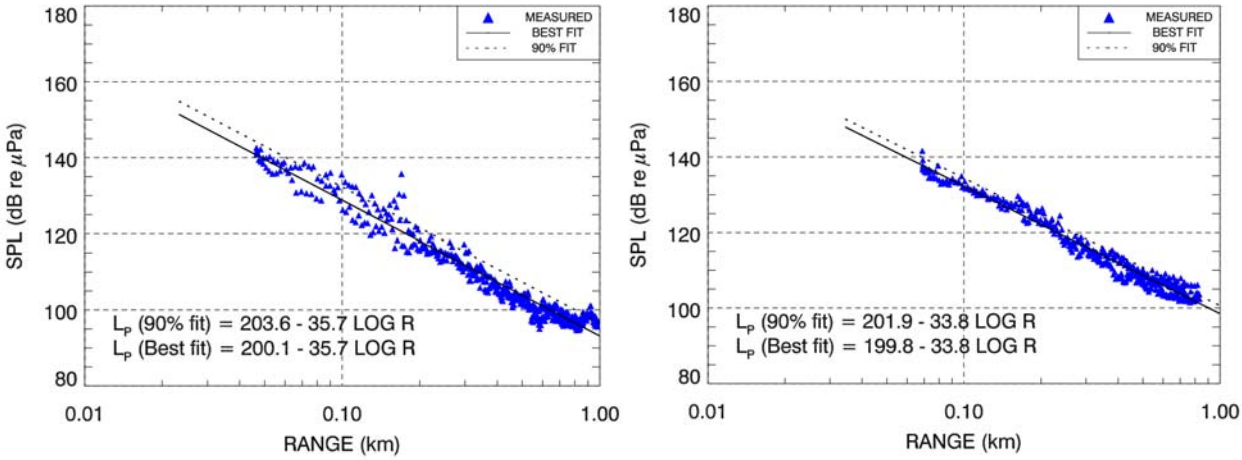


FIGURE 3.25 RECEIVED SOUND PRESSURE LEVELS AS FUNCTIONS OF RANGE FROM OBH-A (LEFT) AND OBH-B (RIGHT) FOR THE HOUSING VESSEL *ARCTIC WOLF*, MEASURED 12 AUGUST 2008 AT 0152 HOURS AKDT. BOTH MEASUREMENTS INDICATE A HIGHER RATE OF TRANSMISSION LOSS THAN OTHER VESSELS MONITORED HERE. THIS EFFECT IS ATTRIBUTED TO DOMINANCE OF LOW FREQUENCY SOUND EMISSIONS BY THE *ARCTIC WOLF*.

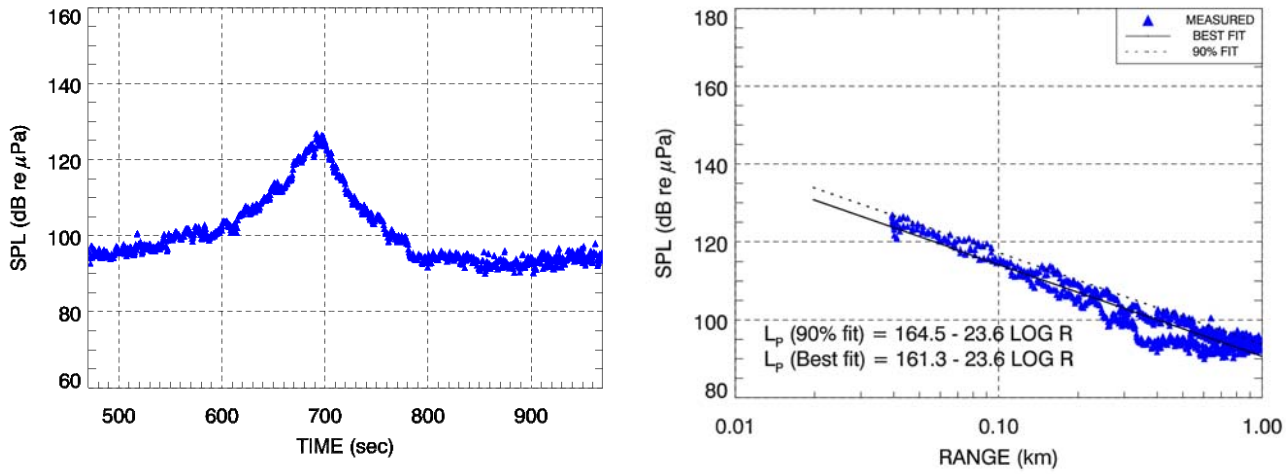


FIGURE 3.26 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE BOWPICKER *F/V CAPE FEAR* TRAVELING AT 7.2 KTS, MEASURED 12 AUGUST 2008 AT 0412 HOURS AKDT.

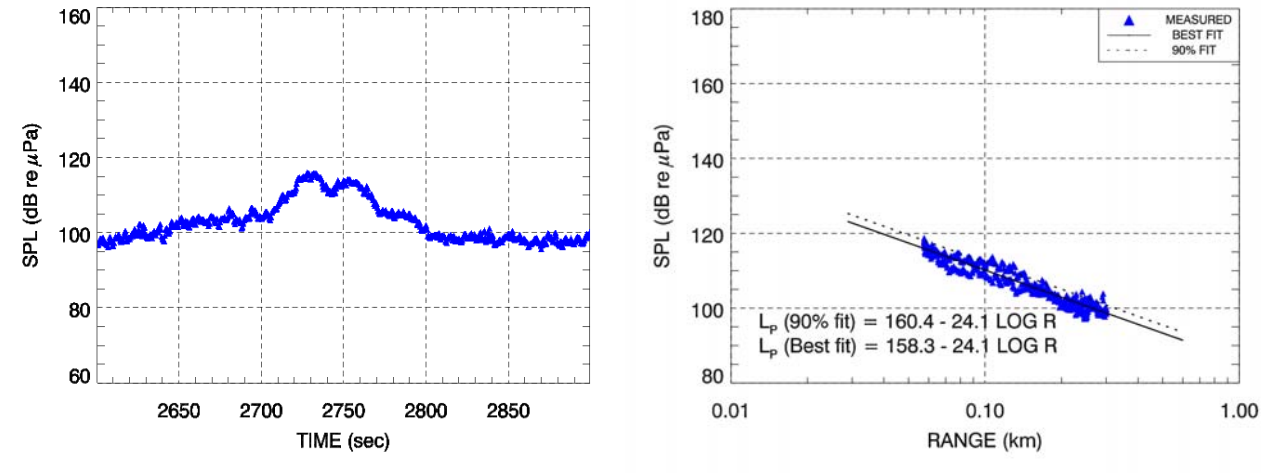


FIGURE 3.27 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE BOWPICKER *F/V CAPE FEAR* TRANSITING AT 4.1 KTS, MEASURED 12 AUGUST 2008 AT 0535 HOURS AKDT.

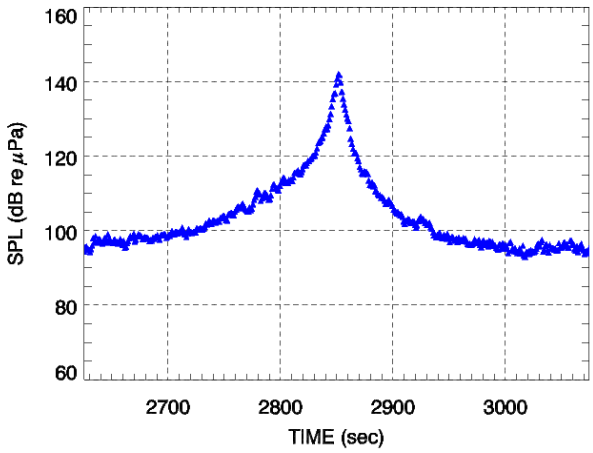


FIGURE 3.28 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME FOR THE ACS VESSEL *GWYDYR BAY* TRANSITING AT 7.1 KTS, MEASURED 11 AUGUST 2008 AT 1854 HOURS AKDT.

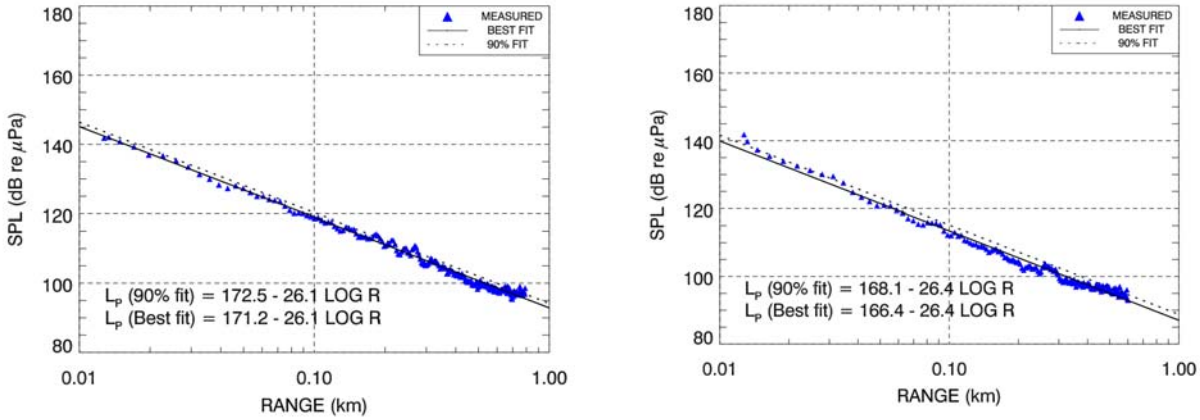


FIGURE 3.29 RECEIVED SOUND PRESSURE LEVELS WITH EMPIRICAL FITS FOR BOW ASPECT (LEFT) AND STERN ASPECT (RIGHT) FOR THE *GWYDYR BAY* TRANSITING AT 7.1 KTS, MEASURED 11 AUGUST 2008 AT 1854 HOURS AKDT.

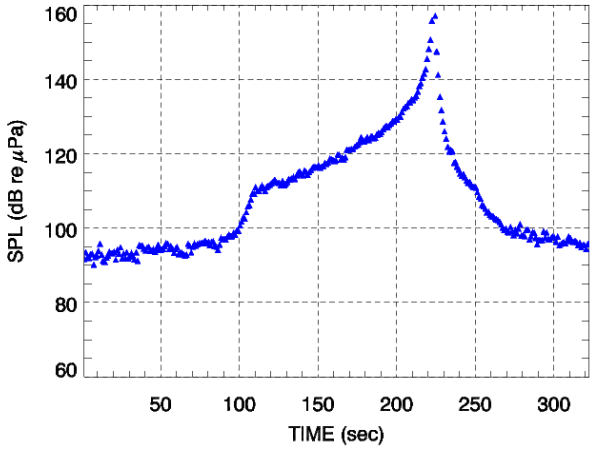


FIGURE 3.30 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS A FUNCTION OF TIME FOR THE ACS VESSEL *GWYDYR BAY* TRANSITING AT 20.5 KTS, MEASURED 11 AUGUST 2008 AT 1854 HOURS AKDT.

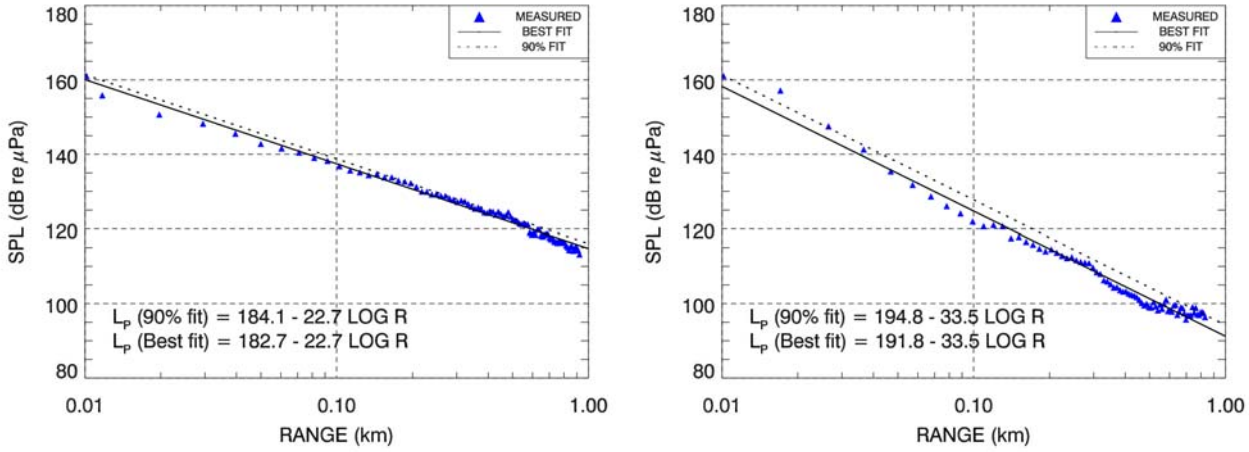


FIGURE 3.31 RECEIVED SOUND PRESSURE LEVELS ON OBH-A WITH EMPIRICAL FITS FOR BOW ASPECT (LEFT) AND STERN ASPECT (RIGHT) FOR THE ACS VESSEL *GWYDYR BAY* TRANSITING AT 20.5 KTS, MEASURED 11 AUGUST 2008 AT 1854 HOURS AKDT.

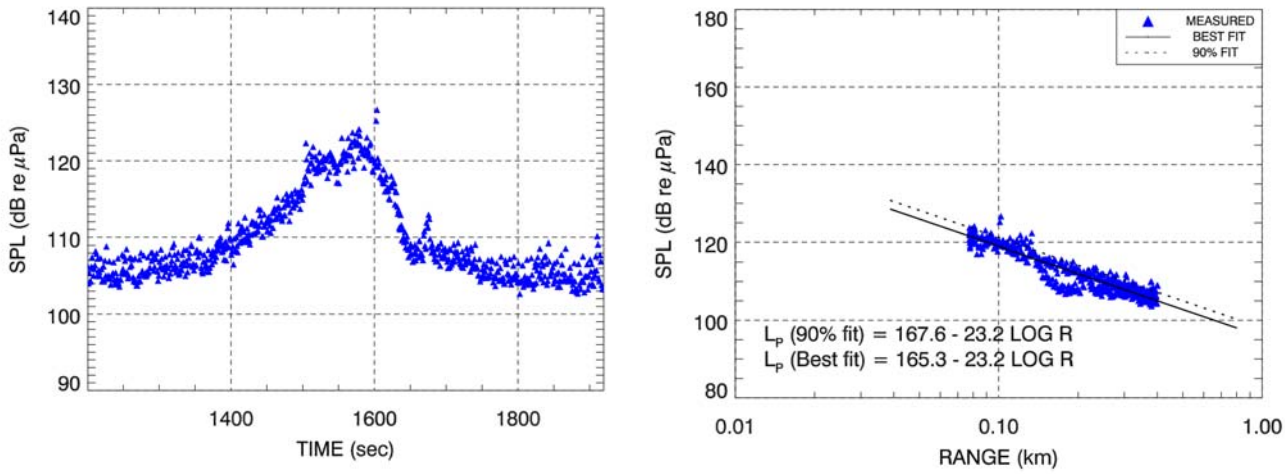


FIGURE 3.32 RECEIVED SOUND PRESSURE LEVELS ON OBH-B AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE RECORDER VESSL BARGE COMBINATION *ALAGANIK/HOOK POINT* TRANSITING AT 3.6 KTS, MEASURED 12 AUGUST 2008 AT 1127 HOURS AKDT.

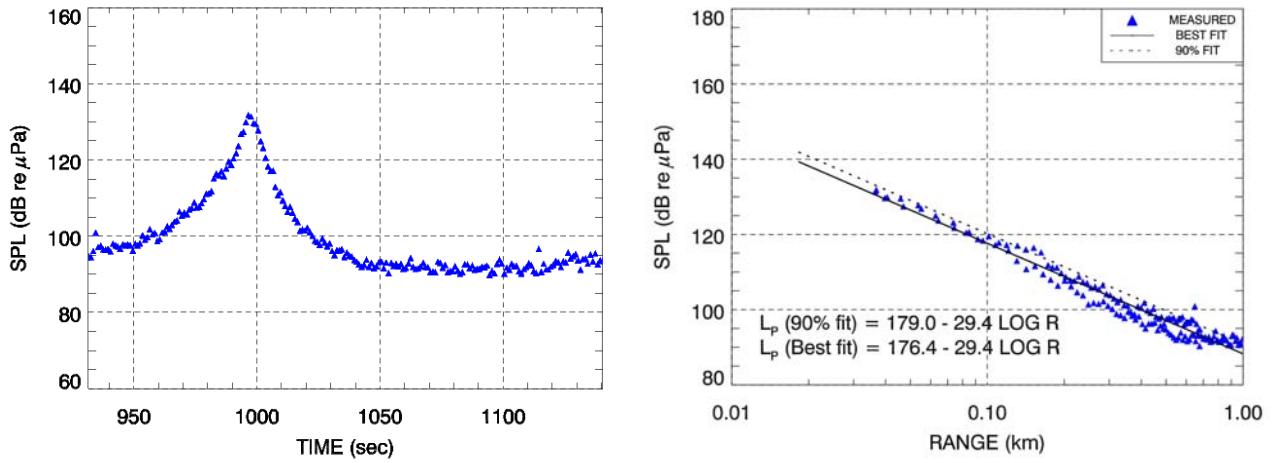


FIGURE 3.33 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE SUPPORT VESSEL *MARIAH B* TRANSITING AT 22.5 KTS, MEASURED 12 AUGUST 2008 AT 1728 HOURS AKDT.

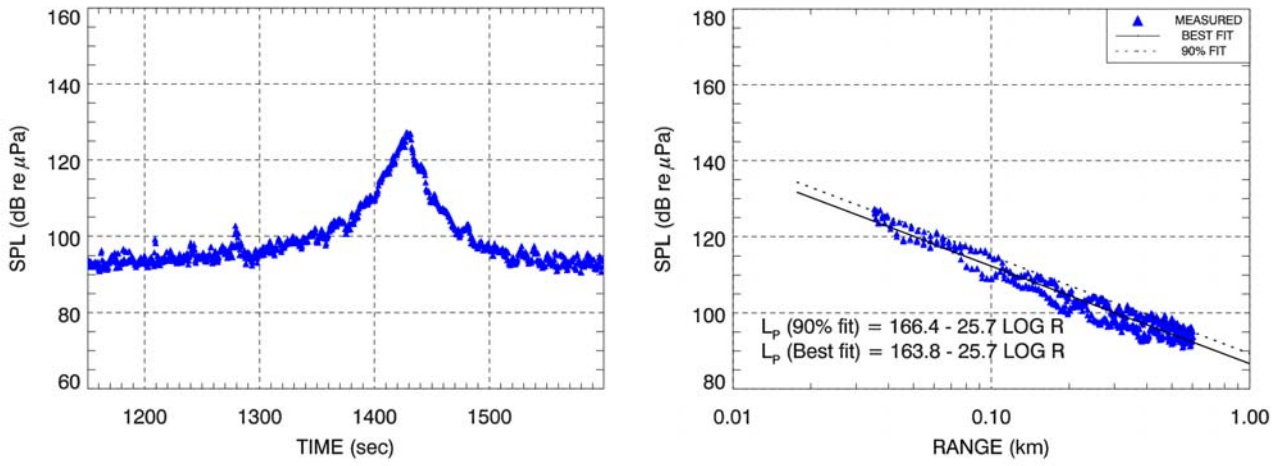


FIGURE 3.34 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE SUPPORT VESSEL *MARIAH B* TRANSITING AT 8.0 KTS, MEASURED 12 AUGUST 2008 AT 1728 HOURS AKDT.

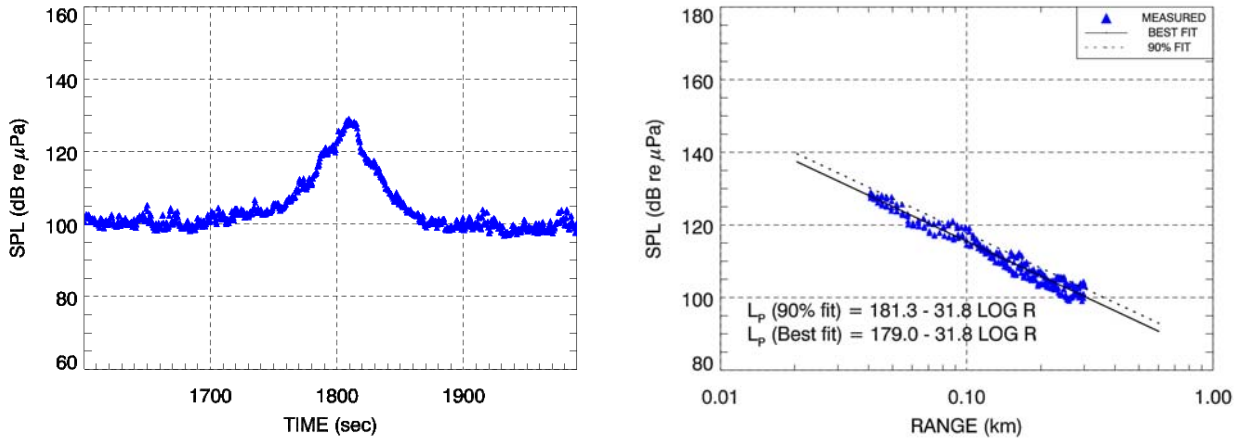


FIGURE 3.35 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE *PEREGRINE* TRANSITING AT 8.1 KTS, MEASURED 12 AUGUST 2008 AT 0859 HOURS AKDT.

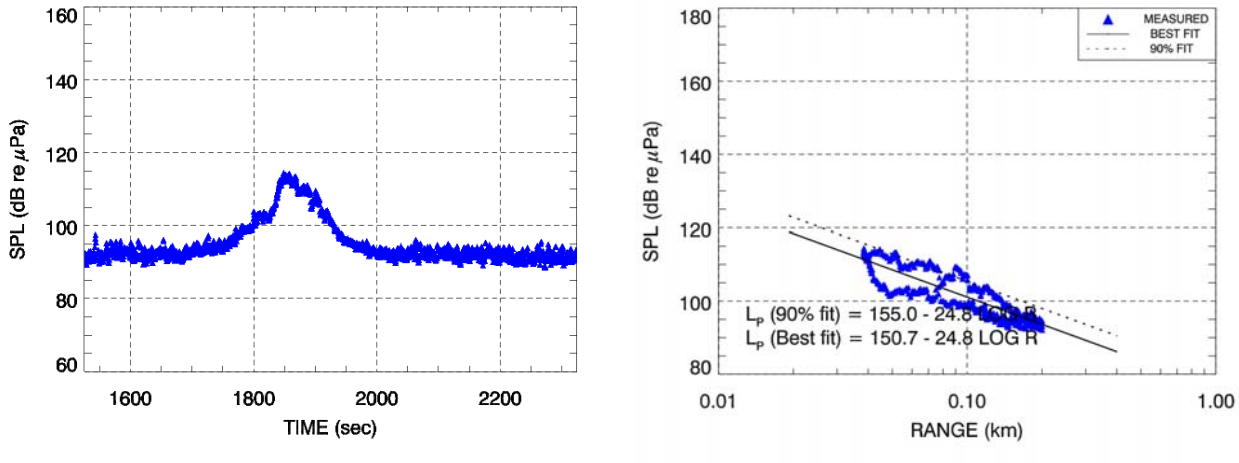


FIGURE 3.36 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE RUMPLE MINZE TRANSITING AT 3.2 KTS, MEASURED 11 AUGUST 2008 AT 1637 HOURS AKDT.

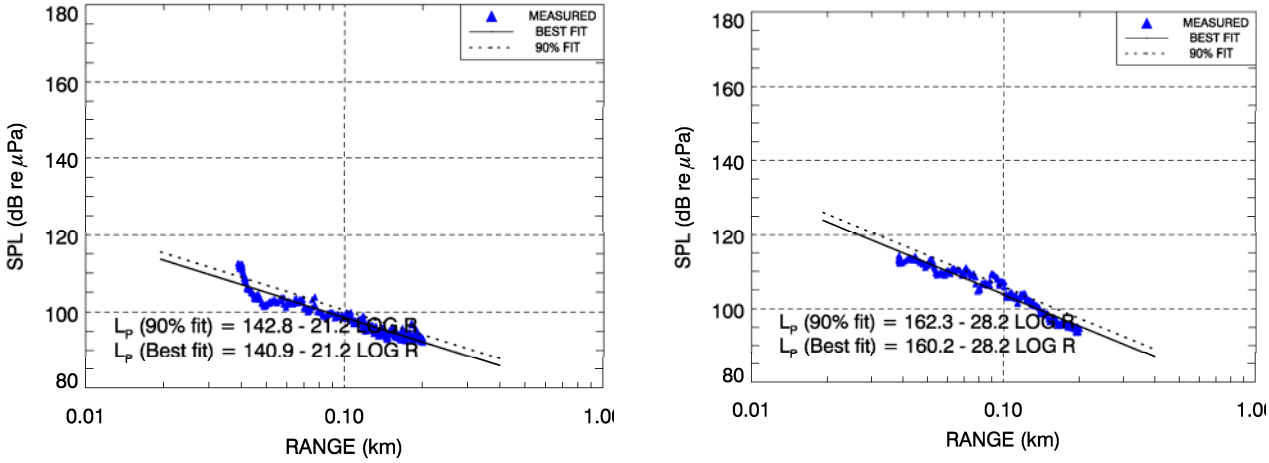


FIGURE 3.37 RECEIVED SOUND PRESSURE LEVELS ON OBH-A WITH BEST FIT AND 90TH PERCENTILE FIT FOR BOW ASPECT (LEFT) AND STERN ASPECT (RIGHT) FOR THE RUMPLE MINZ TRANSITING AT 3.2 KTS, MEASURED 11 AUGUST 2008 AT 1637 HOURS AKDT.

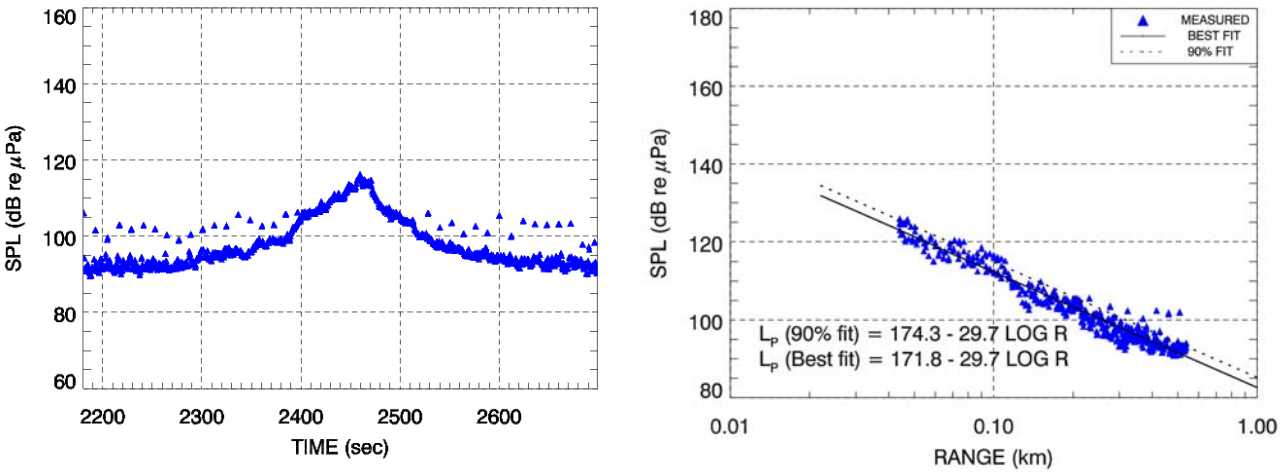


FIGURE 3.38 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE BOWPICKER *F/V SLEEP ROBBER* TRANSITING AT 3.2 KTS, MEASURED 11 AUGUST 2008 AT 1450 HOURS AKDT.

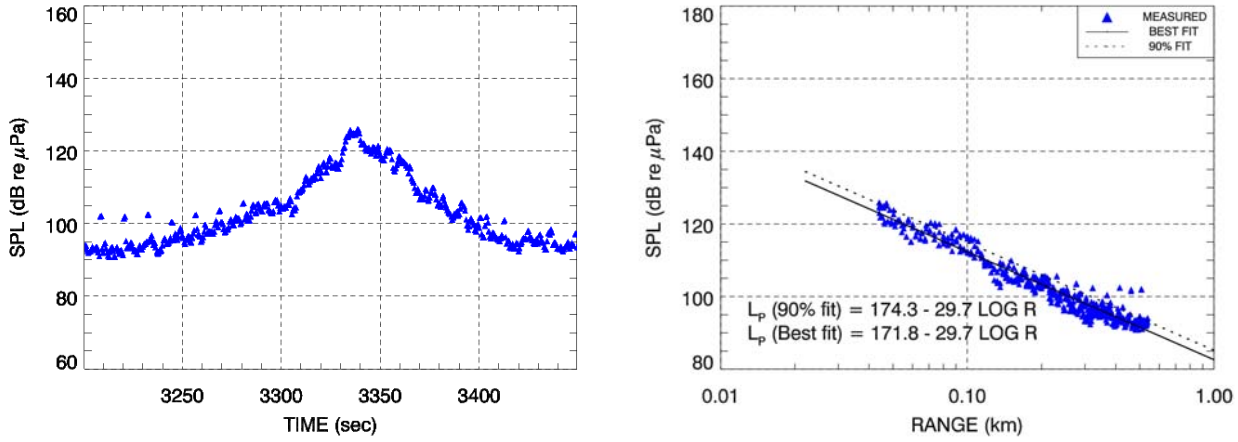


FIGURE 3.39 RECEIVED SOUND PRESSURE LEVELS ON OBH-A AS FUNCTIONS OF TIME (LEFT) AND RANGE (RIGHT) FOR THE BOWPICKER *F/V SLEEP ROBBER* TRANSITING AT 7.5 KTS, MEASURED 11 AUGUST 2008 AT 1450 HOURS AKDT.

3.4 Acoustic Footprint of the Seismic Survey

This section presents the results of the received sound levels of the airguns and combined vessel sounds in relation to the presence or absence of the barrier islands.

The main objectives of these measurements were: (1) to characterize and compare airgun pulses and background levels at three different locations, (2) to determine to what extent the islands function as an acoustic barrier; and (3) to determine the offshore distance to received airgun broadband sound levels of 160 dB and 120 dB (rms).

The acoustic measurements were performed by Greeneridge Sciences, Inc. under subcontract to LGL Alaska Research Associates, Inc.

Equipment used

Directional Autonomous Seafloor Acoustic Recorders (DASARs) were used for these measurements (Figure 3.40). DASARs are deployed on the seafloor and include an omnidirectional pressure sensor (hydrophone) and 25.4 GB of hard disk space for storage of acoustic data. (In addition, DASARs include two orthogonal horizontal particle velocity sensors that provide for the directional capability, which was not used in this study). The acoustic sensor channel was sampled at 1000 samples per second, assuring good performance at frequencies up to 450 Hz, which would include the airgun pulse energy and the dominant sounds from the vessels and from wind and waves. They had one disadvantage—their sensitivity was -134 dB re 1 V/µPa at 100 Hz. Such relatively high sensitivity was certain to overload on strong airgun pulses. However, the closest DASAR was deployed at a location on average several km away from the seismic activities. Only a certain fraction of the received airgun pulses at this closest location were expected to be overloaded (see also results below), allowing comparison of received sound levels between the three DASAR locations.

FIGURE 3.40 THE THREE DASARS USED FOR THE LIBERTY SEISMIC SURVEY ON THE ACS VESSEL *GWYDYR BAY*, JUST BEFORE THEIR DEPLOYMENT ON 3 AUGUST.

Methods

Three locations outside, but near the Liberty seismic survey area were selected for monitoring of the underwater sounds. The locations for these recorders were selected so that one was inside the barrier islands (DASAR *In*), one was outside but beyond a gap between barrier islands with respect to the survey area (DASAR *Gap*), and the third was behind a barrier island with respect to the survey area (DASAR *Out*). Figure 3.41 illustrates the locations of the three recorders in relation to the seismic survey area and the barrier islands.

Seismic pulses were detected and analyzed automatically with a combination of MATLAB and JAVA software developed by Dr. Aaron Thode at Scripps Institution of Oceanography. Pulses were selected by the software if their SNR (signal to noise ratio) was at least 10 dB, meaning their received SPL was 10 dB above background levels. This ensured that the analysis was limited to well-defined seismic pulses but also meant that lower intensity pulses were ignored. Thousands of seismic pulses were detected, and for that reason the analysis examined successive 10-minute sections of data for which it calculated the following six parameters:

1. Median of the instantaneous peak pressures of the airgun pulses;
2. Median of the rms airgun sound pressure levels (SPL), where the SPL is the root-mean-square pressure over the duration of the pulse, over the frequency range 10–450 Hz;
3. Background SPL, taken as the minimum SPL observed from successive, 50% overlapped, two-second SPL averages over the entire 10-minute period;
4. The percentage of pulses that overloaded the hydrophone, i.e., exceeded the limit of the recorder's analog-to-digital converter range;
5. Median pulse duration;
6. Median inter-pulse interval (IPI).

When no airgun pulses were received, only the minimum background SPL value was calculated and plotted. Overloaded pulses, which only occurred on DASAR *In*, were excluded from the calculations of peak pressure, rms sound pressure level, and pulse durations.

Results

Figures 3.42 to 3.44 present the sound measurements graphically, spanning the operational period from 3 through 26 August. The high background level recorded by all three DASARs on 3 August corresponds to the vessel deploying the recorders, all three of which were recording before deployment. Similarly, the high background levels on 26 August were recorded when the DASARs were retrieved. Spikes in the background sound level probably correspond to sounds from vessels passing near the recorders.

As expected, the DASAR located inside the barrier islands and closest to the seismic survey area received the highest peak levels and pulse SPLs (Figure 3.42). It was also the only DASAR that recorded overloaded pulses, i.e. pulses with sound pressures that exceeded the hydrophone sensitivity. DASAR *Out*, located offshore and behind the barrier islands received the lowest peak levels and pulse SPLs (Figures 3.44). The percentage of 10-minute samples with received median SPLs that exceeded 120 dB dB re 1 μPa was 90.1% for DASAR *In*, 25.3% for DASAR *Gap*, and 0.5% for DASAR *Out*. . The percentage of 10-min samples with received median SPLs that exceeded 135 dB re 1 μPa was 1.7% for DASAR *In* and 0% for DASARs *Gap* and *Out*.

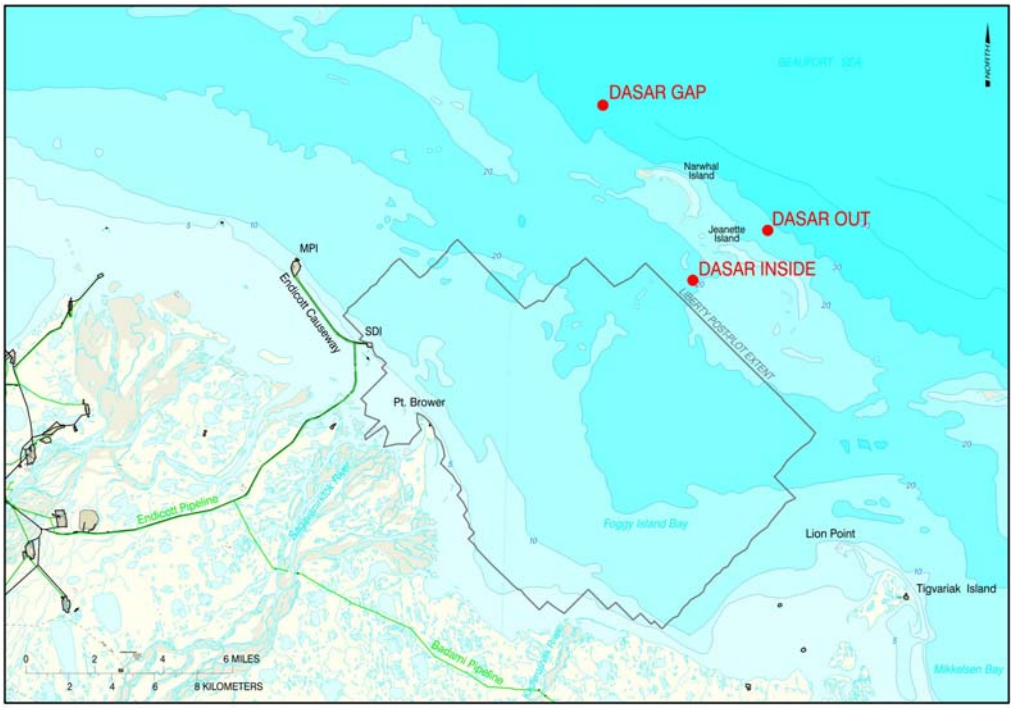


FIGURE 3.41 LOCATIONS OF THE THREE DASARS RELATIVE TO THE POST-SURVEY SEISMIC SURVEY AREA AND TO THE BARRIER ISLANDS. THE PICTURE SHOWS TWO OF THE THREE DASARS JUST AFTER RETRIEVAL ON AUGUST 26. THE SOCK ON ONE OF THE DASARS WAS TORN DURING RETRIEVAL.

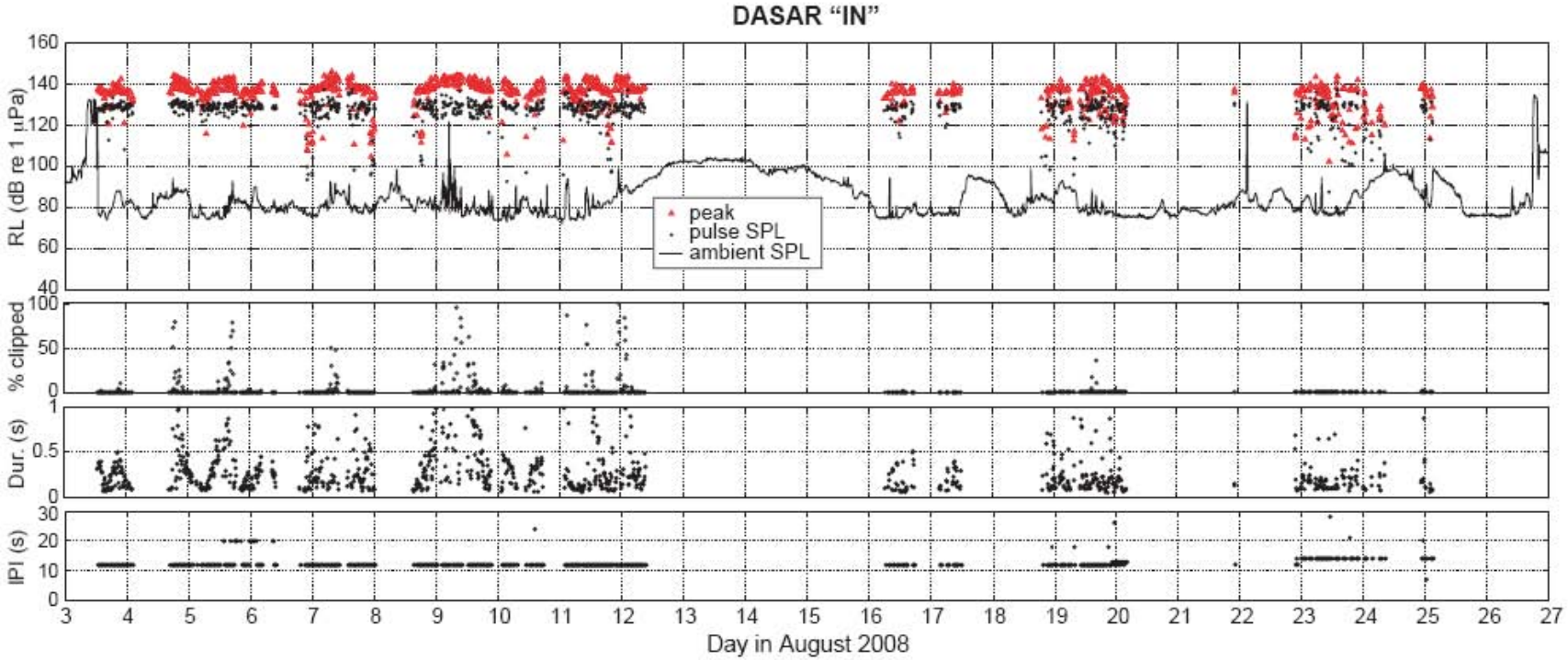


FIGURE 3.42 SEISMIC SOUND CHARACTERISTICS AND BACKGROUND SOUND PRESSURE LEVELS AS RECORDED BY DASAR *IN* DURING THE PERIOD 3 TO 26 AUGUST. THE MEDIAN OVER 10-MINUTE INTERVALS IS SHOWN FOR PEAK PRESSURE, RMS SOUND PRESSURE LEVEL (SPL), PULSE DURATION AND INTER PULSE INTERVAL (IPI). THE OVERLOADED PULSES ARE PRESENTED IN PERCENTAGES AND THE BACKGROUND SOUND LEVELS AS THE MINUMUM VALUE OVER THE SAME 10-MINUTE INTERVALS.

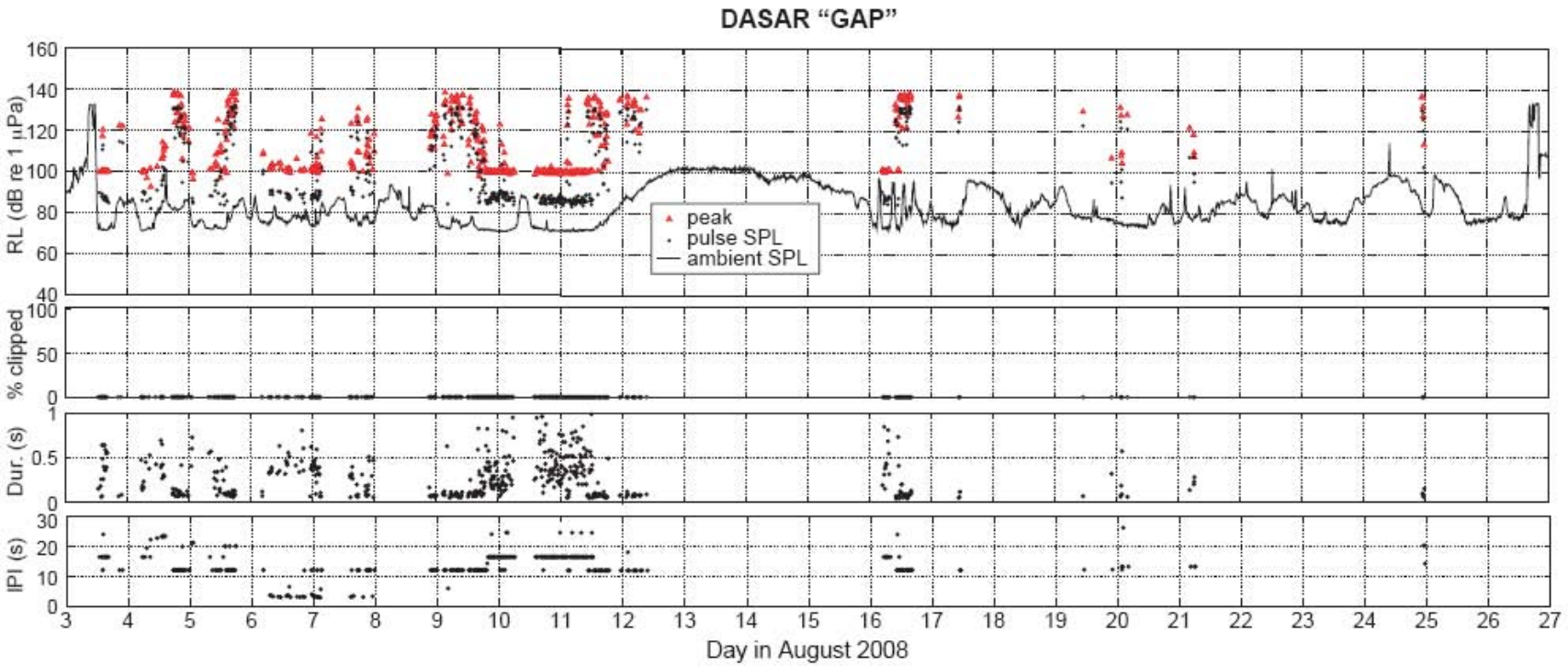


FIGURE 3.43 SEISMIC SOUND CHARACTERISTICS AND BACKGROUND SOUND PRESSURE LEVELS AS RECORDED BY DASAR *GAP* DURING THE PERIOD 3 TO 26 AUGUST. THE MEDIAN OVER 10-MINUTE INTERVALS IS SHOWN FOR PEAK PRESSURE, RMS SOUND PRESSURE LEVEL (SPL), PULSE DURATION AND INTER PULSE INTERVAL (IPI). THE OVERLOADED PULSES ARE PRESENTED IN PERCENTAGES AND THE BACKGROUND SOUND LEVELS AS THE MINUMUM VALUE OVER THE SAME 10-MINUTE INTERVALS.

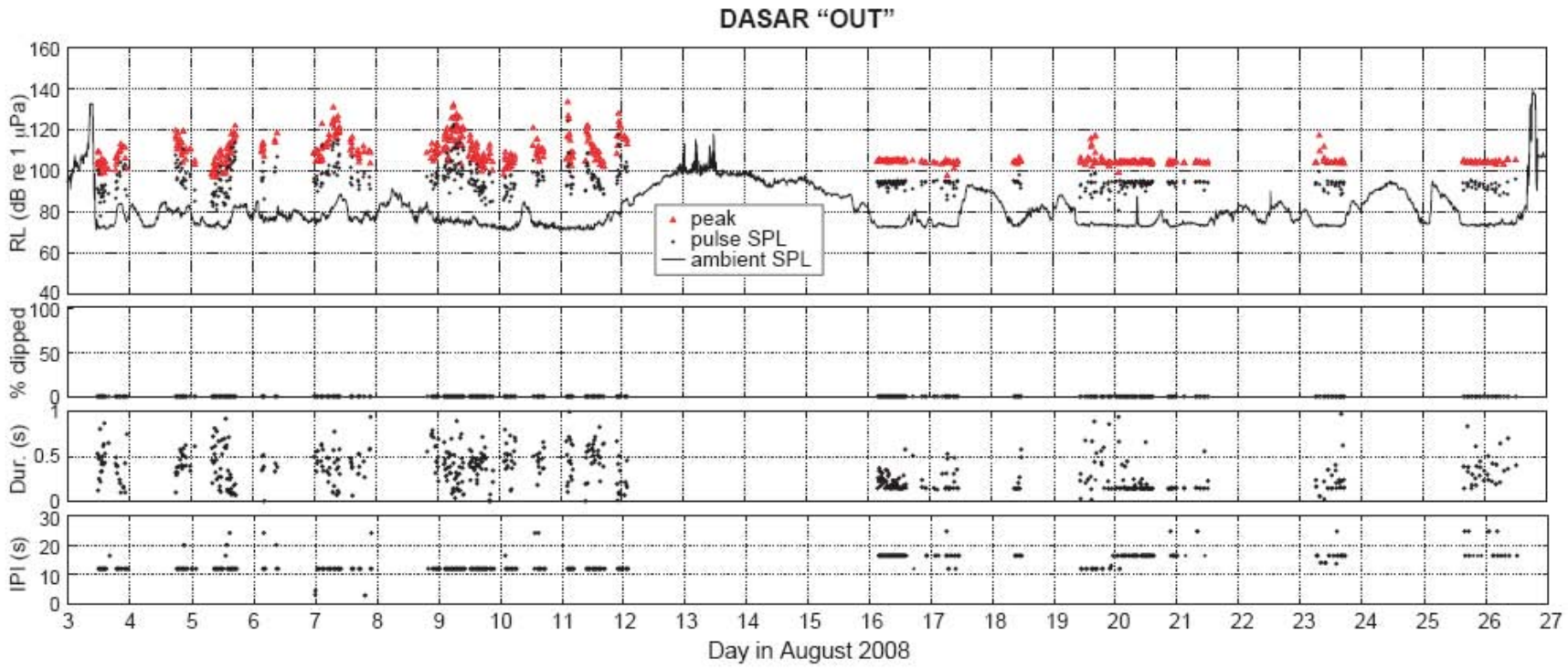


FIGURE 3.44 SEISMIC SOUND CHARACTERISTICS AND BACKGROUND SOUND PRESSURE LEVELS AS RECORDED BY DASAR *OUT* DUIRNG THE PERIOD 3 TO 26 AUGUST. THE MEDIAN OVER 10-MINUTE INTERVALS IS SHOWN FOR PEAK PRESSURE, RMS SOUND PRESSURE LEVEL (SPL), PULSE DURATION AND INTER PULSE INTERVAL (IPI). THE OVERLOADED PULSES ARE PRESENTED IN PERCENTAGES AND THE BACKGROUND SOUND LEVELS AS THE MINUMUM VALUE OVER THE SAME 10-MINUTE INTERVALS.

The pulse durations ranged from about 0.1 to 1 second at all three sites. Pulse duration varies due to several factors, such as the distance between the source and receiver, the acoustic path between source and receiver and the frequency components of the sound. Pulse duration is also important in the calculation of rms SPL values. It is apparent from the figures that the pulse duration was variable at all three sites, mainly because the distance between the seismic source vessels and DASARs was constantly changing, and with it the path along which the acoustic wave traveled. Even in water with good propagation, pulse duration increases with increasing distance (pulse spreading) due to the growing separation in arrival time of the sound energy. In the shallow water environment where the Liberty seismic survey took place, the complex bottom characteristics play an even more important role in sound propagation, thus a higher variation in pulse spreading is expected. This complexity was also apparent from the sound source verification and vessel measurements, described in the previous sections. In addition, at the DASAR *Out* location bottom-borne energy, at necessarily lower frequencies because higher frequencies are attenuated in the earth, dominated the received pulse, accounting for longer durations.

The inter-pulse intervals (IPIs) at the three sites are interesting. The basic interval of the Liberty seismic survey was 12 seconds, the predominant IPI observed at the location inside the barrier islands. There is also evidence of a 20-second IPI at this site on 5 and 6 August, which did not appear on the DASAR records for the *Gap* and *Out* locations, leaving its source unaccounted for. DASAR *Gap* and *Out* recorded intervals of ~17 seconds and longer, indicating other surveys than Liberty were also occurring. This is most obvious on DASAR *Out* where seismic pulses with ~17 second intervals appear on 25 and 26 August, after seismic data acquisition at Liberty was completed. It is not known why these, and other pulses, do not appear on the DASAR *Gap* record or vice versa. The variable IPIs, however, are a strong indication that the recorded sounds are not limited to the Liberty source vessels only.

To illustrate the effect that the barrier islands might have on the propagation of sound from seismic activity within the Liberty survey area, received SPLs at each DASAR location were plotted as a function of distance from the seismic vessel (Figure 3.45). For this purpose, four distinct periods of seismic activity were chosen: (a) the early afternoon of 3 August; (b) the early morning of 12 August; (c) mid afternoon of 16 August; and (d) late morning of 17 August. On each of these four days, samples of analyzed data were selected from the three DASAR records, during which the position of the seismic vessel was known. This figure shows, for example, that on 12 August received SPLs at the DASAR locations *In* and *Gap* were 130 dB and 128 dB, respectively, 13.3 km and 19.2 km (8.3 mi and 11.9 mi) from the seismic vessel. Received levels at the DASAR *Out* location, 17.3 km (10.5 mi) from the seismic vessel, were 100 dB. This is much lower than would be expected from standard water-borne sound propagation and from the results of the SSV measurements (see Section 3.1). The same unexpectedly low received levels were seen at DASAR *Out* on 3, 16, and 17 August. Slopes for propagations of 10log(R) and 30log(R), representative of the spreading losses obtained from the SSV measurements, were included in Figure 3.45 to show what SPLs could be expected at DASAR locations *Out* and *Gap*, based on RLs at the location of DASAR *In*. In general, Figure 3.45 shows that the presence of the barrier islands had a strong influence on sound propagation.

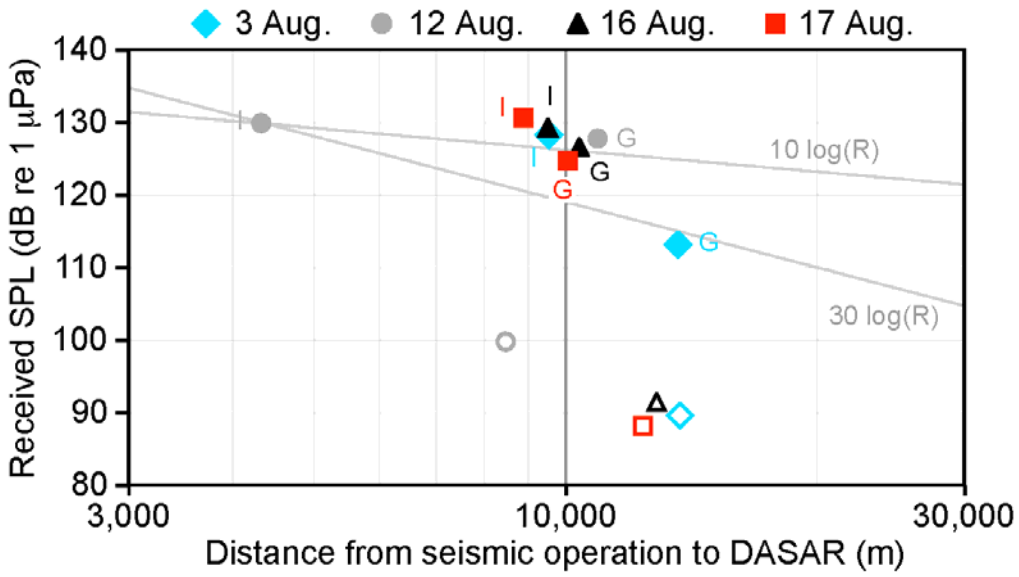


FIGURE 3.45 CONCURRENT RECEIVED SPLS FROM SEISMIC PULSES AT THE LOCATIONS OF DASAR *IN* (I), DASAR *GAP* (G) AND DASAR *OUT* (OPEN SYMBOLS), ON FOUR DAYS, AS A FUNCTION OF DISTANCE FROM THE SEISMIC VESSEL. SLOPES OF 10 LOG(R) AND 30 LOG(R), REPRESENTATIVE OF THE SPREADING LOSSES OBTAINED FROM SSV MEASUREMENTS, ARE SHOWN FOR COMPARISON. BOTH T SLOPES ARE PLACED SO THAT THEY INTERSECT THE RL VALUE FOR DASAR *IN* ON 12 AUGUST (GRAY CIRCLES). SEE TEXT FOR MORE INFORMATION.

Figure 3.46 presents percentile data of underwater background sound (10–450 Hz bandlevel), as recorded over the 24 days of DASAR recordings. The 5th–95th percentile sound levels were in the range of 70 to 100 dB re 1 µPa, which is consistent with the levels observed offshore of Northstar, allowing for the protected area of Foggy Island Bay. Blackwell and Greene (2006) report values recorded over three summer seasons (2001–2003), ~22 km NE of Northstar Island. Their 5th–95th percentiles were in the range 80.5 to 110.4 dB re 1 µPa the 10–500 Hz band. Background sound levels at the DASAR *In* location were always slightly higher than those at the DASAR *Gap* and *Out* locations. This was most apparent for the maximum received background levels. It is likely that vessel movements within the Liberty area resulted in the higher maximum levels at the DASAR *In* location.

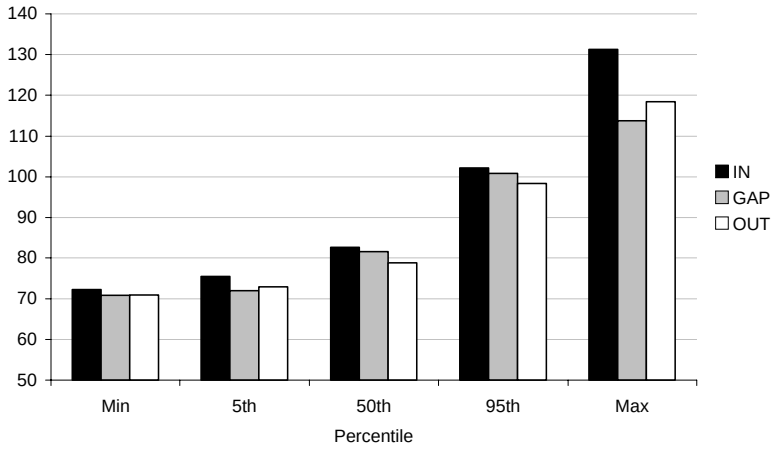


FIGURE 3.46 PERCENTILE LEVELS (MINIMUM, 5TH, 50TH, 95TH AND MAXIMUM) OF BACKGROUND SOUND (EXCLUDING AIRGUN PULSES), CALCULATED FOR THE *IN*, *GAP*, AND *OUT* DASAR LOCATIONS.

In summary:

- The acoustic records of DASARs *Out* and *Gap*, and likely also of DASAR *In*, contained seismic pulses from other seismic operations. This was most apparent on DASAR *Out* on August 26, after data acquisition for the Liberty survey was completed.
- Received levels of sound from seismic pulses were highest at DASAR *In*, located closest to the Liberty seismic operations. At DASAR *In*, 88.4% of 10-min periods had median received SPLs in the range 120–135 dB re 1 µPa, and 1.7% exceeded 135 dB. The maximum received SPLs at DASAR *In* are not known because 14% of 10-min samples analyzed from that DASAR contained one or more pulses that were overloaded.
- In contrast, at DASAR *Gap* the majority (74.7%) of median received SPLs was below 120 dB, and at DASAR *Out* this value was close to 100%. No overloaded pulses were recorded at DASARs *Gap* and *Out*.
- Received SPLs at DASAR *Out*, which was separated from the Liberty seismic area by a barrier island, were lower than expected from standard water-borne propagation by up to ~30 dB, demonstrating the effectiveness of these islands as acoustic barriers.
- The 160 dB isopleth (for airgun pulse SPLs) was not estimated but would have been well inshore of the DASAR locations (closer to the seismic operations), i.e., inshore of the barrier islands.
- Whereas the presence of islands serves as a sound barrier, the gaps between the barrier islands potentially serve as funnels through which sound can propagate seaward. Median received pulse SPLs at DASAR *Gap* were >120 dB re 1 µPa about 25% of the time. At these times, and depending on the spreading loss term, the 120 dB isopleth could have been located up to 20 or 30 km seaward of the barrier islands,
- Background levels at the three DASAR locations were within the range of similar measurements made in the Prudhoe Bay area. Background levels were highest at DASAR *In*, probably due to vessel traffic.

4 MARINE MAMMAL MONITORING AND MITIGATION

This chapter describes the marine mammal monitoring and mitigation measures implemented for BPXA's 2008 Liberty Seismic Survey in Foggy Island Bay, Beaufort Sea, addressing the requirements specified in the NMFS IHA and USFWS LOA (Appendices A and B). The first section provides a brief overview of the monitoring tasks relevant to mitigation for marine mammals, followed by a section summarizing the mitigation measures as adhered to in the field, based on the requirements from the IHA and LOA. The chapter ends with a description of the visual marine mammal monitoring protocol. Data analysis methods and the results of the marine mammal monitoring and mitigation program are provided in Chapter 5.

4.1 Monitoring Tasks

The main purposes of the vessel-based marine mammal monitoring program were to ensure that the provisions of the IHA and LOA issued to BPXA by NMFS and USFWS were satisfied, effects on marine mammals were minimized, and residual effects on animals were documented. Tasks specific to dedicated Marine Mammal Observers (MMOs) are listed below:

- Use visual monitoring to record the occurrence and behavior of marine mammals near the airguns when the airguns are operating and during a sample of the times when they are not;
- Use visual monitoring as a basis for implementing the required mitigation measures;
- Use visual monitoring to estimate the number of marine mammals potentially exposed to airgun sounds at specified levels.

4.2 Mitigation Measures as Implemented

General mitigation measures (all vessels)

The general mitigation measures summarized below, as identified in the IHA and LOA, were implemented, where applicable, by the captain and crew of all project vessels during the seismic operations, including the transit of the *Arctic Wolf*. Mitigation measures specific for the seismic source vessels, and implemented by dedicated MMOs, are summarized in the section below. Note that, where necessary, human safety took precedence over the mitigation measures for the avoidance of disturbance and harassment of marine mammals.

- Avoid groups of marine mammals (including walrus and polar bears on ice or land) and stay as far away from these groups as possible. Also do not operate vessels in such a way as to separate members of a group;
- Keep a 0.5-mi (0.8 km) safety radius around Pacific walrus groups hauled out onto land or ice;
- Conduct activities as far away as possible from marine mammal groups, including walrus and polar bear on land or ice. When operations within 900 ft (275 m) of such groups are unavoidable, the following actions are to be taken:
  - Reduce vessel speed and, if possible, steer around such groups;
  - Avoid multiple changes in direction and speed.

- Do not operate small boats at speeds that increase collision risk with marine mammals. When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to marine mammals;
- Make sure that no marine mammal can be injured when engaging the vessel's propellers (or screws);
- If unsure about how to avoid potentially harassing effects of certain operations on marine mammals, take every possible measure to avoid further harassment until the NMFS/USFWS is consulted for instructions or directions.

The IHA and LOA also require the implementation of mitigation measures that pertain to aircraft operations. However, because no aircraft or helicopters were used to support the Liberty seismic operations, these measures were not implemented and therefore not summarized here.[4]

Seismic source related mitigation measures

The mitigation measures implemented by the MMOs on the seismic source vessels during seismic data acquisition included, among others, observation of safety zones, ramp-ups, power-downs, shut-downs, and course alterations, provided that doing so did not compromise operational safety requirements. These mitigation measures are standard procedures during seismic surveys and were identified in the IHA and LOA (Appendices A and B) as indicated below.

Safety zones

Safety zones are defined by the distance from the source to specific received levels that are related to potential physical or behavioral impacts of marine mammal species as a response to the sounds generated by that source. For this seismic survey, safety zones for received sound levels of 190 dB (for pinnipeds and polar bears in water) and 180 dB (for cetaceans and walrus) were estimated and then verified with in-field acoustic measurements by Greeneridge Sciences and monitored by MMOs before and during all daylight seismic activities. Power-down or shut-down procedures (see below) were implemented when a marine mammal was sighted within or approaching the applicable safety radius while the airguns were operating.

Mitigation source

The mitigation source was the smallest airgun in the array (70 in^3) and was used to alert marine mammals of the presence of airgun sounds, with the intent to trigger marine mammals to avoid the area of operations. The use of a separate, smaller airgun of 6 in^3 was considered as the mitigation source at the start of the project, and was installed at both the *Peregrine* and *Miss Diane*. However, due to operational complexity and the relatively low sound level emitted by the 6 in^3 gun, the decision was made to only use the 70 in^3 as mitigation source.

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[4] Helicopters were used to support the bird banding study that was implemented as part of the Liberty seismic operation.

Ramp-up

A ramp-up is a gradual increase in the number of active airguns before line shooting or after a shut-down or power-down of airguns. The gradual increase in sound level allows marine mammals the opportunity to leave the immediate area before the airgun array reaches full volume. Ramp-up procedures required airgun arrays to increase by no more than 6 dB per 5-minute interval (essentially a doubling of the air-volume). Both source vessels conducted seismic data acquisition with an airgun volume of 440 in^3 (Figure 4.1). The *Peregrine* used 880 in^3 only during the SSV measurements and during limited test shooting at the beginning of the survey. The ramp-up sequence (volume in in^3) for the source boats operating at 440 in^3 was as follows: 70 in^3, 140 in^3, 290 in^3, and 440 in^3. This procedure took approximately 15 minutes (20 minutes if operating at 880 in^3).

- Ramp-up procedures were implemented whenever (a) initiating airgun operation when >10 minutes elapsed since shut-down of full airgun array, or (b) increasing airgun volume following a power-down. If <10 minutes elapsed since full shut-down or power-down, ramp-up procedures were not required;
- An initial ramp-up or a ramp-up from a complete shut-down (i.e. no airguns operating) was only initiated if the entire 180 dB safety zone for the full array was visible and clear of marine mammals for 30 minutes prior to the commencement of ramp-up. The start of ramp-up was postponed if:
  - the safety zone was inhibited in any way during the 30-minute watch period (i.e. fog or darkness);
  - a cetacean or walrus was sighted within the 180 dB safety zone during the 30 minute watch period;
  - a pinniped or polar bear was sighted within the 190 dB safety zone 15 minutes prior to the intended ramp-up.
- If the mitigation source, described above, was operating, a ramp-up can be initiated even if the safety zone is not visible (i.e. due to fog or darkness) because the mitigation source was assumed to alert marine mammals of the presence of airgun sounds, with the intent to trigger marine mammals to avoid the area of operations.

Daylight ramp-up procedure – During daylight, a ramp-up was implemented whenever the airgun array was shut down for >10 minutes during the following conditions:

- After a full shut-down or power-down due to a marine mammal entering the safety zone, 2 MMOs conducted a 30-minute watch prior to initiating a ramp-up procedure;
- In the event of an operational shut-down of the airgun array (i.e. not for a marine mammal), a 30-minute watch was conducted by at least 1 MMO prior to ramp-up.

Darkness ramp-up procedure – During periods of darkness, initial ramp-up, or ramp-up after a full shut-down, was only commenced if the entire 180 dB safety zone was visible for 30 minutes using the aid of night vision or vessel lights. In practice this meant that ramp-up procedures could not be initiated after a full shut-down of airguns during darkness for more than 10 minutes. During this seismic survey, the mitigation gun was activated prior to darkness, after

clearance of the safety zone during the preceding 30-minute period with adequate light conditions[5].

Power-down and Shut-down

A power-down is the reduction of active airguns and was implemented for several reasons, such as (a) a marine mammal sighted within or approaching the applicable safety zone of the full array, (b) mechanical or operational reasons, or (c) changes between lines or patches, depending on the time required to conduct those. A shut-down is the cessation of all active airguns, including the mitigation source and was implemented when (a) a marine mammal was sighted within or approaching the safety zone of the mitigation source, or (b) there were mechanical, operational, or weather-related reasons. Details of the power-down and shut-down procedures are as follows:

- If a marine mammal was first observed within the full array safety zone, the airguns were immediately powered down to the 70 in^3 mitigation source. If the marine mammal was still traveling towards or entering the reduced safety zone, a shut-down was administered;
- After a complete shut-down of the full array, clearance of the applicable safety zone had to be visually confirmed before any ramp-up procedures could begin. If the

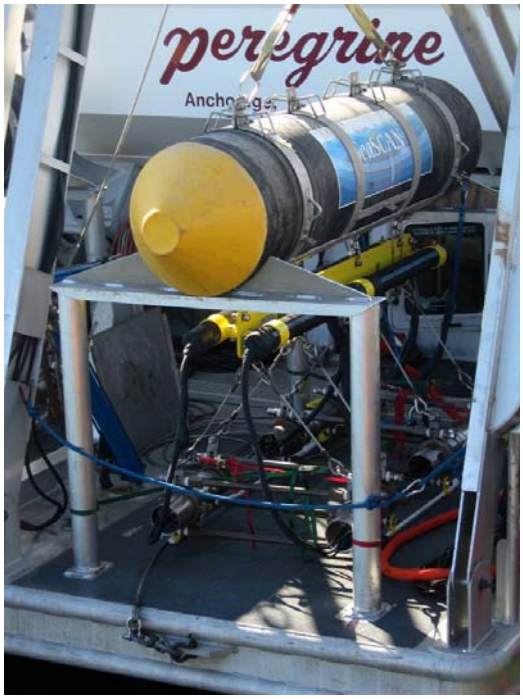

FIGURE 4.1 ONE 440 IN^3 AIRGUN ARRAY ON THE *PEREGRINE*.

[5] On one occasion (17 August) an alternate procedure was used when, under decreasing visibility conditions, the *Miss Diane* almost finished line shooting and the *Peregrine* was supposed to take over. Taking advantage of the safety zone of the *Miss Diane's* 440 in^3 array, the *Peregrine* started a normal ramp-up procedure until full array volume of 440 in^3 was reached. Although this procedure seemed to generate less sounds than activating mitigation sources on both vessels during the entire night, just in case they would need to resume operations, it was not repeated.

airguns were down for >10 minutes and/or no observer was on duty, a 30-minute watch by 2 MMOs was required to clear the 180 dB safety zone prior to ramp-up;

- An emergency shut-down procedure was implemented any time an injured or dead marine mammal was observed in the seismic survey area. Ramp-up was only allowed after permission from the relevant agency was granted. This measures, as per the IHA issued on 8 July 2008 (Appendix A), was amended on 28 July 2008 (Appendix A). The amendment allowed for an initial examination by the lead MMO regarding the estimated time and cause of death that determined whether shut-down and ramp-up procedures needed to be implemented.

Course alterations

Vessel course and speed were adjusted when practical in case a marine mammal was detected outside the safety radius and, based on its position and motion relative to the vessel track, was judged likely to enter the safety radius. Although the small seismic source vessels are relatively maneuverable, a change in course (and speed) was never implemented, because there were no marine mammal encounters that made this necessary.

4.3 Visual Monitoring Protocol

The visual monitoring protocol implemented during the transit of the housing vessel *Arctic Wolf* and during the seismic survey itself was designed in accordance with the requirements of the IHA and LOA (Appendices A and B). Prior to the start of the survey, all MMOs participated in a 3-day MMO training course to familiarize them with the monitoring protocol, the local marine mammals, and operational procedures. In addition, all MMOs working on the seismic source vessels participated in a 2-day Health, Safety, and Environment (HSE) seminar, facilitated by CGGVeritas. During this seminar all survey participants were informed of the operational procedures relevant to HSE issues.

Arctic Wolf Transit

Two Inupiaq-speaking MMOs boarded the *Arctic Wolf* in the Port of Anchorage on 24 June and the vessel departed on 26 June. The primary roles of the MMOs aboard the *Arctic Wolf* were to (a) communicate with the communication-centers in the whaling villages, as per the CAA (Appendix C), as the vessel approached or passed hunting areas during the subsistence hunt periods and, (b) visually monitor for marine mammals, implement mitigation measures and collect baseline data.

The MMOs observed in shifts, one at a time and were on watch ~16 hours per day (from 0600 to 2200 hours) when the vessel was underway. If the vessel was anchored due to inclement weather or ice, the MMOs were not required to be on watch. The MMOs observed from the center of the bridge when aboard the *Arctic Wolf*. They systematically observed the area, alternating scans with reticle binoculars, Fujinon 7x50, and the naked eye. Observations were focused forward and to the sides of the vessel while it was underway, or in all directions when not moving. MMOs checked the stern of the vessel for marine mammals as often as reasonably practicable. If marine mammals were sighted approaching the vessel, the MMOs informed the captain and requested a course alteration, when required.

MMOs recorded systematic data while on watch including date, time, observer initials, locations of other vessels, water depth, Beaufort wind force, visibility, glare, and sea-ice

information, as well as the location, speed, and activity of the vessel. These data were recorded at least every 30 minutes or whenever conditions changed significantly. Additional data were recorded whenever marine mammal(s) were sighted. This data included date, time, species, total number of individuals, number of juveniles, bearing relative to vessels heading, direction of movement relative to the vessel, distance from the vessel, behavior when sighted, whether the animal was in water or hauled out on ice or land, behavioral pace, reaction to the vessel, vessel position, water depth, observer initials, species identification reliability, and the time that mitigation measures were requested (if necessary). All data collected during the transit were later entered into an Excel database and manually checked by comparing the handwritten datasheets to the database. Calls to the communication centers were made every 6 hours and documented in a logbook.

Seismic Source Vessels Peregrine and Miss Diane

A total of seven MMOs were present during the entire seismic survey in order to ensure that at all times two MMOs were available on the seismic source vessels, with at least one MMO on watch while airguns were operating (see Figure 4.2). The number of MMOs was in part dictated by the limited availability of accommodation and living space on the seismic source vessels. The *Peregrine* could accommodate two MMOs for the duration of the survey, with a third MMO rotating on board at the noon to midnight shift each day. Because no accommodation was available aboard the *Miss Diane*, four MMOs were housed on the *Arctic Wolf* and rotated in 12-hour shifts each day: two MMOs were on board from midnight to noon, and the other two MMOs from noon to midnight.

The two MMOs accommodated aboard the *Peregrine* mobilized to the vessel on 14 July and the third MMO started the first 12-hour shift on 15 July, when airgun sound source verification measurements commenced. The MMOs for the *Miss Diane* also started their rotations on 15 July. Because the *Arctic Wolf* was delayed one week, due to ice, MMOs were housed in Deadhorse during that week and transported by bus and crew vessel to the field. Occasionally, transportation delays occurred causing shift times to fluctuate, however, there were always at least two MMOs aboard each source vessel during seismic activity – one biologist experienced in MMO observations during seismic surveys and data management and one Inupiaq speaking MMO with experience identifying local marine mammals.

MMOs observed from the bridge of both source vessels with an observer's eye level at ~6 m above sea level (ASL) on the *Peregrine* and ~5.5 m ASL on the *Miss Diane*. If one MMO was on watch, observations were made primarily from the starboard side of the *Peregrine* and the port side of the *Miss Diane.* The view from the MMO station on both source vessels included full forward visibility with some peripheral limitation to the opposite side. The navigator was positioned opposite of the MMO on both source vessels and would notify the MMO of sightings. The MMOs periodically repositioned his or her location to maximize the observation range[6]. If two MMOs were on watch, MMOs observed from the center-most point possible to maximize the observation area. MMOs generally observed in shifts no longer than 4 hours, with breaks between each shift, in order to minimize observer fatigue. Some MMOs rotated on approximate 2-week shifts; however several MMOs remained for the majority of the 6-week survey.

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[6] The distance from the MMO observation post to the actual location of the airguns, which are the reference for the safety radius, was ~50 to 80 ft (~15 to25 m). Although this distance is small, it was taken into consideration by the MMOs when estimating the distance of the marine mammal in relation to the safety zone.

FIGURE 4.2 MARINE MAMMAL OBSERVER RICHARD BODFISH ON THE *MISS DIANE*.

MMOs systematically scanned (described in previous section) using the naked eye, Fujinon 7x50 reticle binoculars, and Zeiss 20x60 image stabilized binoculars during all daylight seismic operations. Typically, daylight observations were conducted by a single MMO due to the limited space on the bridge of the source vessels, except for the 30-minute watch prior to ramp-up after a full shut-down for a marine mammal. MMOs were not required to be on watch during periods of darkness, other than for the 30 minutes prior to ramp up from a complete shut-down if the entire safety zone was visible (i.e. by vessel lights or night vision). MMOs were on stand-by during darkness and the bridge crew observed for marine mammal during nighttime.

MMOs recorded systematic data while on watch, including date, time, observer initials, seismic activity, locations of other vessels, water depth, Beaufort wind force, visibility, glare, and sea-ice information, as well as the location, speed, and activity of the vessel. These data were recorded at least every 30 minutes, or whenever conditions changed significantly. Additional data were recorded whenever marine mammal(s) were sighted. Figures 4.3 and 4.4 show two examples of marine mammal sightings. This data included date, time, species, total number of individuals, number of juveniles, bearing relative to vessel's heading, direction of movement relative to the vessel, distance from the vessel, behavior when sighted, whether the animal was in water or hauled out on ice or land, behavioral pace, reaction to the vessel, vessel position, water depth, observer initials, species identification reliability, and the time that mitigation measures were requested (if necessary). Calls to the com-centers were made every 6 hours and documented in a log-book. Data were later entered into an Excel database and manually checked by comparing the handwritten datasheets to the database. During data processing, where the Excel databases were converted into Access databases, further quality control exercises were conducted, to resolve or eliminate inconsistent data entry, wrong combination of codes, or other factors. Chapter 5 provides more details on the analyses that were performed.

Communications between MMOs, navigators, and airgun operators were conducted via radio or verbally on the bridge to update status of operations or alert of power-down or shut-down requests. Radios were used to communicate with the project headquarters at Endicott and with the other vessels working in the project area.

FIGURE 4.3 BELUGA OBSERVED DURING THE LIBERTY SEISMIC SURVEY.

FIGURE 4.4 POLAR BEAR OBSERVED DURING THE LIBERTY SEISMIC SURVEY.

5 MARINE MAMMAL MONITORING AND MITIGATION: ANALYSIS & RESULTS

This chapter describes the results of the marine mammal mitigation and monitoring program implemented during BPXA's 2008 Liberty Seismic Survey. It includes a description of post-field data processing and analysis. For the purpose of marine mammal data analyses, the northbound transit of the *Arctic Wolf* and the period covering the actual seismic data acquisition were considered separately. An estimation of the numbers of marine mammals potentially affected during the seismic survey operations is also provided, though proved challenging due to the limited number of marine mammal encounters. All tables and figures within this chapter include distance measurements in metric units, with the conversion factor for U.S. units provided in the captions, where applicable.

The marine mammals known to occur within the Beaufort and Chukchi seas include nine cetacean species, five pinnipeds species, and polar bears. Of these 15 species, four are listed under the U.S. Endangered Species Act (ESA) as endangered: the bowhead, humpback, and fin whales, and the polar bear. Appendix E summarizes the abundance, habitat, and conservation status of the marine mammal species likely to occur in the transit and seismic survey area.

5.1 Data Analyses

For all data analysis presented in the sections below, only the daylight marine mammal observations are used since observations were not required during darkness. To distinguish potential differences in behavior and distribution of marine mammals with and without seismic activity, data were categorized as seismic, non-seismic, or post-seismic. The criteria for each category are as follows:

- **Seismic** included the data collected from both source vessels (*Peregrine* and *Miss Diane*) while airguns were operating. This includes ramp-up, power-down, and the periods that only the mitigation source was active. Analyzing data from *Peregrine* and *Miss Diane* separately seems justified, because during seismic data acquisition the distance between both vessels was at least 1.6 km, or 1 mi, to avoid noise interference. According to the sound source verification measurements, this distance coincides with sound levels of 160 dB and less, a sound level and distance that elicit limited behavioral responses in pinnipeds (Richardson 1998).
- **Post-seismic** was defined as the period *up to* 1 hour after cessation of all airguns on either one of the two source vessel. These data were excluded from analyses where seismic versus non-seismic sightings were compared.
- **Non-seismic** activity included all data that were obtained 1 hour *after* the airguns on one of the two vessels were deactivated. This cutoff period is comparable to those used in other recent seismic survey analysis (Ireland et al. 2007a,b; Patterson et al. 2007) and is arbitrarily determined, based on the likelihood that:
  - Marine mammal responses to seismic sound diminish with time after the cessation of seismic activity, and for pinnipeds this seems to occur relatively quickly (Gordon et al. 2004). This is also expected based on the fact that pinnipeds display limited behavioral responses to seismic sounds (Richardson, 1998);

- Both the animals and the vessels are mobile and may not be within the exposed area after 1 hour. This is especially likely in this survey, due to the relatively limited distances to received sound levels of 160 dB (and less).

Environmental factors including high sea conditions, poor visibility, glare, and MMO experience can make marine mammal identification difficult, and pinniped species could not always be identified to species with a high level of certainty. Distinguishing ringed seals from spotted seals is especially difficult. During this survey, there were limited pinniped sightings. For analysis purposes, all these sightings were labeled pinnipeds, regardless of whether they were identified to the species level.

Estimated number of exposures — For purposes of the IHA, NMFS assumes that any marine mammal potentially exposed to airgun pulses with received levels of ≥160 dB re 1µPa (rms) may have been disturbed. In this survey, the distances of the marine mammal sightings to the source vessels were always within or close to the 160 dB radii of the 440 in^3 airgun array. Due to the limited number of marine mammal sightings (a total of 23 sightings from both source vessels), it is not reasonable to calculate species densities and to use that number to estimate the number of exposures to seismic sounds. Instead of using densities, as was done for other seismic surveys (e.g. Richardson 1998, Funk et al. 2008), the procedure described below was used to obtain a minimum and maximum estimated number of marine mammal exposures to ≥160 dB re 1µPa for comparison with the numbers as estimated in the IHA. The results of these calculations are presented in Section 5.5 of this chapter.

- The estimated *minimum* number of marine mammals that could have been exposed to seismic sounds of 160 dB or more is assumed to be the number of animals actually observed within the applicable safety radii during airgun operations. In this survey all cetaceans and pinnipeds sighted when airguns were operating were within the 160 dB safety zone.
- For an estimated *maximum* number, marine mammal sighting rates were calculated per hour effort for all daylight hours (# sightings/h) for the period when airguns were turned off for more than one hour (referred to as non-seismic period). Under the assumption that the non-seismic sighting rate was representative for a non-disturbed presence of marine mammals, it was used to calculate the number of sightings that could have occurred during the daylight period when airguns were operating, based on the seismic effort in hours. No marine mammal observations were made during darkness. Because marine mammals are undoubtedly present during seismic activity in darkness, the non-seismic daylight sighting rate (# sightings/h) was used to calculate the number of animals expected to be present during darkness, based on the seismic effort in darkness. Separate sighting rates were calculated for cetaceans and pinnipeds for each source vessel and the maximum non-seismic sighting rate was used for the maximum exposure calculations.

5.2 Results *Arctic Wolf* Transit

Observer effort

The *Arctic Wolf* mobilized from the Port of Anchorage and started its transit to West Dock on 26 June. The planned transit time was two weeks with the expected arrival date on 12 July. However, due to ice conditions in the Chukchi Sea and around Barrow, the total transit time took about three weeks and the *Arctic Wolf* arrived at West Dock, Prudhoe Bay, on 20 July. Here the MMOs demobilized and the vessel took on new provisions, water and fuel before proceeding to the project area on 22 July.

During the 24 days aboard the *Arctic Wolf* the total observation time of the MMOs was 369 hours, which is 23 days of observation at 16 hours per day. There was no darkness during the transit period, so all marine mammal observations were conducted during daylight. Four sightings were made by the captain or crew during hours when MMOs were not on duty. These sightings are noted in figures and tables. A total of 206 observation hours or 56% of the total observation hours were conducted during actual transit (defined by vessel speed of 3.7 km/h or ≥ 2 kts) and 151 hours (41%) while on anchor or idle (defined by vessel speeds of 3.7 km/h or < 2 kts). There were 11 hours (3%) of observation time during which the speed and activity of the vessel was not clearly determined. No animals were sighted during these hours and they are excluded from further analysis.

Figures 5.1 and 5.2 show the Beaufort wind force (Bf) and visibility conditions during the marine mammal observations when the vessel was actually transiting and when it was on anchor or idle. Most of the observations, 200 h (54%) while on transit and 134 h (36%) while on anchor or idle, were made when visibility was more than 3.5 km (2.2 mi). The observation effort under different Bf wind force conditions were more variable and without a clear pattern.

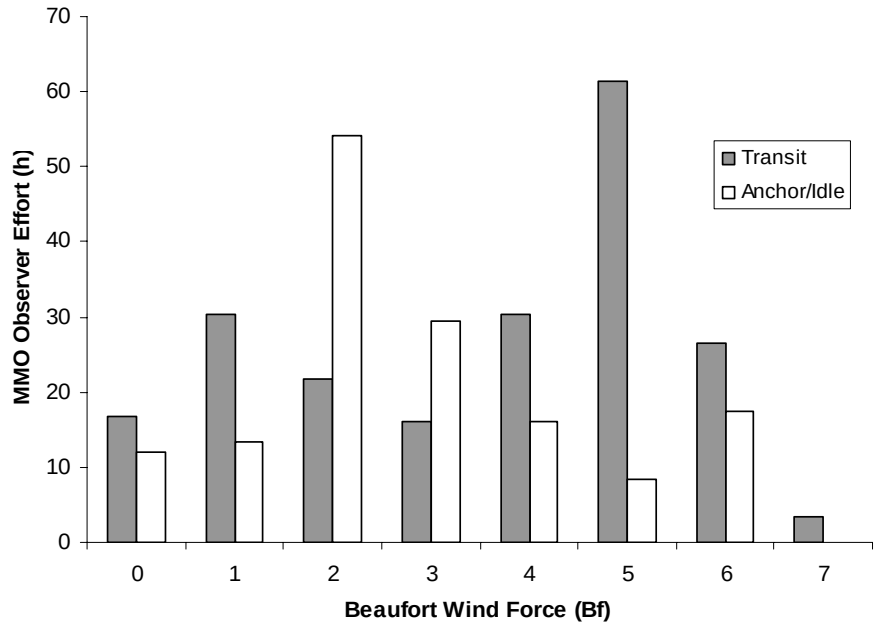

FIGURE 5.1 BEAUFORT WIND FORCE CONDITIONS DURING TOTAL MARINE MAMMAL OBSERVER EFFORT (H) FROM THE *ARCTIC WOLF* WHILE IN TRANSIT (DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS OR 3.7 KM/H) AND ON ANCHOR OR IDLE (DEFINED BY SPEEDS <2 KTS OR 3.7 KM/H) OVER THE PERIOD 26 JUNE TO 20 JULY.

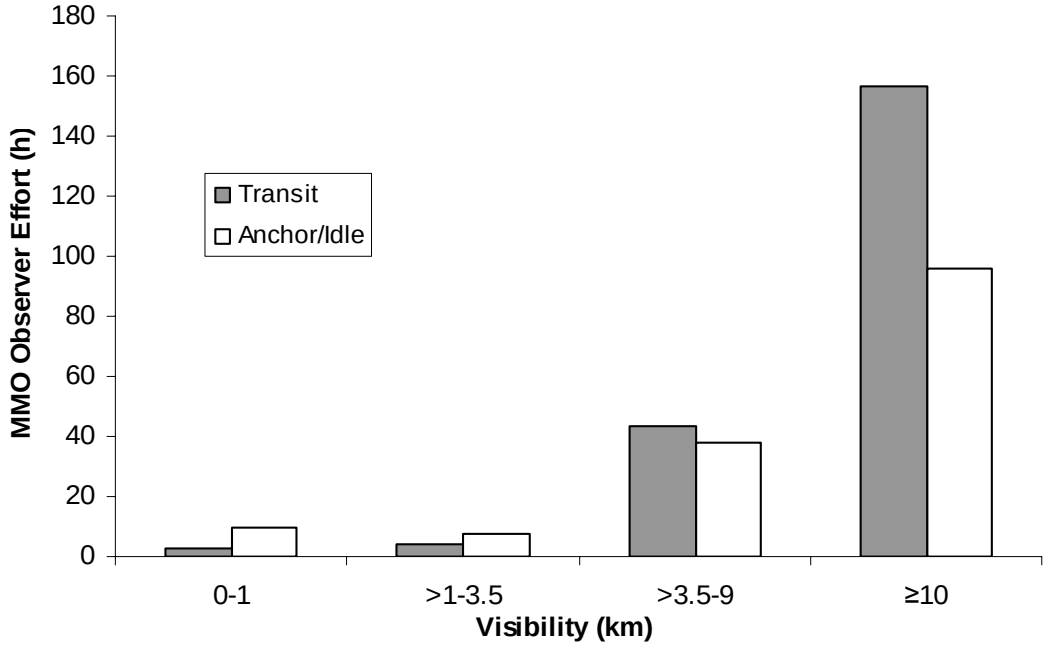

FIGURE 5.2 VISIBILITY CONDITIONS DURING TOTAL MARINE MAMMAL OBSERVER EFFORT (H) FROM THE *ARCTIC WOLF* WHILE IN TRANSIT (DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS OR 3.7 KM/H) AND ON ANCHOR OR IDLE (DEFINED BY SPEEDS <2 KTS OR 3.7 KM/H) OVER THE PERIOD 26 JUNE TO 20 JULY. 1 KM = 0.62 MI.

Cetaceans and Pinnipeds

During the 24-day transit of the *Arctic Wolf* from the Port of Anchorage to West Dock, Prudhoe Bay, six cetacean species and five pinniped species were sighted, not counting walrus (Table 5.1, Figure 5.3). A total of 56 sightings were made of 107 individuals, of which 29 sightings of 73 animals were cetaceans and 27 sightings of 34 animals were pinnipeds.

Most cetacean species (five of the six) and one pinniped species (harbor seal) were only encountered in the Gulf of Alaska or Bering Sea. Only the Gray whale was observed over the entire range. The other pinniped species were mainly sighted around Point Lay in the Chukchi Sea. The ringed seal was also observed at Wainwright and Barrow (Figure 5.4).

Figure 5.5 shows the number of sightings made during transit and when the vessel was on anchor or idle. The latter occurred mainly when weather conditions prevented the *Arctic Wolf* from further travel, either due to storms or the presence of ice. Most sightings were made when the vessel was actually traveling. This was most apparent for cetaceans; the number of sightings per hour effort when the vessel was traveling was approximately four and a half times higher than when it was on anchor or idle (Figure 5.6).

Most pinniped observations from the *Arctic Wolf*, excluding walrus, were observed at distances between 5 and 668 m from the vessel, with exception of one bearded seal observed at 1187 m. Cetacean sightings mostly occurred at distances of 5 to 1187 m, with three sightings of each of the following species at 2975 m: gray whale, humpback whale and an unidentified whale.

TABLE 5.1 NUMBER OF SIGHTINGS (NUMBER OF INDIVIDUALS) OF CETACEANS AND PINNIPEDS (EXCEPT WALRUS) OBSERVED FROM THE *ARCTIC WOLF* WHILE ON TRANSIT AND WHILE ON ANCHOR/IDLE OVER THE PERIOD 26 JUNE TO 20 JULY.

Species	Transit	Anchor/Idle	Total
Cetaceans			
Dall's porpoise	3 (10)	0	*3 (10)*
Gray whale	6 (9)	4 (9)	*10 (18)*
Harbor porpoise	4 (19)	0	*4 (19)*
Humpback whale	6 (10)	0	*6 (10)*
Killer whale	3 (8)	0	*3 (8)*
Risso's dolphin	1 (1)	0	*1 (1)*
Unidentified whale	2 (7)	0	*2 (7)*
Total Cetaceans	*25 (64)*	*4 (9)*	*29 (73)*
Pinnipeds			
Bearded seal	4 (4)	1 (1)	*5 (5)*
Harbor seal	2 (2)	0	*2 (2)*
Ringed seal	10 (11)*	6 (9)	*16 (20)*
Spotted seal	1 (2)	1 (1)	*2 (3)*
Steller's sea lion	2 (4)	0	*2 (4)*
Total Pinnipeds	*19 (23)*	*8 (11)*	*27 (34)*
Grand Total	***44 (87)***	***12 (20)***	***56 (107)***

* One sighting (1 individual) by captain/crew when MMOs not on watch.

FIGURE 5.3 THE HOUSING VESSEL, *ARCTIC WOLF*, ON SITE DURING THE LIBERTY SEISMIC SURVEY.

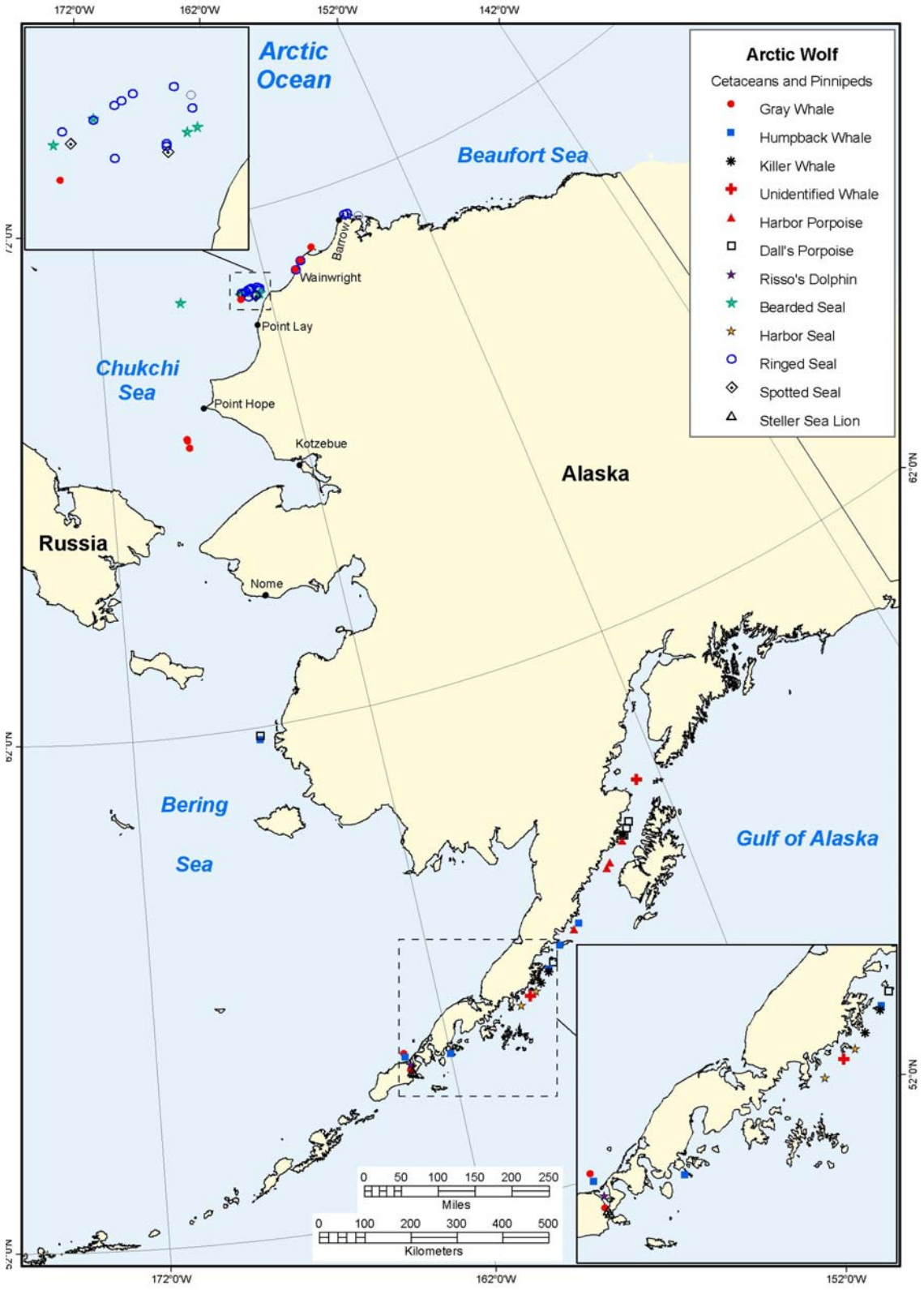

FIGURE 5.4 CETACEANS AND PINNIPEDS SIGHTED FROM THE *ARCTIC WOLF* DURING ITS TRANSIT FROM THE PORT OF ANCHORAGE TO THE LIBERTY SEISMIC SURVEY AREA DURING THE PERIOD FROM 26 JUNE TO 20 JULY.

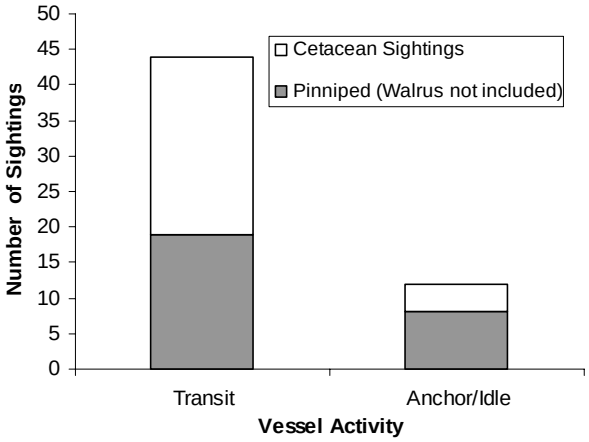

FIGURE 5.5 NUMBER OF PINNIPEDS AND CETACEANS SIGHTED FROM THE *ARCTIC WOLF* DURING MMO OBSERVATIONS BY VESSEL ACTIVITY OVER THE PERIOD 26 JUNE TO 20 JULY. TRANSIT IS DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS (3.7 KM/H) AND ON ANCHOR/IDLE IS DEFINED BY SPEEDS <2 KTS (3.7 KM/H).

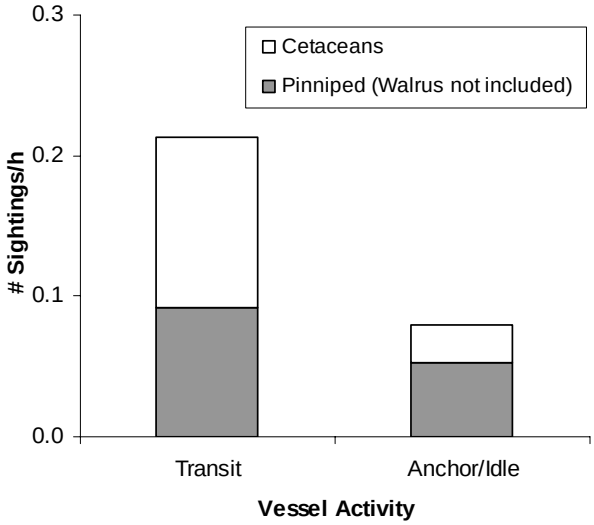

FIGURE 5.6 PINNIPED AND CEATACEAN SIGHTING RATE (IN NUMBER OF SIGHTINGS PER HOUR) BY VESSEL ACTIVITY DURING MMO OBSERVATIONS FROM THE *ARCTIC WOLF* OVER THE PERIOD 26 JUNE TO 20 JULY. TRANSIT IS DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS (3.7 KM/H) AND ON ANCHOR OR IDLE IS DEFINED BY SPEEDS <2 KTS (3.7 KM/H).

The ability to detect marine mammals depends very much on the weather conditions, such as wind force and associated sea state (Appendix F), visibility and presence of ice. Table 5.2 summarizes the number of sightings per hour for cetaceans and pinnipeds under different Bf wind force and visibility conditions. As expected the detectability of marine mammals increases with increasing visibility, especially apparent for cetaceans. For pinniped species, there is not much difference in detectability between the visibility categories >3.5 to 9 km and ≥10 km (>1.9 to 5.6 mi and ≥ 6.2 mi). This is likely due to the fact that it is difficult to detect pinniped species (in water) at distances of 3.5 km (2.2 mi) or more, regardless of whether the visibility is 5 km or ≥10 km (3.1 mi or ≥6.2 mi). The ability to detect marine mammals also decreases with increasing wind force (Table 5.2).

TABLE 5.2 SIGHTING RATES FOR CETACEAN AND PINNIPED SIGHTINGS DURING DIFFERENT VISIBILITY AND BF WIND FORCE CONDITIONS FROM THE TOTAL MMO WATCH EFFORT FROM THE *ARCTIC WOLF*. 1 KM = 0.62 MI.

Environmental conditions	Observation Effort (h)	CETACEANS		PINNIPEDS	
		# of Sightings	Sighting rate (#/h)	# of Sightings	Sighting rate (#/h)
Visibility					
0 - 1 km	12	1	0.084	1	0.084
>1 - 3.5 km	12	0	0	0	0
>3.5 – 9 km	81	4	0.049	16	0.123
≥10 km	253	24	0.095	10	0.063
Bf wind force					
0	29	7	0.241	5	0.172
1 - 3	165	17	0.103	22	0.133
≥4	164	5	0.030	0	0

Polar Bear and Walrus

Figure 5.7 shows the approximate location of walrus and polar bears sighted during the transit of the *Arctic Wolf* over the period 26 June to 20 July. Most conspicuous were the many individual walrus that were sighted in the area of Point Lay during 6, 7 and 8 of July. Ice conditions at Wainwright prevented the *Arctic Wolf* from continuing its northbound travel. Once in the area around Wainwright, another walrus sighting was recorded of one animal swimming at about 900 m from the vessel. A total of six groups of walrus were observed on ice floes. One sighting mentions 10000 individuals. According to the MMOs of the *Arctic Wolf*, walruses were observed on ice floes everywhere around the vessel, while it was traveling north through some ice leads. Due to the large number of animals spread out over ~6.5 km (~4 mi), they recorded this as one sighting with the estimated number of individuals observed. This was also the case for one sighting of 1000 individuals. The remaining four sightings contained ~205 animals total (Table 5.3). Smaller groups of walruses, varying between one and eight animals, were sighted in the water. A total of two polar bear sightings of one individual each were observed on 6 and 7 July. Both bears were observed on the ice about 700 m from the vessel (Figure 5.7, Table 5.3). On 29 June, when the *Arctic Wolf* was still in the southern part of Alaska, 50 otters were observed in one sighting at ~3 m from the vessel. This sighting is not included in the figures and maps.

Figures 5.8 and 5.9 show the number of sightings and sighting rate, which is the number of sightings per hour effort, for polar bear and walrus observed from the *Arctic Wolf* while in transit and on anchor or idle. Although the total number of walrus sightings seems to be higher during transit than on anchor or idle, the sightings per hour observation effort are similar (0.068 for transit and 0.053 for anchor or idle).

Walruses were observed primarily at distances between 9 and 668 m, with the exception of three sightings at 1187 m and two at 2975 m. Both polar bear sightings were observed at 668 m from the vessel.

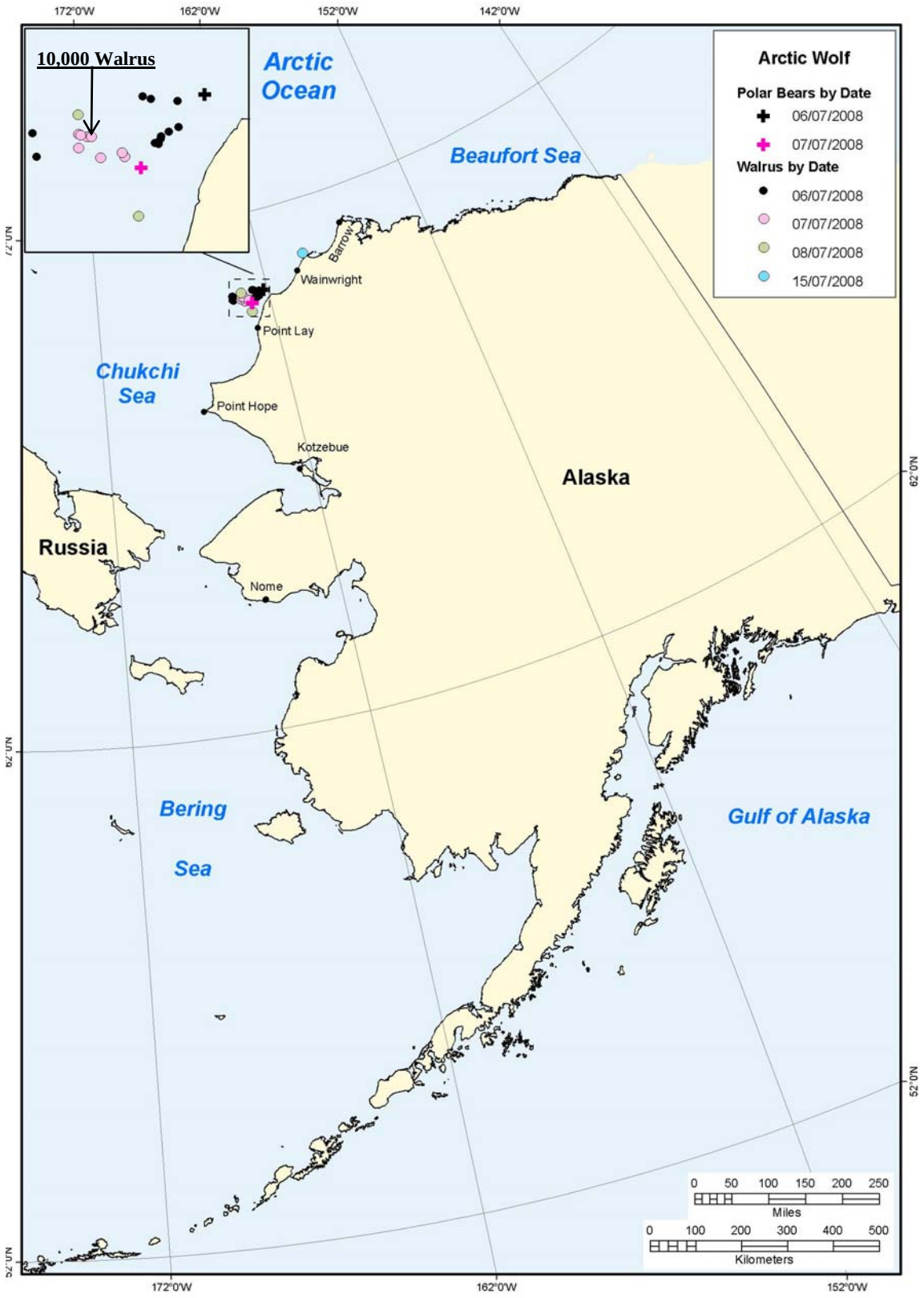

FIGURE 5.7 POLAR BEARS AND WALRUS SIGHTED FROM THE *ARCTIC WOLF* DURING ITS TRANSIT FROM THE PORT OF ANCHORAGE TO THE LIBERTY SEISMIC SURVEY AREA IN THE PERIOD FROM 26 JUNE TO 20 JULY. THE LOCATION WHERE THE LARGE GROUP OF 10,000 WALRUSES WERE SIGHTED IS INDICATED.

TABLE 5.3 NUMBER OF SIGHTINGS (NUMBER OF INDIVIDUALS) OF POLAR BEARS AND WALRUSES OBSERVED FROM THE *ARCTIC WOLF* WHILE IN TRANSIT AND WHILE ON ANCHOR OR IDLE OVER THE PERIOD 26 JUNE TO 20 JULY.

Species*	Transit	Anchor/Idle	Total
Pacific walrus			
In water	10 (18)**	5 (12)	*15 (30)*
On ice/land	3 (11100)	3 (105)***	*6 (11205)*
Both	1 (100)	0	*1 (100)*
Total Pacific walrus	*14 (11218)*	*8 (117)*	*22 (11335)*
Polar bear			
In water	0	0	*0*
On ice/land	2 (2)	0	*2 (2)*
Total Polar bear	*2 (2)*	*0 (0)*	*2 (2)*
Grand Total	***16 (11220)***	***8 (117)***	***24 (11337)***

* One Sea Otter sighting of 50 individuals was made while in transit.

** Two sightings (5 individuals) by captain/crew when MMOs were not on watch.

*** One sighting (100 individuals) by captain/crew when MMOs were not on watch.

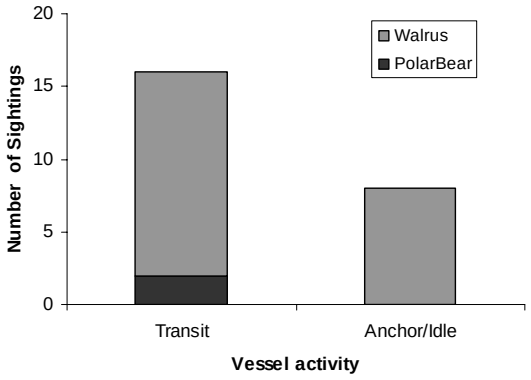

FIGURE 5.8 NUMBER OF POLAR BEARS AND WALRUSES SIGHTED FROM THE *ARCTIC WOLF* DURING MMO OBSERVATIONS BY VESSEL ACTIVITY OVER THE PERIOD 26 JUNE TO 20 JULY. TRANSIT IS DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS (3.7 KM/H) AND ON ANCHOR OR IDLE IS DEFINED BY SPEEDS <2 KTS (3.7 KM/H)

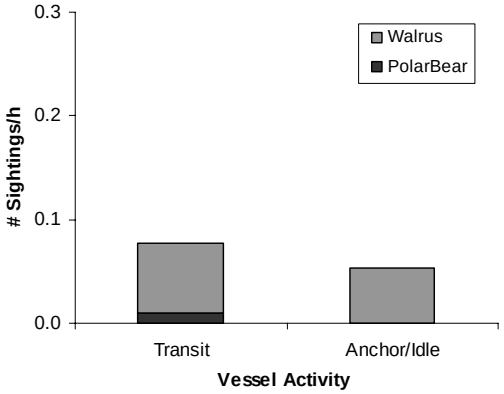

FIGURE 5.9 POLAR BEAR AND WALRUS SIGHTING RATE (IN NUMBER OF SIGHTINGS PER HOUR) BY VESSEL ACTIVITY DURING MMO OBSERVATIONS FROM THE *ARCTIC WOLF* OVER THE PERIOD 26 JUNE TO 20 JULY. TRANSIT IS DEFINED AS TRAVELING WITH SPEEDS ≥2 KTS (3.7 KM/H) AND ON ANCHOR/IDLE IS DEFINED BY SPEEDS <2 KTS (3.7 KM/H).

5.3 Results Seismic Survey

Observer effort

The seismic survey started 15 July with the lay-out of the first cable patch, and seismic data acquisition started 24 July. In the period between 15 and 24 July, both the *Peregrine* and *Miss Diane* were engaged in sound source verification (SSV) measurements and conducted seismic tests on the first patch to optimize data acquisition methods. Seismic activity ended in the early morning on 25 August in accordance with the CAA. During the 41-day seismic survey, the airguns on the *Peregrine* were operating for a total of 383.9 hours, with 352.7 hours (92%) during daylight and 31.5 hours (8%) during darkness. Airguns on the *Miss Diane* were active for a total of 260.2 hours, with 244.3 hours (94%) during daylight and 15.9 hours (6%) during darkness. There was no darkness, i.e. sighting conditions that limited reliable detection of marine mammals in the 180 dB safety zone, during the first 4 weeks of the survey, roughly from 15 July to 10 August. After mid August, periods of darkness increased to ~5 hours on 24 August, the last full day of seismic data acquisition.

MMOs were on watch during all daylight hours when airguns were operating, and during many hours when the source vessel was not operating its airguns. Observations during darkness were not required, although MMOs were sometimes on watch under conditions that were regarded as dark (Figure 5.10, Figure 5.11). The MMOs on the *Miss Diane* were almost always on watch when airguns were operating in darkness (81% of the time), mainly because they were not housed on the seismic vessel and there was limited space available besides their MMO observation post on the bridge. The MMOs on the *Peregrine* covered 25% of darkness when airguns were active.

The ability to detect marine mammals depends largely on the environmental conditions, such as wind force and visibility. Beaufort (Bf) wind force during observations conducted from both seismic source vessels over the 41-day survey period ranged from 0 to 8. About 76% of the total observer effort on the *Peregrine* and 91% on the *Miss Diane* took place during conditions of Bf wind force 1 to 3, which corresponds to wind speeds between 2 to 19 km/h or 1 to 10 kts (Appendix F). Figure 5.12 shows the occurrence of Bf wind force conditions separated for each source vessel during seismic, post-seismic and non-seismic activities. Sighting conditions during seismic operations were similar to the overall trend, with 79% of observations conducted during Bf wind force 1 to 3 on the *Peregrine* and 87% on the *Miss Diane*. Airgun operations on both

source vessels were difficult with Bf wind force greater than 4 and most of the time, when weather conditions were not expected to improve, airguns were retrieved. This was especially the case for the smaller source vessel, the *Miss Diane* (Figure 5.13).

Marine mammal observations during seismic activities on the *Peregrine* were mostly, i.e. 85% of all observations, conducted under visibility conditions of more than 3.5 km (2.2 mi), and this was even higher for the *Miss Diane* at 96% (Figure 5.14). Visibility conditions less than 1 km (0.6 mi), which result in less effective monitoring of the 180 dB safety radii (550 m for the 440 in^3 array of the *Peregrine* and 300 m for the *Miss Diane*), only occurred 33 h (9%) and 4 h (2%) of the total observer effort with airguns operating for *Peregrine* and *Miss Diane*, respectively. Wind force conditions of Bf >4 combined with a visibility of <1 km (0.6 mi) during marine mammal observations when airguns were shooting occurred for a total of 14.4 h (1%) on the *Peregrine* and 2.2 h (0.1%) on the *Miss Diane*. The lower number for the *Miss Diane* is due to the fact that airguns were almost always retrieved when winds were picking up to a level of Bf 4 (>20.4 km/h or 11 kts).

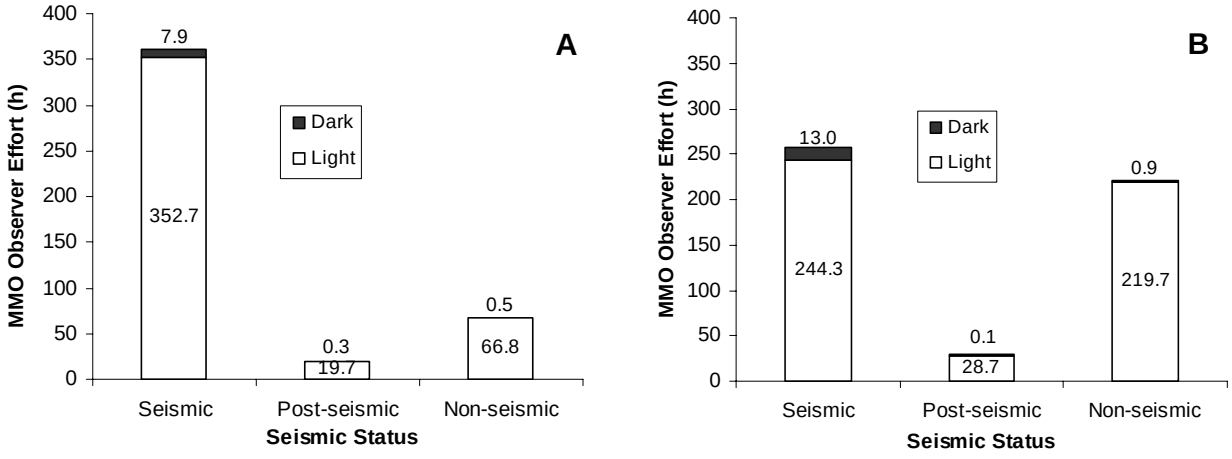

FIGURE 5.10 TOTAL MARINE MAMMAL OBSERVER EFFORT (H) FOR THE *PEREGRINE* (A) AND THE *MISS DIANE* (B) IN DAYLIGHT AND DARKNESS, DURING SEISMIC, POST-SEISMIC AND NON-SEISMIC ACTIVITY OVER THE PERIOD 15 JULY TO 25 AUGUST.

FIGURE 5.11 EXAMPLE OF DARKNESS VISIBILITY CONDITIONS.

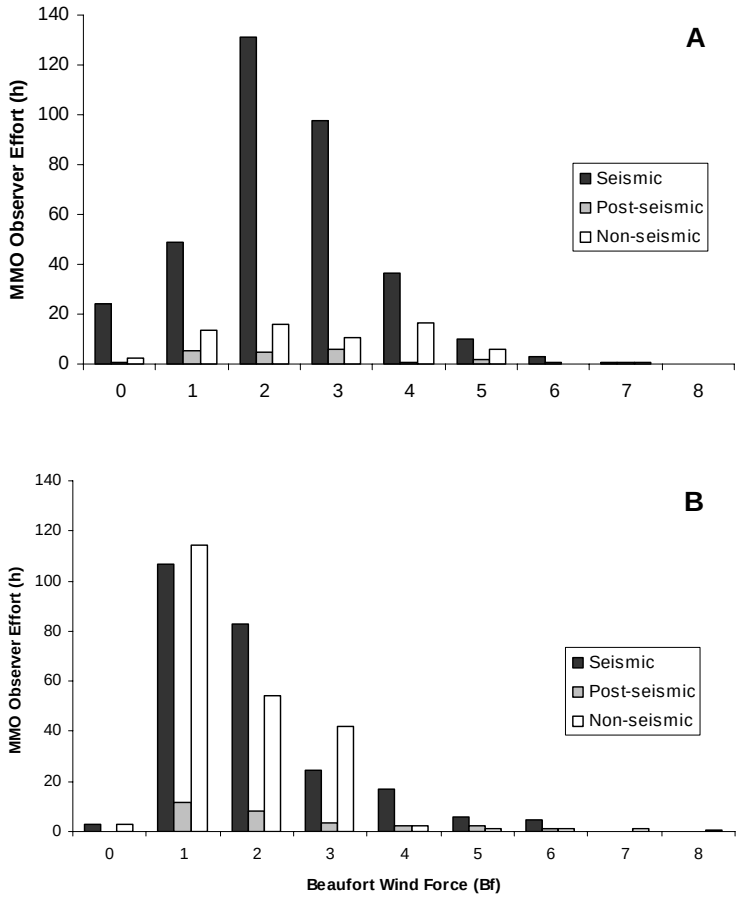

FIGURE 5.12 TOTAL DAYLIGHT MARINE MAMMAL OBSERVER EFFORT (H) FROM THE *PEREGRINE* (A) AND *MISS DIANE* (B) BY BEAUFORT WIND FORCE AND SEISMIC ACTIVITY.

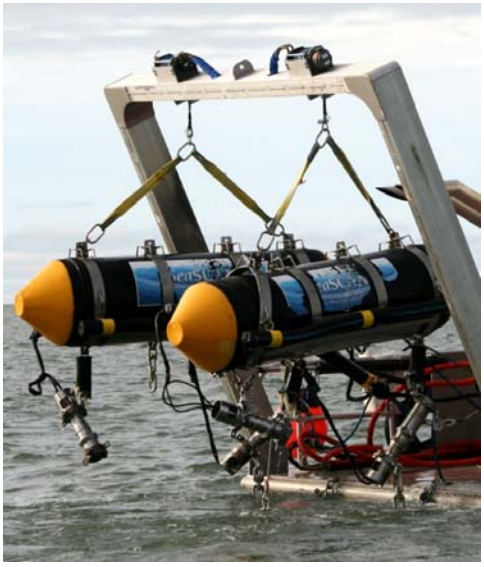

FIGURE 5.13 RETRIEVAL OF AIRGUNS FROM *MISS DIANE*.

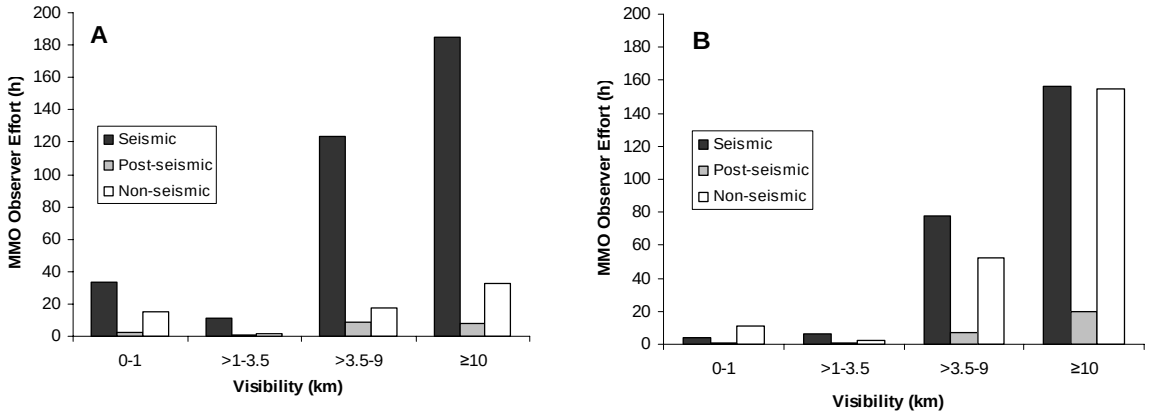

FIGURE 5.14 TOTAL DAYLIGHT MARINE MAMMAL OBSERVER EFFORT (H) FROM THE *PEREGRINE* (A) AND *MISS DIANE* (B) BY VISIBILITY CONDITIONS AND SEISMIC ACTIVITY.

Cetaceans and Pinnipeds

Total numbers observed. An estimated 16 cetaceans and 13 pinnipeds were seen in 4 and 13 sightings, respectively, within the seismic survey area during the period 15 July to 25 August from the two seismic source vessels (Table 5.4). One cetacean sighting from the *Miss Diane* consisted of eight individuals of two different species: bowhead and gray whale. It was documented as one sighting with an unknown number of individuals for each species. MMOs documented one additional cetacean and five pinniped sightings totaling two and five individuals, respectively, during periods while not officially on watch (off-watch). Figure 5.15 shows the distribution of all cetacean and pinniped sightings.

TABLE 5.4 NUMBER OF SIGHTINGS (NUMBER OF INDIVIDUALS) OF CETACEANS AND PINNIPEDS (EXCLUDING DEAD SEALS) OBSERVED FROM THE *PEREGRINE* AND *MISS DIANE* DURING THE SEISMIC SURVEY (15 JULY TO 25 AUGUST). THE OFF-WATCH SIGHTINGS ARE PRESENTED SEPARATELY FROM THOSE CONDUCTED DURING DAYLIGHT MMO WATCH PERIODS.

Species	ON-WATCH			OFF-WATCH		
	Peregrine	***Miss Diane***	**Total**	***Peregrine***	***Miss Diane***	**Total**
Cetaceans						
Beluga whale	1 (1)	2 (7)	*3 (8)*	1 (2)	0	*1 (2)*
Bowhead/Gray whale	0	1 (8)	*1 (8)*	0	0	*0 (0)*
Total Cetaceans	*1 (1)*	*3 (15)*	*4 (16)*	*1 (2)*	*0*	*1 (2)*
Pinnipeds						
Ringed seal	0	8 (8)	*8 (8)*	0	1 (1)	*1 (1)*
Spotted seal	0	1 (1)	*1 (1)*	0	1 (1)	*1 (1)*
Bearded seal	0	0	*0 (0)*	1 (1)	0	*1 (1)*
Unidentified seal	3 (3)	1 (1)	*4 (4)*	2 (2)	0	*2 (2)*
Total Pinnipeds	*3 (3)*	*10 (10)*	*13 (13)*	*3 (3)*	*2 (2)*	*5 (5)*
Grand Total	***4 (4)***	***13 (25)***	***17 (29)***	***4 (5)***	***2(2)***	***6 (7)***

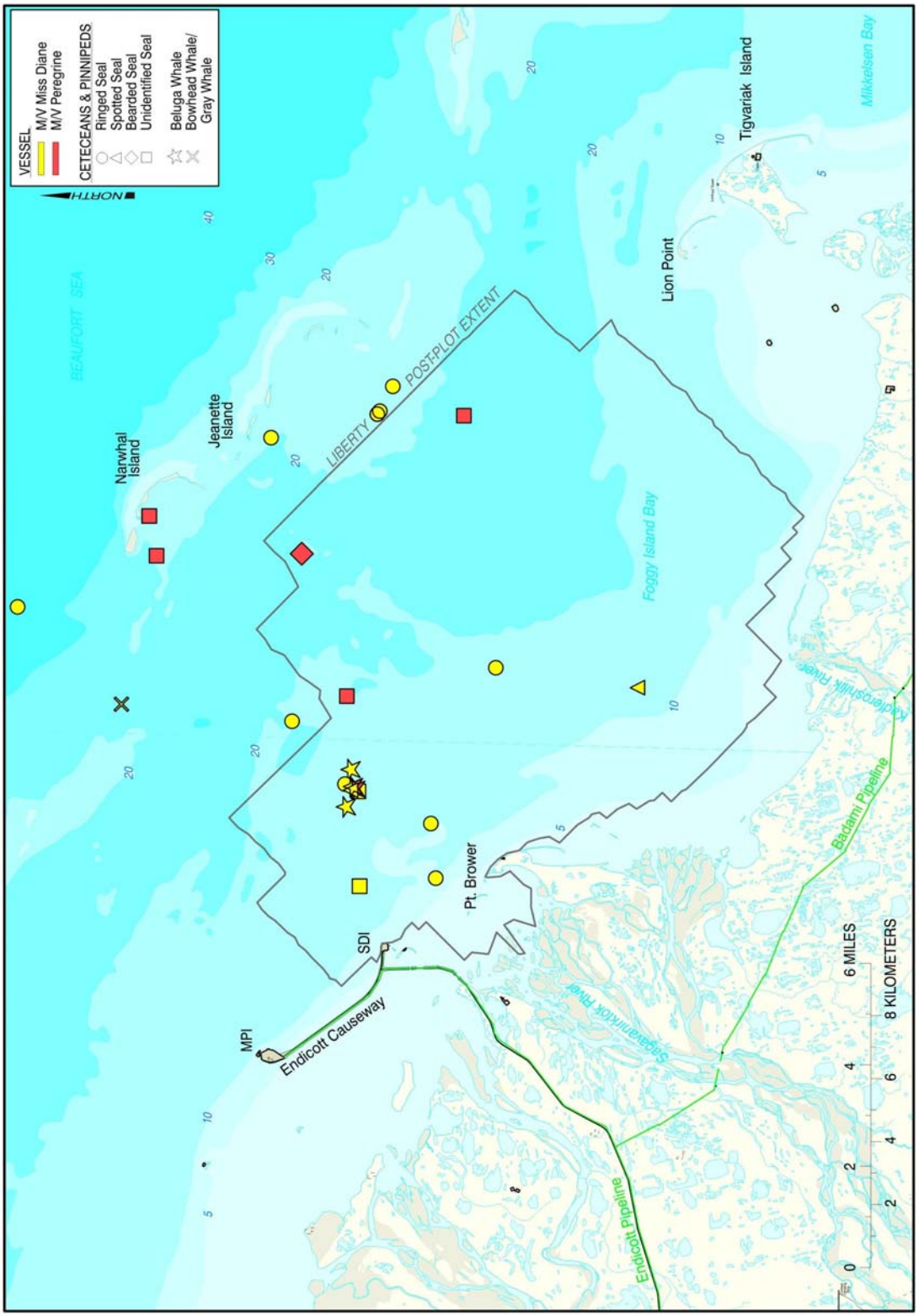

FIGURE 5.15 DISTRIBUTION OF CETACEANS AND PINNIPEDS SIGHTED FROM THE *PEREGRINE* AND *MISS DIANE* DURING THE SEISMIC SURVEY FROM 15 JULY TO 25 AUGUST, INCLUDING SIGHTINGS MADE DURING OFF-WATCH PERIODS. THE POST-SURVEY SEISMIC SURVEY AREA IS INCLUDED FOR REFERENCE.

Sightings during seismic activity. Figure 5.16 shows the number of sightings made with and without operating airguns. The MMOs on the *Peregrine* observed a total of three pinniped sightings of one individual each when airguns were operating. One cetacean sighting (beluga whale) was made during periods without seismic activity. From the *Miss Diane* a total of three cetacean sightings of 15 individuals and 10 pinniped sightings of 10 individuals were observed during periods when no airguns were operating.

Sighting rates, which is the number of daylight MMO watch sightings per unit of effort, are shown in Figure 5.17 and summarized in Table 5.5. The sighting rate was calculated by dividing the total number of the combined cetacean and pinniped sightings on each vessel with the observer effort for the three activities. Re-sights of the same animal were not counted.

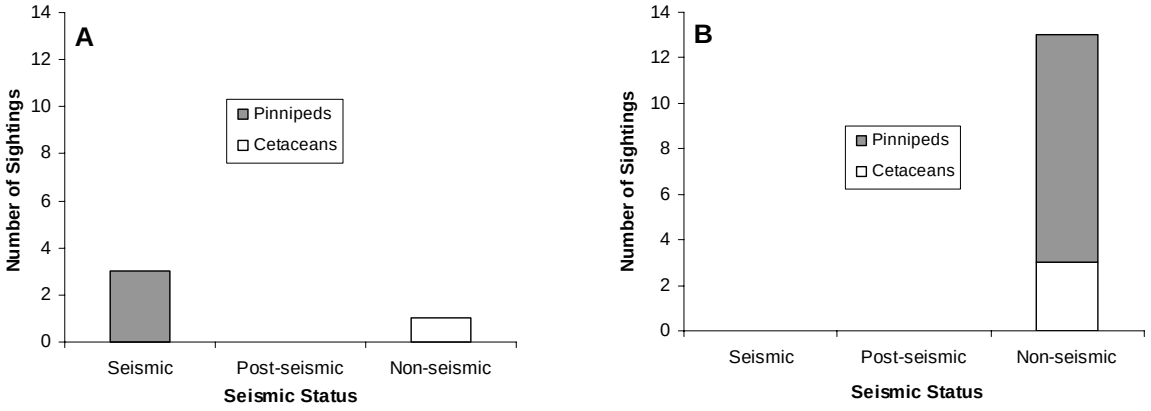

FIGURE 5.16 NUMBER OF MARINE MAMMAL SIGHTINGS DURING DAYLIGHT MMO OBSERVATIONS BY SEISMIC STATE FOR THE *PEREGRINE* (A) AND THE *MISS DIANE* (B). RAMP-UP AND POWER-DOWN EFFORTS ARE INCLUDED IN THE SEISMIC CATEGORY.

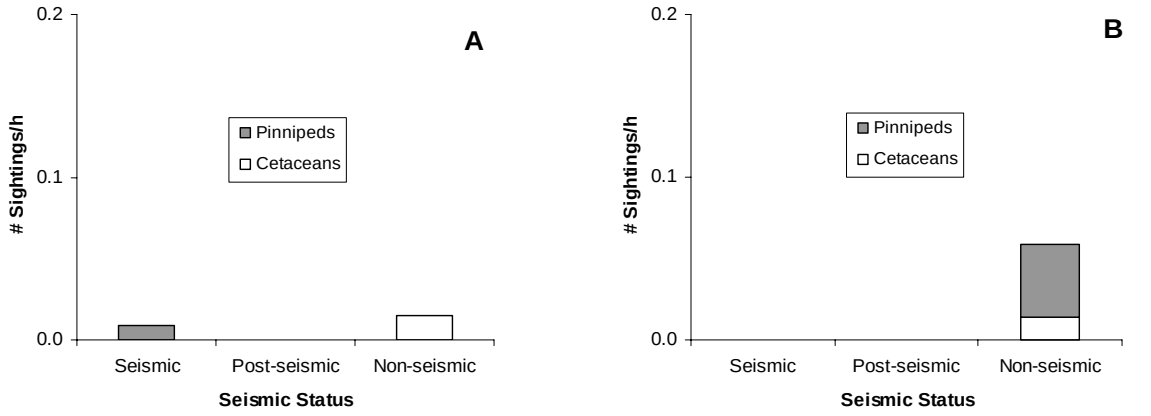

FIGURE 5.17 MARINE MAMMAL SIGHTING RATE (IN NUMBER OF SIGHTINGS PER HOUR) DURING DAYLIGHT MMO OBSERVATIONS BY SEISMIC STATE FOR THE *PEREGRINE* (A) AND THE *MISS DIANE* (B). RAMP-UP AND POWER-DOWN EFFORTS ARE INCLUDED IN THE SEISMIC CATEGORY.

TABLE 5.5 SIGHTING RATES FOR MARINE MAMMAL SIGHTINGS DURING DIFFERENT SEISMIC STATES FROM DAYLIGHT MMO WATCH EFFORT FROM THE *PEREGRINE* AND THE *MISS DIANE*. RAMP-UP AND POWER-DOWN EFFORTS ARE INCLUDED IN THE SEISMIC CATEGORY.

Seismic state	Observation Effort (h)	CETACEANS		PINNIPEDS	
		# of Sightings	Sighting rate (#/h)	# of Sightings	Sighting rate (#/h)
Peregrine					
Seismic	352.4	0	0	3	0.009
Post-seismic	19.9	0	0	0	0
Non-seismic	66.8	1	0.015	0	0
Miss Diane					
Seismic	244.3	0	0	0	0
Post-seismic	28.7	0	0	0	
Non-seismic	219.7	3	0.014	10	0.046

Because the sighting rate takes the observer effort into account, it is possible to make a comparison between both source vessels. Unfortunately, the total number of sightings is too low to really define a pattern. In general, the cetacean sighting rate for both the *Peregrine* and *Miss Diane* during non-seismic activities was similar. The MMOs from the *Peregrine* observed more pinnipeds during seismic activities than during non-seismic activities and this was the opposite for the *Miss Diane.* As was expected, the sighting rate increased with increasing visibility. The two sightings conducted when the visibility was less than 1 km (0.6 mi) were both beluga whales at 100 m and 150 m from the vessel. There was no clear pattern apparent between Bf wind force and sighting rate (Table 5.6). The same beluga sightings mentioned above occurred with wind forces of Bf 4 and 7. The other sighting in the category Bf ≥4 was a ringed seal at 4 m from the vessel.

TABLE 5.6 SIGHTING RATES FOR COMBINED CETACEAN AND PINNIPED SIGHTINGS DURING DIFFERENT VISIBILITY AND BF WIND FORCE CONDITIONS FROM THE TOTAL DAYLIGHT MMO WATCH EFFORT FROM THE *PEREGRINE* AND THE *MISS DIANE* COMBINED.

Environmental conditions	Observation Effort (h)	# of Sightings	Sighting rate (#/h)
Visibility			
<1 km	16	2	0.129
1-3.5	9	0	0
>3.5 – 9	138	2	0.015
≥10	331	13	0.039
Bf wind force			
0	6	1	0.172
1-3	448	13	0.029
≥4	39	3	0.077

Due to the position of the MMO station on the bridge of the *Peregrine* and *Miss Diane*, most marine mammal sightings were made within ~200° of the bow. All pinniped sightings from the *Peregrine* were within 120 to 500 m (394 to 1640 ft) distance from the vessel. The distances of the two cetacean sightings from the *Peregrine*, both beluga whales, were 900 m (2953 ft) and 100 m (328 ft). Distances to pinniped sightings from the *Miss Diane* ranged from 1 to 500 m (3.3 to 1640 ft) and there was one pinniped sighting at 885 m (2904 ft). Beluga whales were sighted at 150 m and 206 m (492 and 676 ft) and the cetacean sighting consisting of both bowhead and gray whales was at 3 km (1.9 mi) from the vessel. Due to the limited number of sightings with and without seismic activity, an analysis of behavioral reactions in relation to airgun sounds was not reasonable.

Polar Bear and Walrus

Table 5.7 shows the number of polar bear sightings made during the seismic survey period (15 July through 25 August) by the MMOs on the seismic source vessels during daylight MMO watch. Sightings made by both source vessels during off-watch periods and by the other vessels in the survey area are summarized as well. All polar bears sighted by crew on the other vessels were reported to the lead MMO on the *Peregrine* to avoid duplicate reporting. Most polar bear sightings were made when no seismic data acquisition was taking place and vessels were hiding from bad weather close to the barrier islands or behind Endicott Satellite Drilling Island (SDI) (see also Figure 5.18). The bears observed on land were either walking or resting on the beach. Sometimes bears would enter the water, swim around, and come ashore again. Or vice-versa, they were observed swimming in the water and seen exiting the water to come ashore. There was one polar bear sighted during the MMO watch period on the *Miss Diane* when seismic airguns were operating. This bear was swimming at 1.1 km (0.7 mi) distance, far outside the 190 dB safety radius for the 440 in^3 airgun array (150 m or 492 ft).

TABLE 5.7 NUMBER OF SIGHTINGS (NUMBER OF INDIVIDUALS) OF POLAR BEARS OBSERVED FROM THE *PEREGRINE* AND *MISS DIANE* DURING MMO DAYLIGHT WATCH PERIODS AND OFF-WATCH SIGHTINGS FROM BOTH SEISMIC SOURCE VESSELS AND OTHER VESSELS INVOLVED IN THE SEISMIC SURVEY. THERE WERE NO WALRUS SIGHTINGS.

Species	ON-WATCH			OFF-WATCH			
	Peregrine	***Miss Diane***	**Total**	***Peregrine***	***Miss Diane***	**Other**	**Total**
Polar bears							
In Water	0	1 (1)	*1 (1)*	0	0	4 (4)	*4 (4)*
On Ice/Land	0	0	*0*	1 (2)	1 (1)	3 (3)	*5 (6)*
Total Polar Bears	***0 (0)***	***1 (1)***	***1 (1)***	***1 (2)***	***1 (1)***	***7 (7)***	***9 (10)***

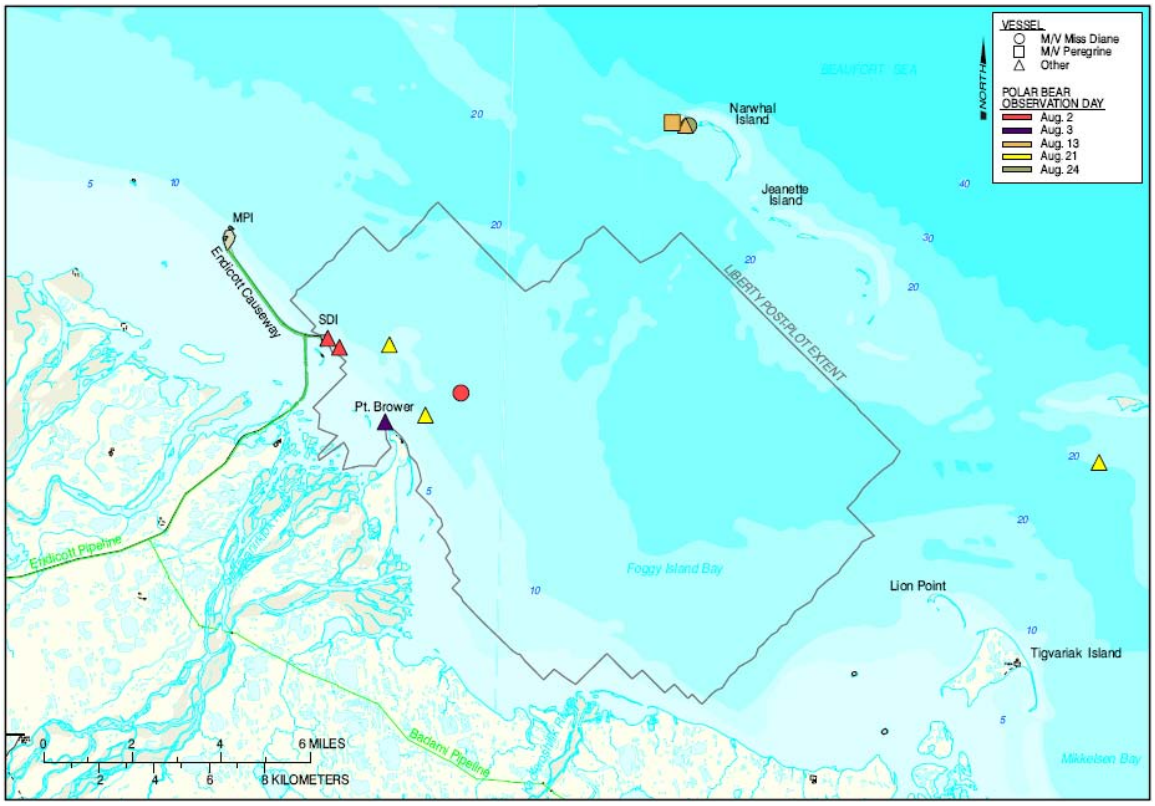

FIGURE 5.18 POLAR BEARS SIGHTED FROM THE *PEREGRINE*, *MISS DIANE* (BOTH ON-WATCH AND OFF-WATCH SIGHTINGS) AND OTHER VESSELS DURING THE SEISMIC SURVEY OVER THE PERIOD 15 JULY TO 25 AUGUST. THE POST-SURVEY SEISMIC SURVEY AREA IS INCLUDED FOR REFERENCE.

5.4 Mitigation Measures Implemented

During the Liberty seismic survey a total of three shut-downs and one power-down were implemented for marine mammals, as summarized below.

- Two shut-downs were implemented for carcasses observed while airguns were operating, on 24 and 28 July. NMFS was immediately notified on both occasions. Approval from NMFS to restart the operation was only required on 24 July. Due to an IHA amendment effective as of 28 July, ramp-up of operations was allowed if, after examination of the carcass by the MMO, it could be confirmed that the cause of death was something other than the seismic operation. All carcasses examined showed gunshot wounds which were the likely cause of death (Figure 5.19).

FIGURE 5.19 DEAD RINGED SEAL CARCASS, OBSERVED DURING THE SEISMIC SURVEY.

- One power down and one shut-down were implemented by the *Peregrine* due to ringed seal sightings, both times one individual, within the 190 dB safety zone. The power-down safety radius for pinnipeds on the *Peregrine* for the 440 in^3 airgun array was 250 m (820 ft) and the shut-down radius, for the mitigation source, was 100 m (328 ft). On 17 July, one seal was observed at about 250 m (820 ft) distance from the source vessel, hence on the edge of the 190 dB safety radius of the 440 in^3 airgun array. The airguns were powered down to 220 in^3. Operations restarted 15 minutes later when the seal was not observed anymore. On 24 July, a seal was observed at ~400 m (1312 ft) and re-sighted at ~125 m (410 ft), close to the 190 dB radius for the 70 in^3 mitigation source (100 m or 328 ft). A shut-down was implemented immediately, and operations restarted when 6 minutes later the seal was observed again at ~300 m (984 ft) distance from the vessel
- No power-down or shut-down was implemented for cetaceans, Pacific walrus, or polar bears during the seismic survey.

5.5 Estimated Numbers of Exposures

It is required under the IHA to provide estimates of the amount and nature of potential harassment of marine mammals. Meaningful estimates of the number of marine mammals potentially exposed to seismic sounds are difficult to obtain for several reasons: (*i*) The relationship between numbers of marine mammals that are observed and the number actually present is uncertain; (*ii*) The distance to which a received sound level exceeds a specific criterion such as 190 dB and 180 dB re 1 µPa (rms) is variable, especially in the shallow water environment in which the Liberty seismic survey took place (Chapter 3; see also Greene 1998, Greene et al. 1998; Burgess and Greene 1999; Caldwell and Dragoset 2000; Tolstoy et al. 2004a,b); (*iii*) The sounds received by marine mammals vary depending on their depth in the water, and will be considerably reduced for animals near the surface (Greene and Richardson 1988; Tolstoy et al. 2004a,b); and (*iv)* The most appropriate criteria for harassment from exposure to sounds are uncertain and presumed to vary among different species and situations. In addition to these reasons, there were relatively few marine mammal sightings during the Liberty seismic survey, which further complicates the provision of meaningful estimates.

The method applied to estimate the number of marine mammals exposed to seismic sound levels strong enough that they might have caused a disturbance or other potential impacts is explained in Section 5.1. It includes (*i*) minimum estimates based on the direct observations of marine mammals by MMOs, and (*ii*) estimates based on pinniped and cetacean sighting rates obtained during this survey. The actual number of individuals exposed to, and potentially impacted by, strong seismic survey sounds likely was between the minimum and maximum estimates provided in the following sections and summarized in Table 5.8.

Minimum estimate

The actual number of marine mammals observed within the applicable safety radii of the *Peregrine* and *Miss Diane* during seismic operations provides a minimum estimate of the number potentially affected by seismic sounds. This is likely an underestimate of the actual number potentially affected because it is unlikely that MMOs were able to detect all marine mammals near the vessel. During daylight, animals are missed if they are below the surface when the ship is nearby. Some other mammals, even if they surface near the vessel, are missed because of limited visibility (e.g. fog), glare, or other factors limiting sightability. Furthermore, marine mammal

observations were not required during darkness, which occurred for increasing numbers of hours per day after 12 August.

Cetacean exposures — There were no sightings (zero individuals) of cetaceans observed by MMOs on both source vessels while the airguns were operating. The minimum number of cetacean exposures to≥160 dB is therefore 0.

Pinniped exposures — There were three seal sightings (two individuals) sighted by *Peregrine* MMOs while airguns were firing and no seal sightings (zero individuals) by the *Miss Diane* MMOs while airguns were firing.

Maximum estimate

Cetacean exposures — The sighting rate for cetaceans during daylight seismic operations is zero. The highest daylight sighting rate for the period that the airguns were turned off for one hour or more, i.e. 0.015 sightings/h, was used to calculate the potential number of animals that could have been present during the daylight and nighttime period when airguns were operating. The maximum number of potential cetacean exposures to ≥160 dB, which is the number of sightings one might have expected in the absence of airguns, was calculated as follows:

- Total daylight seismic effort = 352.7 h (*Peregrine*) + 244.3 h (*Miss Diane*) = 597 h.
- Total nighttime seismic effort = 31.5 h (*Peregrine*) + 15.9 h (*Miss Diane*) = 47.4 h.
- Maximum number of potential exposures = (597 h+ 47.7 h) x 0.015 sightings per hour = 9.7 (rounded to 10)

Pinniped exposures — The pinniped sighting rate during periods when airguns were operating was 0.009 sightings/h and 0.046 sightings/h for periods one hour or more after airguns were turned off (non-seismic). Under the assumption that the non-seismic pinniped sighting rate is representative for seismic daylight and night time hours, the maximum number of potential pinniped exposures to ≥160 dB, which is the number of sightings one might have expected in the absence of airguns, was calculated as follows:

- Total daylight seismic effort = 352.7 h (*Peregrine*) + 244.3 h (*Miss Diane*) = 597 h.
- Total nighttime seismic effort = 31.5 h (*Peregrine*) + 15.9 h (*Miss Diane*) = 47.4 h.
- Maximum number of potential exposures = (597 h+ 47.7 h) x 0.046 sightings per hour = 29.7 (rounded to 30).

TABLE 5.8 SUMMARY OF MINIMUM AND ESTIMATED MAXIMUM NUMBER OF POTENTIAL MARINE MAMMAL EXPOSURES TO AIRGUN SOUNDS OF ≥160 DB FROM THE *PEREGRINE* AND *MISS DIANE* DURING THE LIBERTY SEISMIC SURVEY. THE ESTIMATED NUMBER OF PINNIPED AND CETACEAN EXPOSURES AS PER THE IHA ARE PROVIDED FOR COMPARISON.

Species	Potential Calculated Exposures to≥160 dB		Estimated Exposures to≥160 dB as per IHA
	Minimum	Maximum	
Cetaceans	0	10	28
Pinnipeds	3	30	250
Total	***3***	***40***	***278***

In summary, the maximum number of cetaceans and pinnipeds potentially exposed to ≥160 dB based on actual sightings was 36% and 11% of the estimated numbers, respectively, based on available literature and associated assumptions (see IHA application, BPXA 2007).

5.6 Communication Centers

This section provides brief summaries of the communications with the subsistence hunters through the communication centers. These communications took place from the *Arctic Wolf* while in transit through the Chukchi and Beaufort Sea and from the seismic source vessels during the seismic survey in Foggy Island Bay. There is no indication that the above mentioned activities resulted in an impact to the subsistence resources of the local communities.

Arctic Wolf Transit, 26 June to 20 July 2008

Two Inupiat speaking MMOs were aboard the *Arctic Wolf* primarily to communicate with the subsistence villages during the transit through the Chukchi Sea. The intention was to call the appropriate communication centers (com. centers) when the vessel approached subsistence villages to ensure that the hunters were aware of the vessel's position and planned destination or activities. Communications began 30 June at 1010 hours to the Barrow com. center providing information of the vessel's position as they approached the village of Nome. Calls were made frequently when underway, but typically suspended during times at anchor while waiting for weather or ice conditions to improve. The Wainwright and Barrow com. centers often provided weather and sea-ice information to the *Arctic Wolf* that was very useful for planning the vessel's route. The final call was made at 1420 hours on 20 July to inform the Barrow com. center that the *Arctic Wolf* had arrived at its destination in Prudhoe Bay. A summary of the calls to the com. centers made by the MMOs from the *Arctic Wolf* is presented in Appendix G.

Liberty Seismic Survey, 15 July to 25 August 2008

The Liberty seismic survey started prior to the fall bowhead whale migration and the corresponding subsistence hunt by the village of Nuiqsut. Calls to the Deadhorse com. center were required to begin on 15 August and to continue through the end of the seismic survey on 25 August. At all times, at least one Inupiat speaking MMO was on board each source vessel. Calls were made every 6 hours, primarily by the Inupiaq MMOs aboard the *Miss Diane*, and occasionally from the *Peregrine* or the *Arctic Wolf*, where some MMOs were accommodated. Each call to the com. center provided the position (latitude and longitude) of each of the source vessels and a brief description of planned activities. The first call was made at 0000 hours on 15 August and the last call was made at 0000 hours on 25 August. The seismic data acquisition was completed approximately 3 hours later.

In addition to the calls by the MMOs, the seismic survey simultaneous operations (SIMOPS) manager provided information on a daily basis to the com. center project manager from ASRC for inclusion in the North Slope Com Center Daily Reports. These contained one report for vessel traffic and one report with all com. center location activities summarized for each reporting date.

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APPENDIX A: NMFS INCIDENTAL HARASSMENT AUTHORIZATION

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUL 0 8 2008

Dr. Bill Streever
Environmental Studies Leader
BP Exploration (Alaska), Inc.
P.O. Box 196612
Anchorage, Alaska 99519-6612

Dear Dr. Streever:

Enclosed is an Incidental Harassment Authorization (IHA) issued to BP Exploration (Alaska), Inc. (BPXA), pursuant to Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.), to take, by Level B harassment only, marine mammals incidental to conducting seismic surveys. BPXA is required to comply with the conditions contained in the IHA. In addition, BPXA must cooperate with any Federal, state, or local agency monitoring the impacts of your activities, and submit a draft report to the National Marine Fisheries Service's (NMFS) Office of Protected Resources, within 90 days after completion of the work authorized herein. Along with other mitigation measures to be incorporated, the IHA requires monitoring for the presence and behavior of marine mammals.

If you have any questions concerning the IHA or its requirements, please contact Candace Nachman or Kenneth Hollingshead, Office of Protected Resources, NMFS, at (301) 713-2289.

Sincerely,

for James H. Lecky, Director
Office of Protected Resources

Enclosure

1

DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL MARINE FISHERIES SERVICE

Incidental Harassment Authorization

BP Exploration (Alaska) Inc. (BPXA), 900 East Benson Boulevard, Anchorage, Alaska, is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107 to take, by Level B harassment only, small numbers of marine mammals incidental to conducting a 3D ocean-bottom cable (OBC) seismic survey program in the Beaufort Sea in Arctic Ocean waters under the jurisdiction of the United States, contingent upon the following conditions:

1. This Authorization is valid from July 8, 2008, through August 25, 2008.

2. This Authorization is valid only for activities (including support vessels and aircraft) associated with the *M/V Peregrine* and *M/V Miss Dianne* OBC seismic surveys in the Liberty Prospect area of the U.S. Beaufort Sea, as specified in BPXA's November, 2007 application.

3. (a). The species authorized for incidental harassment takings are: bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), beluga whales (*Delphinapterus leucas*), ringed seals (*Phoca hispida*), spotted seals (*P. largha*), and bearded seals (*Erignathus barbatus*).

(b). The authorization for taking by harassment is limited to the following acoustic sources without an amendment to this Authorization:

(i) A seismic airgun array with a total discharge volume of 880 in^3 on both source vessels; and

(ii) Sonar Dyne pingers.

(c). The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Alaska Regional Administrator (907-586-7221) or his designee in Anchorage (907-271-3023), National Marine Fisheries Service (NMFS) and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources, NMFS, at (301) 713-2289, ext 110, or his designee.

4. The holder of this Authorization is required to cooperate with NMFS and any other Federal, state or local agency with authority to monitor the impacts of the activity on marine animals. The holder must notify the Chief of the Permits, Conservation and Education Division, Office of Protected Resources at least 48 hours prior to the start of

collecting seismic data (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible) and whenever not conducting seismic for more than 48 hours.

5. Prohibitions

(a). The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above. The taking by serious injury or death of these species or the taking by behavioral harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

(b). The taking of any marine mammal is prohibited whenever the required seismic vessel marine mammal observer (MMO), required by condition 7(a)(i), is not onboard in conformance with condition 7(a)(i) or the dedicated vessel monitoring program has not been fully implemented as required by this Authorization; the Holder shall be found to be in non-compliance with this Authorization, which may result in the modification, suspension, or revocation of this Authorization.

(c) The taking of any marine mammals by seismic sounds when the seismic vessel is within 15 miles of another operating seismic vessel is prohibited.

6. Mitigation.

(a). General Mitigation: The holder of this Authorization is required to:

(i). (A). Avoid concentrations or groups of whales by all vessels and aircraft under the direction of BPXA. Operators of support vessels and aircraft should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas; and (B). When weather conditions do not allow a 1,000-ft flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-ft altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.

(ii). Take every precaution to avoid harassment of whale concentrations when a vessel is operated near these animals. Vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.

(iii). Avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

(iv). Not operate support vessels (including small boats) at a speed that would make collisions with whales likely.

(v). When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.

(vi). Operate in full compliance with the Conflict Avoidance Agreement signed on May 30, 2008.

(vii). Cease all seismic data acquisition after August 25, 2008.

(b). Seismic Vessel Mitigation: The holder of this Authorization is required to:

(i). Reduce the volume of the airgun array during vessel turns while running seismic lines to one airgun or a reduced number of airguns.

(ii). Whenever a marine mammal is detected outside the exclusion zone radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, calculate and implement an alternative ship speed or track.

(iii). Exclusion and Monitoring-Safety Zones:

(A) Establish and monitor with trained observers a preliminary exclusion zone for cetaceans surrounding the seismic airgun array on the *M/V Peregrine* and *M/V Miss Dianne* where the received level would be 180 dB re 1 μPa rms. For purposes of the field verification test, described in condition 7(b), this radius is estimated to be 0.55 mi (880 m) from the seismic source.

(B) Establish and monitor with trained observers a preliminary exclusion zone for pinnipeds surrounding the seismic airgun array on the *M/V Peregrine* and *M/V Miss Dianne* where the received level would be 190 dB re 1 μPa rms. For purposes of the field verification test described in condition 7(b), this radius is estimated to be 0.24 mi (390 m) from the seismic source.

(C) Immediately upon completion of data analysis of the field verification measurements required under condition 7(b) below, establish and monitor the new 180-dB and 190-dB marine mammal exclusion zones.

(iv). Power-down/Shut-down:

(A) Immediately power-down the seismic airgun array and/or other acoustic sources, whenever any cetaceans are sighted approaching close to or within the area delineated by the 180 dB (re 1 μPa_{rms}), or pinnipeds are sighted approaching close to or within the area delineated by the 190 dB re 1 μPa rms isopleth as established under condition 6(b)(iii) for the authorized seismic airgun array. If the power-down operation cannot reduce the received sound pressure level at the cetacean or pinniped to 180 dB or 190 dB, whichever is appropriate, the Holder of this Authorization must immediately shut-down the seismic airgun array and/or other acoustic sources.

(B) Not proceed with powering up the seismic airgun array unless the marine mammal exclusion zones described in condition 6(b)(iii)(A) and (B) are visible and no marine mammals are detected within the appropriate safety zones; or until 15 minutes (for small odontocetes, pinnipeds) or a minimum of 30 minutes (for mysticetes) after there has been no further visual detection of the animal(s) within the safety zone and the trained MMO on duty is confident that no marine mammals remain within the appropriate safety zone.

(C) Conduct an emergency shut-down if observations are made or credible reports are received that one or more marine mammals are within the area of this activity in an injured or mortal state or are indicating acute distress; the seismic airgun array shall be immediately shut down and the Chief of the Permits, Conservation and Education Division, Office of Protected Resources or a staff member contacted. The airgun array shall not be restarted until review and approval has been given by the Director, Office of Protected Resources or his designee.

(v). Ramp-up:

(A) Conduct a 30-minute period of marine mammal observations by at least one trained MMO prior to commencing ramp-up described in condition 6(b)(v)(C) (1) at the commencement of seismic operations and (2) at any time electrical power to the airgun array has been discontinued for a period of 10 minutes or more and the MMO watch has been suspended;

(B) Not commence ramp-up if the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime and not commence ramp-up unless the seismic source has maintained a sound pressure level at the source of at least 180 dB re 1 μPa rms during the interruption of seismic survey operations.

(C) Ramp-up the airgun arrays at no greater than 6 dB per 5-minute period starting with the smallest airgun in the array and then adding additional guns in sequence until the full array is firing, if no marine mammals are observed while undertaking conditions 6(v)(A) and (B): (1) At the commencement of seismic operations, and (2), anytime after the airgun array has been powered down for more than 10 minutes;

7. Monitoring.

(a). Vessel Monitoring:

(i). The holder of this Authorization must designate biologically-trained, on-site individuals to be onboard the *M/V Peregrine* and *M/V Miss Dianne* approved in advance by NMFS (one may be an Inupiat), to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals.

(ii). To the extent possible, MMOs should be on duty for 4 consecutive hours or less, although more than one 4-hour shift per day is acceptable.

(iii). Monitoring is to be conducted by the MMOs described in condition 7(a)(i) above, onboard each active seismic vessel, to (A) ensure that no marine mammals enter the appropriate safety zone whenever the seismic array is on, and (B) to record marine mammal activity as described in condition 7(a)(vi) below, at least two observers must be on watch during ramp ups and the 30 minutes prior to full ramp ups, and for as large a fraction of the other operating hours as possible. At all other times, at least one observer must be on active watch whenever the seismic airgun array is operating during all daytime airgun operations, during any nighttime power-ups of the airguns and at night, whenever daytime monitoring resulted in one or more power-down situations due to marine mammal presence.

(iv). At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the biological observer on-watch. If a marine mammal is within, or closely approaching, its designated safety zone, the airgun array must be immediately powered down or shutdown (in accordance with condition 6(b)(iv)(A) above).

(v). Observations by the MMOs described in condition 7(a)(i) above on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(vi). Monitoring will consist of recording: (a) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc) and; (b) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (1) any time a marine mammal is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable); and, (c) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

(vii). All MMOs must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.

(b). Field Source Verification. The holder of this Authorization is required to measure and report within 72 hours of completing the test the empirical distances from the airgun array to broadband received levels of 190, 180, 170, and 160 dB (rms) re 1 μPa, and the radiated sounds vs. distance from the primary seismic vessels supporting the survey.

8. Reporting.

(a). Field Source Verification and the distances to the various radii are to be reported to NMFS within 72 hours of completing the measurements.

(b). Seismic Vessel Monitoring Program: A draft report will be submitted to NMFS within 90 days after the end of BPXA's seismic survey program in the Beaufort Sea. The report will describe in detail: (i) the operations that were conducted; (ii) the results of the acoustical measurements to verify the safety radii; (iii) the methods, results, and interpretation pertaining to all monitoring tasks; (iv) the results of the 2008 shipboard marine mammal monitoring; (v) a summary of the dates and locations of seismic operations, including summaries of power downs, shut downs, and ramp up delays; (vi) marine mammal sightings (species, numbers, dates, times and locations, age/size/gender, environmental correlates, activities, associated seismic survey activities); (vii) estimates of the amount and nature of potential take (exposure) of marine mammals (by species) by harassment or in other ways to industry sounds; (viii) an analysis of the effects of seismic operations (e.g., on sighting rates, sighting distances, behaviors, movement patterns of marine mammals); (ix) provide an analysis of factors influencing detectability of marine mammals; and (x) provide summaries on communications with hunters and potential effects on subsistence uses.

(c). The draft report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. The draft report will be considered the final report for this activity under this Authorization if NMFS has not provided comments and recommendations within 90 days of receipt of the draft report.

(d). A draft comprehensive report describing the acoustic, vessel-based, and aerial monitoring programs will be prepared and submitted within 240 days of the date of this Authorization (in cooperation with other authorized companies for 2008). The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of all industry activities and their impacts on marine mammals in the Arctic Ocean during 2008.

(e). The draft comprehensive report will be reviewed by participants at the 2009 Open Water Scientific Meeting to be held in Anchorage AK in the spring of 2009. The draft comprehensive report will be accepted by NMFS as the final comprehensive report upon incorporation of recommendations by the workshop participants.

9. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

10. The Plan of Cooperation and the Conflict Avoidance Agreement outlining the steps that will be taken to cooperate and communicate with the native communities to ensure the availability of marine mammals for subsistence uses, must be implemented to the extent one exists.

11. This Authorization may be modified, suspended or withdrawn if the holder fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals, or if there is an unmitigable adverse impact on the availability of such species or stocks for subsistence uses.

12. A copy of this Authorization must be in the possession of each seismic vessel operator taking marine mammals under the authority of this Incidental Harassment Authorization.

13. BPXA is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion.

James H. Lecky
Director, Office of Protected Resources
National Marine Fisheries Service

Date

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

JUL 28 2008

Dr. Bill Streever
Environmental Studies Leader
BP Exploration (Alaska), Inc.
P.O. Box 196612
Anchorage, Alaska 99519-6612

Dear Dr. Streever:

On July 18, 2008, BP Exploration (Alaska), Inc. (BPXA) requested a modification to the Incidental Harassment Authorization issued on July 8, 2008, under the authority of Section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1361 *et seq.*), for the taking, by harassment, of marine mammals during a seismic survey in the Beaufort Sea, Alaska. BPXA requested that condition 6(b)(iv)(C) be clarified to better explain as to when seismic operations must shut down if an injured or dead marine mammal is sighted in the operational area.

The National Marine Fisheries Service (NMFS) has reviewed BPXA's request and has determined that the wording in the condition should be altered in order to clarify when a shutdown must occur and the points of contact for when such a situation occurs. Therefore, BPXA's request to clarify condition 6(b)(iv)(C) has been granted.

Accordingly, Condition 6(b)(iv)(C) is amended to read as follows. The change has been highlighted in bold text:

6. Mitigation

(b). Seismic Vessel Mitigation: The holder of this Authorization is required to:

(iv). Power-down/Shut-down:

(C) In the unanticipated event that an injured or dead marine mammal is sighted within an area where the holder of this Authorization deployed and utilized seismic airguns within the past 24 hours, immediately shutdown the seismic airgun array.

(I) In the event that the marine mammal has been determined to have been deceased for at least 72 hours, as certified by the lead MMO onboard the seismic vessel, and no other marine mammals have been reported injured or dead during that same 72 hour period, the airgun array may be restarted (by conducting the necessary ramp-up procedures described in condition 6(b)(v) below) upon completion of a written certification, including supporting documents (e.g., photographs or other evidence to support the

certification) by the MMO. Within 24 hours after the event specified herein, the holder of this Authorization must notify the designated staff person (see III below) by telephone or email of the event and ensure that the written certification and supporting documents are provided to the NMFS staff person.

(II) In the event that the marine mammal injury resulted from something other than seismic airgun operations (e.g., gunshot wound, polar bear attack), as certified by the lead MMO onboard the seismic vessel, the airgun array may be restarted (by conducting the necessary ramp-up procedures described in condition 6(b)(v) below) upon completion of a written certification, including supporting documents (e.g., photographs or other evidence to support the certification) by the MMO. Within 24 hours after the event specified herein, the holder of this Authorization must notify the designated staff person (see III below) by telephone or email of the event and ensure that the written certification and supporting documents are provided to the NMFS staff person.

(III) In the event that the cause of the injury or death cannot be immediately determined by the lead MMO, the holder shall immediately report the incident to either the NMFS staff person designated by the Director, Office of Protected Resources (Candace Nachman, Office of Protected Resources, NMFS, 301-713-2289 ext 156 or Candace.Nachman@noaa.gov) or to the staff person(s) designated by the Alaska Regional Administrator (Brad Smith or James Wilder, Alaska Regional Office, NMFS, 907-271-5006 or Brad.Smith@noaa.gov or James.Wilder@noaa.gov).

(*1*) The seismic airgun array shall not be restarted until NMFS is able to review the circumstances of the take, make determinations as to whether modifications to the activities are appropriate and necessary, and has notified the holder that activities may be resumed.

(*2*) NMFS approval to resume operations may be given by the Director, Office of Protected Resources, NMFS, or his designee or by the Alaska Regional Administrator, NMFS, or his designee. NMFS approval may be provided in writing via a letter or an email or via the telephone.

A copy of this modification letter must be attached to the IHA and must be in the possession of the operator of each vessel, aircraft, and marine mammal monitors operating under the authority of this Authorization.

If you have any questions concerning the IHA please contact Candace Nachman or Kenneth Hollingshead, Office of Protected Resources, NMFS at (301) 713-2289 or Brad Smith, Alaska Regional Office, NMFS at (907) 271-3023.

Sincerely,

James H. Lecky
Director, Office of Protected Resources

APPENDIX B: USFWS LETTER OF AUTHORIZATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

IN REPLY REFER TO:

AFES/MMM

JUL 2 2008

Dr. Bill Streever
Leader – Environmental Studies
BP Exploration (Alaska) Inc.
900 East Benson Boulevard
P.O. Box 196612
Anchorage, Alaska 99519-6612

Dear Dr. Streever:

This supplements your December 14, 2008, request for Letters of Authorization (LOA) from the U.S. Fish and Wildlife Service (Service) for the incidental take of polar bears and Pacific walrus in regards to the BP Exploration (Alaska), Inc. (BPXA) 2008 3D OBC Liberty Seismic Survey and Bathymetry Survey. The Service issued an authorization for the initial portion of this project, the bathymetry survey during the ice-covered season (March 6, 2008).

The LOA (08-10) allowed BPXA to take small numbers of polar bears incidental to the bathymetry survey. The second portion of BPXA's program, a 3D, ocean bottom Cable (OBC) seismic survey in the Liberty area during the open-water season (July through October), was not initially added to allow the Service time to conduct a more thorough review of the open-water OBC portion of your seismic program.

The Service will amend LOA 08-10 to include the additional seismic work (discussed below) for this project. This is based on BPXA's initial LOA request to the Service, the background information described in BPXA's, "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," to the National Marine Fisheries Service (NMFS), and the subsequent proposed Incidental Harassment Authorization by NMFS (73 FR 24236). All provisions contained within LOA 08-10 remain in effect for this amended LOA. In addition, please review the following seismic stipulations that are now included by reference into LOA 08-10. This authorization continues to be effective until November 30, 2008.

In accordance with section 7 of the Endangered Species Act of 1973, as amended (ESA), issuance of this LOA also fulfills the requirements for Tier 2 Consultation of the Programmatic Biological Opinion for the activities described herein. In the "Programmatic Biological Opinion for Polar Bears (*Ursus maritimus*) on Beaufort Sea Incidental Take Regulations" (June 2008; Tier 1 BO), the Service determined that the total take anticipated as a result of the issuance of the

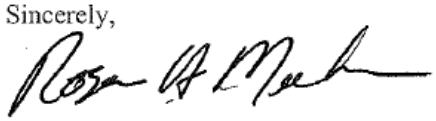
Regulations is not likely to result in jeopardy to the polar bear, in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended. In order for the Tier 2 BO to be consistent with the "no jeopardy" conclusion of the Tier 1 BO and an ESA incidental take statement (ITS) to be provided: (1) the proposed activity must provide the required information, as described in the §18.124 of the incidental take regulations, (2) the LOA includes any mitigation measures that the Marine Mammals Management Office (MMM) believes appropriate for the specific activity and location, as described in §18.128 of the Regulations, and (3) the (MMM) must determine that the incidental take for the specific activity will be consistent with the negligible impact finding for the total take allowed under the incidental take regulations.

A reasonable and prudent measure and implementing terms and conditions were included for MMM in the Tier 1 BO and have been incorporated into the LOA process. Issuance of this ITS with the LOA completes ESA requirements for authorization of incidental take of the polar bear. Compliance with the terms and conditions of this LOA insures that the LOA holder is also in compliance with the ESA.

A requirement of this LOA is to provide observational data of polar bears throughout the project and a complete report of all observations at the conclusion of the project to document take. This final report will be provided to the MMM. This report meets the tracking and reporting requirements relative to the documentation of take as required by the MMPA and the ESA.

This authorization is issued in accordance with our regulations listed at 71 FR 43926, dated August 2, 2006. Should you have any further questions contact Mr. Craig Perham of our Marine Mammals Management Office at (907) 786-3800 or 786-3810.

Sincerely,



Rosa Meehan, Ph.D.
Chief, Marine Mammals Management Office

Enclosure

cc: Mr. Rance Wall, MMS
Mr. Dick Shideler, ADFG
Fairbanks Fish and Wildlife Field Office (FWFO)
USFWS Office of Law Enforcement (OLE)

AFES/MMM

ISSUED: June 28, 2008
EXPIRES: November 30, 2008

LETTER OF AUTHORIZATION
(08-10), amended

BP Exploration (Alaska), Inc. (BPXA) is hereby authorized to take small numbers of polar bears and Pacific walrus incidental to activities occurring during the 2008 3D OBC seismic survey and ocean bottom cable (OBC) seismic survey which is scheduled to occur in the Liberty area during the period of July/August 2008 through to October. These activities are discussed in detail in the, "Request for Letter of Authorization, 3D OBC Liberty Seismic Survey Activities."

This authorization and the required conditions below include contractors of BPXA performing BPXA-approved work under the scope of operations to be conducted. Authorization is subject to the following conditions:

1. BPXA Operations Managers, or their designates, must be fully aware, understand, and capable of implementing the conditions of this authorization.

2. This Authorization is valid only for activities (including support vessels) associated with BPXA's 2008 3D OBC Liberty Seismic Survey Activities, as specified in BPXA's December 14, 2007 application.

3. Intentional take is prohibited under this authorization.

4. BPXA must cooperate with the U.S. Fish and Wildlife Service (Service), and other designated Federal, State, or local agencies to monitor the impacts of oil and gas exploration activities on Pacific walrus and polar bears.

5. If any changes develop in your project during the 2008 open-water season, such as activities or location, notify the Marine Mammals Management Office prior to the planned operation.

6. The BPXA Field Operating Procedure, Polar bear Protocol, (Attachment III) is approved and all provisions must be complied with unless specifically noted otherwise in this Letter of Authorization. A copy of this polar bear interaction plan must be available on

site for all personnel.

7. The species authorized for takings, by Level B Harassment only, are: Pacific walrus (*Odobenus rosmarus divergens*), and polar bear (*Ursus maritimus*). The taking of any walrus or polar bear in a manner prohibited under this authorization must be reported within 24 hours of the taking to the Service Incidental Take Coordinator in Anchorage Alaska (907-786-3800), or their designee, as specified in condition 10(d).

8. The holder of this Authorization is required to cooperate with the Service and any other Federal, state or local agency monitoring the impacts of the activity on walruses and polar bears. The holder must notify the Service Incidental Take Coordinator at least 24 hours prior to the start of collecting seismic data.

9. At the discretion of the Service, the operator will allow the Service to place an observer on site (vessels and aircraft) to monitor the impacts of the activity on Pacific walruses and polar bears.

10. Prohibitions:
(a) The taking, by incidental Level B harassment only, is limited to the species listed under condition 4 above. The taking by Level A harassment, serious injury, or death of these species is prohibited and may result in the modification, suspension or revocation of this Authorization.
(b) The taking of any walrus or polar bear whenever the required marine mammal mitigation and monitoring measures (conditions 11 and 12) have not been fully implemented as required by this Authorization, is prohibited.

11. Mitigation:
(a) *General Mitigation*:
The holder of this Authorization is required to:
(i) (A) Avoid concentrations or groups of walruses and polar bears hauled out onto land or ice by all vessels under the direction of BPXA. Operators of support vessels should, at all time, conduct their activities at the maximum distance possible from known or observed concentrations of animals. Under no circumstances, other than an emergency, should vessels operate within 800 meters (½ mile) of walruses or polar bears observed on land or ice.
(ii) Take every precaution to avoid harassment of walruses or polar bears in water when a vessel is operated near these animals. Vessels must reduce speed when walruses or polar bears are observed in water and vessels capable of steering around these animals must do so. Vessels may not be operated in such a way as to separate members of a group of walruses or polar bears from other members of the group. Vessels should avoid multiple changes in direction and speed when walruses or polar bears are present.
(iii) Operate in full compliance with the terms identified in the approved document identified in Condition 6.
(iv) Restriction of walrus or polar bear movements, by any means, in sea or on land, is prohibited. Exclusion zones will be enforced until animals have left the area.

(b) *Seismic Vessel Mitigation:*
The holder of this Authorization is required to:
(i) Reduce the volume of the airgun array during vessel turns while running seismic lines.
(ii) To the extent practical, whenever a marine mammal is detected outside the exclusion zone radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, an alternative ship speed or track will be calculated and implemented.
(iii) Exclusion and Monitoring-Safety Zones:

(A) Establish and monitor with trained observers an exclusion zone for walruses surrounding the seismic airgun array where the received level would be 180 dB.

(B) Establish and monitor with trained observers an exclusion zone for polar bear surrounding the seismic airgun array where the received level would be 190 dB.
(iv) Power-down/Shut-down Procedures:

(A) Immediately shut-down the seismic airgun array and/or other acoustic sources, whenever any walruses are sighted approaching close to or within the area delineated by the established safety radii for pinnipeds of 180 dB isopleth, or polar bear are sighted approaching close to or within the area delineated by the 190 dB isopleth established under condition 11(b)(iii).

(B) Do not proceed with ramping up the seismic airgun array unless the safety zones described in condition 11(b)(iii) are visible and no walruses and polar bears are detected within the appropriate safety zones; or until 15 minutes after there has been no further visual detection of the animal(s) within the safety zone and the trained marine mammal observer on duty is confident that no walruses and polar bears remain within the appropriate safety zone, provided the entire safety zone was visible for at least 30 minutes.

(C) Emergency shut-down. If observations are made or credible reports are received that one or more walruses and polar bears are within the area of the seismic survey are in an injured or mortal state, or are indicating acute distress due to seismic noise, the seismic airgun array will be immediately shut down and the Service Incidental Take Coordinator contacted. The airgun array will not be restarted until review and approval has been given by either the Service Incidental Take Coordinator or their designee.
(v) Ramp-up Procedures:

(A) Prior to commencing ramp-up described in condition 11(b)(v)(C) the safety radius for polar bears n walruses has to be visible and observed by a marine mammal observer if: a complete shut-down has occurred; or at any time electrical power to the airgun array is discontinued for a period of 10 minutes or more; and the marine mammal observer watch has been suspended;

(B) If the safety radii are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, ramp up can commence following established procedures.

(C) If the complete 180 dB safety range is visible and no walruses and polar bears are observed while undertaking pre-ramp-up monitoring under conditions 11(b)(v)(A) and (B), ramp-up airgun arrays slowly over a period of at least 15 minutes starting with

the smallest airgun in the array and then adding additional guns in sequence, until the full array is firing: (1) At the commencement of seismic operations, and (2), anytime after the airgun array has been powered down for more than 10 minutes.

(vi) Poor Visibility Conditions

(A) 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 shutdown of the airgun array may occur following a 30–min period of observation without sighting marine mammals in the safety zone.

(B) If during foggy conditions or darkness, the full 180–dB safety zone is not visible, the airguns cannot commence a ramp-up procedure from a full shutdown.

(C) 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.

12. Monitoring.

(a) *Seismic Vessel Monitoring*:

(i) The holder of this Authorization must designate biologically-trained, marine mammal observers (MMOs) to be onboard the seismic source vessel and designated support vessels.

(ii) MMOs will monitor to:

(A) Ensure that no walruses and polar bears enter the appropriate safety zones established under condition 11(b)(iii), whenever the seismic array is on.

(B) Record marine mammal activity as described in condition 12(a)(v) below. At least two observers must be on watch during ramp ups and the 30 minutes prior to full ramp ups, and for as large a fraction of the other operating hours as possible. At all other times, at least one observer must be on active watch whenever the seismic airgun array is operating during all daytime airgun operations, during any nighttime power-ups of the airguns and at night, whenever that day's monitoring resulted in one or more power-downs due to marine mammal presence.

(iii) The vessel crews also must be instructed to keep watch for walruses and polar bears at all times. If any are sighted, the bridge watch-stander must immediately notify the MMO on-watch.

(iv) Observations by the MMOs on marine mammal presence and activity will begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(v) For each walrus or polar bear sighting, MMOs will record the following:

(A) Species, group size, age/size/sex categories (if determinable), behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, and apparent reaction of animals seen near the seismic vessel and/or its airgun array.

(B) Time, location, heading, speed, and activity of the vessel, along with sea state, ice cover, visibility, cloud cover and sun glare at (1) any time a marine mammal is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable)

(C) The identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).
(vi) All MMOs must be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars.
(vii) The operator of the seismic vessel must maintain a log of seismic activity noting the date and time of all changes in seismic activity (e.g. ramp up, power down, shut down, changes in the number of active airguns or the volume of airgun arrays) and any corresponding changes in monitoring radii.

(b) *Non-seismic Vessel Monitoring:*

(i) A designated crew member on a non-seismic vessel will immediately contact the seismic survey ship if walruses and polar bears are sighted within the 180/190-dB safety zone of the source vessels.
(ii) For each walrus or polar bear sighting, a designated crew member will either record or communicate to the source vessel MMO the following:

(A) Species, group size, age/size/sex categories (if determinable), behavioral activity, heading (if consistent), bearing and distance from vessel, sighting cue, and apparent reaction of animals seen near the vessel.

(B) Time, location, heading, speed, and activity of the vessel, along with sea state, visibility, cloud cover and sun glare at any time a walrus or polar bear is sighted.

(C) The identification of all vessels that are visible within 5 km of the vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

13. Reporting:

(a*) Marine mammal observer training manual and data collection protocols.* Prior to the initiation of seismic operations, the operator must provide the Service with:
(i) A description and documentation of the MMO training program;
(ii) a copy of the MMO field manual and/or operating procedures; and,
(iii) a key to MMO data codes, including definitions and descriptions of all data fields.

(b) *Sound source verification report.* The results of field source verification and the distances to the various sound radii are to be reported to the Service within 72 hours of completing the measurements.

(c) *Weekly summary of walrus and polar bear sightings.* The operator must tabulate and report all walrus and polar bear sightings recorded by the MMOs from all project vessels to the Service on a weekly basis. For each walrus or polar bear sighting include:
(i) a unique sighting identification number;
(ii) species, group size, age/size/sex categories, and substrate (on ice, in water, both);
(iii) date, time and location (for pre-lease seismic surveys, specific location information may be withheld until the results of the next lease sale are announced);
(iv) environmental conditions including: water depth (meters), sea state (Beaufort scale), visibility 1 (#km), visibility 2 (light/dark), visibility 3 (glare: none, little, moderate,

severe), ice condition 1 (estimated % ice cover in vicinity of sighting), ice condition 2 (estimated distance (km) to pack ice);
(v) estimated range (meters) at first sighting, estimated range (meters) at closest approach;
(vi) the behavior of animals sighted (if determinable);
(vii) Whether animals appeared to react to the presence of the ship (yes, no), if yes, describe the reaction of the animal(s);
(viii) vessel activity at time of sighting including: vessel name; vessel speed (knots); seismic activity code; action taken by operator in response to sighting? (yes, no) If yes, specify (e.g. powerdown, shutdown); and,
(ix) any MMO comments or notes

(d*) Notification of incident report.* The operator must report:

(A) any incidental lethal take or injury of a polar bear or walrus; and,

(B) observations of walruses or polar bears within the prescribed safety zones (180/190 dB radii around seismic arrays, or 0.5 mile marine buffer areas) to the Service within 24 hours. Reports should include all information specified under 10(c) as well as a full written description of the encounter and any actions taken by the operator.

(e) *Post season seismic monitoring report*: A draft report will be submitted to the Service within 90 days after the end of the seismic survey program in the Chukchi Sea. The report will describe in detail:
(i) the operations that were conducted;
(ii) the results of the acoustical measurements to verify the safety radii;
(iii) the methods, results, and interpretation pertaining to all monitoring tasks;
(iv) the results of the 2008 shipboard marine mammal monitoring;
(v) a summary of the dates and locations of seismic operations, including summaries of power downs, shut downs, and ramp up delays;
(vi) marine mammal sightings (species, numbers, dates, times and locations; age/size/gender, environmental correlates, activities, associated seismic survey activities);
(vii) estimates of the amount and nature of potential take (exposure) of walruses and polar bears (by species) by harassment or in other ways to industry sounds;
(viii) an analysis of the effects of seismic operations (e.g., on sighting rates, sighting distances, behaviors, movement patterns of walruses and polar bears);
(ix) provide an analysis of factors influencing detectability of walruses and polar bears; and,
(x) provide summaries on communications with hunters and potential effects on subsistence uses
The draft report will be subject to review and comment by the Service. Any recommendations made by the Service must be addressed in the final report prior to acceptance by the Service. The draft report will be considered the final report for this activity under this Authorization if the Service has not provided comments and recommendations within 90 days of receipt of the draft report.

(f) *Seismic monitoring data*: An electronic copy of all seismic monitoring data described in condition 12(a)(v) and (vii) will be submitted to the Service within 90 days after the end of the seismic survey program.

14. Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

15. A copy of this Authorization and the Service-approved Polar Bear Interaction Plan must be in the possession of the operator of all vessels and aircraft engaging in the activity operating under the authority of this Letter of Authorization.

16. Per the "Programmatic Biological Opinion for the Beaufort Sea Incidental Take Regulations for Polar Bear (June 2008)", your request also triggers the second of the two-tiered programmatic process. In order for incidental take of the polar bear to be exempted from the prohibitions of the ESA, the LOA also serves as an "Incidental Take Statement" (ITS), required under section 7 of the Endangered Species Act of 1973 (ESA). Issuance of the LOA/ITS fulfills the requirements for Tier 2 Consultation of the Programmatic Biological Opinion for the activities described in this letter.

Rosa A. Meehan
Chief, Marine Mammals Management

7/2/08
Date

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

IN REPLY REFER TO:

AFES/MMM

MAR 6 2008

Dr. Bill Streever
Leader – Environmental Studies
BP Exploration (Alaska) Inc.
900 East Benson Boulevard
P.O. Box 196612
Anchorage, Alaska 99519-6612

Dear Dr. Streever:

This responds to your December 14, 2008, request for Letters of Authorization (LOA) from the U.S. Fish and Wildlife Service (Service) for the incidental take of polar bears and Pacific walrus in regards to the BP Exploration (Alaska), Inc. (BPXA) 2008 3D OBC Liberty Seismic Survey and Bathymetry Survey. The proposed start date for the first portion of this project is March 2008. The BPXA Liberty Seismic Program has 2 components:

1. a shallow water bathymetry survey during the ice-covered season (March), and;

2. a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area during the open-water season (July through October).

Enclosed is an LOA (08-10) that would allow BPXA to take small numbers of polar bears and walruses incidental to the bathymetry survey to be conducted during the ice-covered season of 2008. Due to time constraints and the different seasons when the bathymetry (on-ice) and seismic (open-water) surveys will be conducted, the Service is currently conducting a more thorough review of the open-water OBC portion of your seismic program. Upon completion of the review and if the activity is authorized, the Service will amend LOA 08-10 to include open-water seismic survey of this project which will occur during the 2008 open-water season.

The Service believes that protection measures for polar bears described in BPXA's Field Operating Procedure, Polar bear Protocol, Attachment III, contains appropriate safeguards to limit human/animal interactions. BPXA field camps and personnel can limit encounters of polar bears by being observant of approaching animals (i.e., the use of polar bear guards) and breaking off interactions, if practicable, by allowing the animals to continue their travel. The Service biologists are available for consultation if questions or concerns arise regarding polar bears during the project period at the phone numbers listed below and noted in your interaction plan.

Polar bear conservation has benefited from monitoring programs associated with the Incidental Take Program since 1993. Monitoring serves to assess the effect of industrial activities on polar bears by evaluating trends and effects of bear encounter rates, take frequency, as well as the location and timing of encounters. Additionally, through monitoring, the Service seeks to limit disturbance to maternal polar bear den sites, both known dens and those areas that could possibly be preferred by denning polar bears. Use caution when operating near these areas during the maternal denning period (mid November to mid April). The U.S. Geological Survey has posted information regarding polar bear denning habitat on the Alaska Science Center (ASC) website, plus associated documents. The den habitat map (ARC/INFO export file), the mapping manuscript (PDF file) and a picture of den habitat (JPG file) are available on the ASC website (http://www.absc.usgs.gov/dataproducts.htm). Please use these resources when planning activities in potential denning areas and contact us immediately if any dens are found during oil and gas activities.

As a precondition to the Liberty LOA, on January 29, 2008 a FLIR (Forward Looking Infrared) survey flight was conducted along the coastline within the Liberty Project area. The FLIR survey investigated den habitat within a 1-mile envelope along the Liberty Project Area corridor. This survey was a cooperative effort between the BPXA and the Service. No polar bear dens were identified during this survey within the defined Liberty Project Area.

This authorization is issued in accordance with our regulations listed at 71 FR 43926, dated August 2, 2006. Please review these regulations. Should you have any further questions contact Mr. Craig Perham of our Marine Mammals Management Office at (907) 786-3800 or 786-3810.

Sincerely,

Rosa Meehan, Ph.D.
Chief, Marine Mammals Management

Enclosure

cc: Mr. Richard Shideler, ADF&G
Fairbanks Fish and Wildlife Field Office (FWFO)
USFWS Office of Law Enforcement (OLE)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1011 E. Tudor Road
Anchorage, Alaska 99503-6199

IN REPLY REFER TO:

AFES/MMM

ISSUED: March 4, 2008
EXPIRES: November 30, 2008

LETTER OF AUTHORIZATION
(08-10)

BP Exploration (Alaska), Inc. (BPXA) is hereby authorized to take small numbers of polar bears incidental to activities occurring during the on-ice 2008 Bathymetry Survey for the Liberty Development. This is the first portion of the Liberty Seismic Survey. A 3D OBC seismic survey and ocean bottom cable (OBC) seismic survey is scheduled to occur in the Liberty area during the period of July/August 2008 through to October. Upon completion of a more thorough Service review and if the open-water seismic survey meets Service requirements for limiting incidental take of Pacific walrus and polar bears, the Service will amend LOA 08-10 to include the seismic survey. These activities are discussed in detail in the, "Request for Letter of Authorization, 3D OBC Liberty Seismic Survey Activities" and "Liberty Bathymetry Operations Plan."

This authorization and the required conditions below include contractors of BPXA performing BPXA-approved work under the scope of operations to be conducted. Authorization is subject to the following conditions:

1. The BPXA Field Operating Procedure, Polar bear Protocol, Attachment III, is approved and all provisions must be complied with unless specifically noted otherwise in this Letter of Authorization. A copy of this polar bear interaction plan must be available on site for all personnel.

2. BPXA Operations Managers, or their designates, must be fully aware, understand, and capable of implementing the conditions of this authorization.

3. Intentional take is prohibited under this authorization.

4. This authorization is valid only for those activities identified in the request for a Letter of Authorization dated December 14, 2007.

5. Polar bear monitoring, reporting, and survey activities will be conducted in accordance with 50 CFR 18, section 18.128. The basic monitoring and reporting requirements follow:

   - BPXA must cooperate with the U.S. Fish and Wildlife Service (Service), and other designated Federal, State, or local agencies to monitor the impacts of oil and gas exploration activities on polar bears;

   - BPXA must not conduct activities that operate nor pass within 1 mile of known polar bear dens, and all observed dens must be reported to the Marine Mammals Management Office, Fish and Wildlife Service within 12 hours of discovery. Should occupied dens be identified within one mile of activities, work within a one-mile area will cease and Service must be contacted for guidance. The Service will evaluate these instances on a case-by-case basis to determine the appropriate action. Potential actions may range from cessation or modification of work to conducting additional monitoring, and BPXA must comply with any additional measures specified.

   - BPXA will provide copies of the polar bear observation form to all BPXA contractors operating under the LOA.

   - BPXA must designate a qualified individual or individuals to report any polar bear sightings, or signs of polar bears, such as tracks, scat, or diggings, to this office by phone or using the polar bear observation form within 24 hours of visual observation;

   - BPXA must allow the Fish and Wildlife Service to allow an observer on the site to monitor the impacts of the activity on polar bears, at the discretion of the Fish and Wildlife Service;

   - BPXA must submit an annual monitoring report to the Marine Mammals Management Office as required under 18 CFR 18.128(f), which will be received up to 90 days after the expiration date of the LOA (by February 28, 2009).

6. Once the Service has conducted a thorough review of the seismic portion of the Liberty Seismic program and found it acceptable, the Service will amend the LOA to include the open-water seismic survey.

7. This authorization expires November 30, 2008.

Chief, Marine Mammals Management

3/6/08
Date

APPENDIX C: CONFLICT AVOIDANCE AGREEMENT

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2008 OPEN WATER SEASON
PROGRAMMATIC CONFLICT AVOIDANCE AGREEMENT

BETWEEN

BP EXPLORATION (ALASKA), INC.
SHELL OFFSHORE, INC
PIONEER NATURAL RESOURCES ALASKA, INC.
ENI US Operating Co. Inc
PGS Onshore
ASRC Energy Services

AND

THE ALASKA ESKIMO WHALING COMMISSION
THE BARROW WHALING CAPTAINS' ASSOCIATION
THE NUIQSUT WHALING CAPTAINS' ASSOCIATION
THE KAKTOVIK WHALING CAPTAINS' ASSOCIATION
THE WAINWRIGHT WHALING CAPTAINS' ASSOCIATION
THE PT. LAY WHALING CAPTAINS' ASSOCIATION
THE PT. HOPE WHALING CAPTAINS' ASSOCIATION

Final for Signature
May 30, 2008

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(TOC to be corrected)

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I. INTRODUCTION

Unless otherwise specified, this Conflict Avoidance/Mitigation Agreement is intended to apply to all nearshore and offshore oil and gas exploration, development, and production activities by or for any Industry Participant , and barge vessel traffic by or for any Signatory during the 2008 OPEN WATER SEASON in the BEAUFORT and/or CHUKCHI SEAS.

Unless otherwise specified, Vessels and locations covered by this Agreement include those identified in the Agreement, as well as any others that are employed by or for the Industry Participants in the Beaufort and/or Chukchi Seas during the 2008 summer and fall open water season.

All parties identified in the Agreement by name and whose representative(s) has signed the Agreement, including all contractors of such parties, are referred to in this document, jointly, as the "Participants" or where appropriate as the "Industry Participants" or the "Subsistence Participants". Any and all other entities who later become parties to this Agreement or whose activities become subject to this Agreement are referred to in this document as the "Covered Parties". Unless otherwise specified, the term "Industry Participant' shall include such Covered Parties and such Covered Parties shall be subject to all terms and conditions of this Agreement that apply to the Industry Participants.

The Participants agree that, unless otherwise specified, the mitigation measures identified in the Agreement, which are intended to mitigate the potential impacts of oil and gas exploration, drilling, seismic, development, or production and related activities on marine mammals, including migrating bowhead whales and the Alaskan Eskimo Subsistence hunt of those whales, are designed to apply to all activities of each Participant during the 2008 summer and fall open water season, whether referenced specifically or by category, and to all Vessels and locations covered by this Agreement, whether referenced specifically or by category.

II. GENERAL TERMS AND CONDITIONS

A. STATEMENT OF PURPOSE

The purpose of this Agreement is to provide:

1. Equipment and procedures for communications between Subsistence Participants and the Industry Participants; and

2. Avoidance guidelines and other mitigation measures to be followed

by the Industry Participants working in or transiting the vicinity of active subsistence whaling crews, or in areas where subsistence whaling crews anticipate hunting, or in areas that are in sufficient proximity to areas expected to be used for subsistence hunting that the planned activities could potentially affect the subsistence hunt through effects on migrating bowhead whale behavior.

3. Additional Provisions of the Agreement:

   a. measures to be taken in the event of an emergency occurring during the term of this Agreement; and

   b. dispute resolution procedures.

B. LIMITATIONS OF OBLIGATIONS

1. No cooperation among the Participants, other than that required by this Agreement, is intended or otherwise implied by their adherence to this Agreement. In no event shall the signatures of any representative of the Alaska Eskimo Whaling Commission (AEWC), or of the Barrow, Nuiqsut, Kaktovik, Wainwright and Pt. Hope, Pt. Lay Whaling Captains' Associations, or of any other Whaling Captains' Association be taken as an endorsement of any Arctic or Beaufort or Chukchi Sea OCS operations by any oil and/or gas operator or contractor.

2. Adherence to the procedures and guidelines set forth in this Document does not in any way indicate that any Inupiat or Siberian Yupik whalers or the AEWC agree that industrial activities are not interfering with the bowhead migration or the bowhead subsistence hunt. Such adherence does not represent an admission on the part of the Industry Participants or their contractors that the activities covered by this Agreement will interfere with the bowhead migration or the bowhead subsistence hunt.

3. No member of the oil and gas industry or any contractor has the authority to impose restrictions on the subsistence hunting or any other activities of the AEWC, residents of the Villages of Nuiqsut, Kaktovik, Barrow, Wainwright, Pt. Lay, or Pt. Hope, or residents of any other village represented by the AEWC.

4. In the event additional parties from the oil and gas industry operate the Beaufort Sea during the summer or fall of 2008 the, Participants shall exercise their good-faith efforts to bring those parties into this Agreement.

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Should additional parties enter into this Agreement at a date subsequent to the date of the signing of this document and before the termination of the 2008 bowhead subsistence whale hunting season, the Participants will provide to all signatories a supplement to this document containing the added signatures.

5. No Participant is responsible for enlisting additional parties to adhere to the terms and conditions of the Agreement. Similarly, **THE AEWC IS NOT RESPONSIBLE FOR, OR A PARTY TO, ANY AGREEMENT AMONG MEMBERS OF THE OIL AND GAS INDUSTRY** who are Participants in the Agreement or other Covered Parties, concerning the apportionment of expenses necessary for the implementation of this Agreement.

6. In adhering to this Agreement, neither the Participants nor any Covered Party waives any rights existing at law. All Participants agree that the provisions of this document do not establish any precedent as between them or with any regulatory or permitting authority.

7. PARTICIPANTS' OBLIGATIONS SHALL BE SEPARABLE: All Participants to this Agreement understand that each Participant represents a separate entity. The failure of any Participant to adhere to this Agreement or to abide by the terms and conditions of this Agreement shall not affect the obligation of other Participants to adhere to this Agreement and to proceed accordingly with all activities covered by this Agreement. Nor Shall any Participant's adherence to this Agreement affect that Participant's duties, liability, or other obligations with respect to any other Participant beyond those stated in this Agreement.

C. OIL AND GAS INDUSTRY VESSELS AND EQUIPMENT

The Industry Participants hold or have applied for

- A Letter of Authorization from U.S. National Marine Fisheries Service (NOAA Fisheries), pursuant to Section 101 (a)(5)(A) of the Marine Mammal Protection Act (2008 LOAs);

- An Incidental Harassment Authorization from U.S. National Marine Fisheries Service (NOAA Fisheries), pursuant to Section 101 (a)(5)(D) of the Marine Mammal Protection Act (2008 IHAs); or

- A permit from the North Slope Borough that stipulates that the Industry Participant enter into a conflict avoidance agreement

before conducting certain activities in the marine environment (2008 NSB Permits).

The only vessels or other equipment, including but not limited to boats, barges, aircraft, or similar craft, that are owned and/or operated by, or that are under contract to the Industry Participants, for use in the Beaufort and/or Chukchi Seas in support of activities described in their respective applications for 2008 LOAs, 2008 IHAs, or 2008 NSB Permits during the Term of this Agreement are those:

1. Identified in each Industry participant's application, if any, for a 2008 LOA , 2008 IHA or used in activities for which the Industry Participant holds a 2008 NSB Permit, and listed in Attachment II to this Agreement.

2. For and in support of the Monitoring Plan, if any, identified within each Industry Participant's 2008 LOA, 2008 IHA, or conducted pursuant to its 2008 NSB Permits as agreed to between the Industry Participant and the NSB Division of Wildlife Management (NSB DWM), and listed in Attachment III to this Agreement.

The vessels and other equipment identified in 1. and 2. above are referred to in this Agreement as "the Vessels".

NONE OF THE INDUSTRY PARTICIPANTS INTENDS TO OPERATE ANY OTHER VESSEL IN SUPPORT OF ACTIVITIES DESCRIBED IN THEIR RESPECTIVE APPLICATIONS FOR 2008 LOAs, 2008 IHAs, or 2008 NSB PERMITS DURING THE TERM OF THIS AGREEMENT. However, if any Industry Participant decides to use different vessels or equipment or additional vessels or equipment, such vessels and equipment shall be used only for purposes identified in Attachments II or III; and the AEWC and the whaling captains of Nuiqsut, Kaktovik, Barrow, Wainwright, Pt. Hope, and Pt. Lay shall be notified promptly through the appropriate Communications System Coordination Center (Com-Center), as identified in Section III. B. of this Agreement, and in writing, of their identity and their intended use, including location of use.

D. BARGE TRAFFIC

The Participants may also employ barges to transport materials through the Beaufort or Chukchi Seas during the term of this Agreement. Any Participant who employs a barge to transport materials through the Beaufort or Chukchi Seas during the term of this Agreement shall require the barge operator to comply with Sections III. C. 1 and Section III. D of

this Agreement while employed by that Industry Participant.

E. SUBSISTENCE WHALE HUNTING BOATS

1. Boats Owned/Used by Whaling Captains of Nuiqsut (NWCA)

The subsistence whaling crews of the Village of Nuiqsut plan to use twelve (12) boats for subsistence whale hunting during the late summer and fall of 2008.

2. Boats Owned/Used by Whaling Captains of Kaktovik (KWCA)

The subsistence whaling crews of the Village of Kaktovik plan to use eight (8) boats for subsistence whale hunting during the late summer and fall of 2008.

3. Boats Owned/Used by Whaling Captains of Barrow (BWCA)

The subsistence whaling crews of the Village of Barrow plan to use forty (40) boats for subsistence whale hunting during the late summer and fall of 2008.

4. Boats Owned/Used by Whaling Captains of Wainwright (WWCA)

The subsistence whaling crews of the Village of Wainwright plan to use four (4) boats for subsistence whale hunting during the fall of 2008.

5. Boats Owned/Used by Whaling Captains of Pt. Hope (Pt. HWCA)

The subsistence whaling crews of the Village of Pt. Hope plan to use ten (10) boats for subsistence whale hunting during the late fall of 2008.

6. Boats Owned/Used by Whaling Captains of Pt. Lay (Pt. LWCA)

The subsistence whaling crews of the Village of Pt. Lay plan to use four (4) boats for subsistence whale hunting during the fall of 2008.

If any additional boats are put in use by subsistence whaling crews, the industry Participants will be notified promptly through the Com-Center.

F. INDIVIDUALS TO CONTACT

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1. Shell Offshore Inc.'s (Shell) Local Representatives

BOB ROSENBLADT and PETER LITTLEWOOD will be Shell's local representatives on the North Slope during the Term of this Agreement and will be stationed at Barrow during Chukchi Sea operations and at Deadhorse during Beaufort Sea operations and will be available by telephone at (907) 770-3700.

2. WesternGeco's Local Representative-Subcontractor to Shell

JOHN DAVIS will be WesternGeco's local representative on the North Slope during the Term of this Agreement and will be stationed at Barrow during Chukchi Sea operations and at Deadhorse during Beaufort Sea operations and will be available by telephone at (907) 360-3518 Cell Phone.

3. BP Exploration (Alaska), Inc.'s (BP) Local Representative

Lowry Brott will be BP's local representative on the North Slope during the Term of this Agreement and will be stationed at Norhtstar Island and will be available by telephone at (907)670-3520 and when Mr. Brott is not available, his alternate, Dan Ferriter, will be stationed at Northstar Island and will be available by telephone at the above number.

4. Pioneer Natural Resources' (Pioneer) Local Representative

Pat Foley will be Pioneer's local representative during the Term of this Agreement and will be stationed in Anchorage and will be available by telephone at (907) 343-2110.

5. ENI's Local Representative

6. PGS Onshore's Local Representative

Chuck Robinson, Area Manager, will be PGS Onshore, Inc.'s local representative during the Term of this Agreement and will be available by telephone at (907) 569-4049.

7. Contact Persons for ASRC Energy Services
Jana Lage, Principal Marine Geophysicist, Marine Services, will be AES's local representative during the Term of this Agreement and

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will be available by telephone at (907) 339-6452 (Direct), (907) 382-4405 (Cell), (907) 339-6219 (Fax).

8. Contact Persons for the Village of Kaktovik

For purposes of this Agreement, the individuals to contact for the Village of Kaktovik will be: JOSEPH KALEAK at (907) 640-6213 or 640-6515, and FENTON REXFORD at (907) 640-2042 (Home) or (907) 640-6419 (Work).

9. Contact Persons for the Village of Nuiqsut

For purposes of this Agreement, the individuals to contact for the Village of Nuiqsut will be: ISAAC NUKAPIGAK at (907) 480-6220 (Work); (907) 480-2400 (Home), and ARCHIE AHKIVIANA at (907) 480-6918 (Home).

10. Contact Persons for the Village of Barrow

For purposes of this Agreement, the individuals to contact for the Village of Barrow will be: HARRY BROWER, JR. at (907)852-0350 (Work), and EUGENE BROWER at (907)852-3601.

11. Contact Persons for the Village of Wainwright

For purposes of this Agreement, the individuals to contact for the Village of Wainwright will be: JACK PANIK at (907)763-2421 (Home); (907)763-2915 (Work), 763-2171 (Fax), and WALTER NAYAKIK at (907)763-2915 (Work).

12. Contact persons for the Village of Pt. Hope

For purposes of this Agreement, the individuals to contact for the Village of Pt. Hope will be: RAY KOONUK, SR. at (907)368-2120 (Home), 368-3117 (Work); 368-2618 (Fax), JACOB LANE, JR. at (907) 368-3812 (Home), (907) 368-2334 (Work), (907) 368-5402 (Fax) .

13. Contact persons for the Village of Pt. Lay

For purposes of this Agreement, the individuals to contact for the Village of Pt. Lay will be: JULIUS REXFORD (907) 833-4592 (Home), (907) 833-2214 (Work), (907) 833-2320 (Fax), THOMAS NUKAPIAK (907)

833-6467 (Home), (907) 833-3838

14. Contact Persons for the AEWC

For purposes of this Agreement, the individuals to contact for the AEWC shall be: HARRY BROWER, JR. at (907) 852-2910 and (907) 852-0350 (Work) and TERESA JUDKINS at (907) 852-2392.

G. TERM

The Term of the Agreement shall commence with the signing of this document by the designated Signatories and shall terminate upon completion of the Nuiqsut, Kaktovik, Barrow, Wainwright, Pt Lay, and Pt. Hope 2008 Fall Bowhead Hunt; or the Beaufort Sea Post Season Meeting required under Section II.H.1. below, or the Chukchi Sea Post-Season Village (Barrow, Wainwright, Pt. Lay, and Pt. Hope) Meetings required under Section II.H.2. below, whichever is later.

H. POST-SEASON REVIEW/PRESEASON INTRODUCTION

1. Nuiqsut, Kaktovik, Barrow Joint Meeting

Following the end of the fall 2008 bowhead whale subsistence hunt and prior to the 2009 Pre-Season Introduction Meetings, the Industry Participants will host a joint meeting with all whaling captains of the Villages of Nuiqsut, Kaktovik and Barrow, the Inupiat Communicator(s) (defined below) and with the Chairman and Executive Director of the AEWC, at a mutually agreed upon time and place on the North Slope of Alaska, to review the results of the 2008 fall season, unless it is agreed by all designated individuals or their representatives that such a meeting is not necessary.

2. Chukchi Sea Post-Season Village Meetings

Following the completion of Chukchi Sea operations and prior to the 2009 Pre-Season Introduction Meetings, the Industry Participants involved will hold a meeting in each of the following villages: Wainwright, Pt. Lay, Pt. Hope, and Barrow (or a joint meeting of the whaling captains from all of these villages if the whaling captains agree to a joint meeting) to review the results of the operations and to discuss any concerns residents of those villages might have regarding the operations. The

meetings will include the Inupiat Communicators stationed on the Industry Participants' Vessels in the Chukchi Sea. The Chairman and Executive Director of the AEWC will be invited to attend the meeting(s).

3. Pre-season Introduction Meetings

Immediately following each of the above meetings, and at the same location, the Industry Participants will provide a brief introduction to their planned operations for the 2009 open water season. Each Industry Participants should provide hand-outs explaining their planned activities that the whaling captains can review. Subsistence Participants understand that any planned operations discussed at these Pre-Season Introduction Meetings, and the corresponding maps, will represent the Industry Participant's best estimate at that time of its planned operations for the coming year, but that these planned operations are preliminary, and are subject to change prior to the 2009 Open Water Season Meeting.

4. Map of Planned Industry Participant Activities

The Industry Participants, jointly, shall prepare and provide the AEWC with a large-scale map of the Beaufort and Chukchi Seas showing the locations and types of activities planned by each Industry Participant. This map will be for use by the AEWC and Industry Participants during the 2009 CAA Meeting.

I. PRE-SEASON SOUND SIGNATURE TESTS

For purposes of obtaining a sound signature for Industry Participants' sound sources, the Industry Participants shall conduct a test of both the geophysical equipment and the Vessels identified in the Appendices to this Agreement, within 72 hours of initiating or having initiated operations in the Beaufort or Chukchi Seas. If more than one sound source will be used on an individual Vessel, a cumulative test of all sound sources used on that Vessel will be conducted.

Each sound signature test shall be conducted at a site mutually agreed upon by the Industry Participant conducting such test and the AEWC. Each Industry Participant conducting such sound signature test(s) shall provide a minimum of three weeks notice to the AEWC. For sound signature tests conducted in the Beaufort Sea, the Industry Participant conducting such tests shall provide transportation for a mutually agreed number of representatives from each of: the AEWC, the whaling captains of the Villages of Barrow, Nuiqsut, and Kaktovik, and the NSB DWM to observe the sound signature tests. For sound signature tests conducted in the Chukchi Sea, the Industry Participant conducting such

tests shall provide transportation for a mutually agreed number of representative each from the AEWC, the whaling captains of the Villages of Barrow, Wainwright and Pt. Hope, and the NSB DWM to observe the sound signature tests.

Within five (5) days of completing the test(s), each Industry Participant and/or its contractor conducting such test(s) will make all data collected during the test(s) available upon request to the AEWC and NSBDWM and will provide the AEWC and NSBDWM the preliminary analysis of that data, as well as any other sound signature data that is available and that the AEWC, the NSB Department of Wildlife Management, and the Industry Participant agree is relevant to understanding the potential noise impacts of the proposed operations to migrating bowhead whales or other affected marine mammals. The final data analysis will be provided to the AEWC and the NSB Department of Wildlife Management as soon as it becomes available to the Industry Participant. Any Industry Participant who prepares a model of the sound signature of its Vessels and operations, whether before or after the Pre-Season Sound Signature Test, will provide copies of those models and any related analysis to the AEWC and the NSB Department of Wildlife Management.

J. MONITORING PLANS

Each Industry Participant agrees to prepare and implement a noise impact study monitoring plan ("Monitoring Plan: Attachment III") to collect data designed to determine the effects of its operations on fall migrating bowhead whales and other affected marine mammals. Industry Participants whose operations are limited exclusively to vessel traffic will submit sound signature data for each vessel they are using and marine mammal sighting data.

The Monitoring Plans shall be designed in cooperation with the AEWC, the NSB Department of Wildlife Management, NOAA Fisheries, the U.S. Minerals Management Service, (MMS) and any other entities or individuals designated by one of these organizations.

In the Beaufort Sea, the Monitoring Plans shall include an investigation of noise effects on fall migrating bowhead whales as they travel past the noise source, with special attention to changes in calling behavior, deflection from the normal migratory path, where deflection occurs, and the duration of the deflection.

In the Chukchi Sea, the Monitoring Plans should focus on the identity, timing, location, and numbers of marine mammals and their behavioral responses to the noise source.

Prior impact study results shall be incorporated into the Monitoring Plans

prepared by each Industry Participant. Each such Monitoring Plan shall be subject to stake-holder peer review at the 2008 Open Water Season Peer Review Meeting convened by NOAA Fisheries. Draft plans will be submitted to the North Slope Borough and Alaska Eskimo Whaling Commission three weeks prior to the Open Water Meeting. Peer review and acceptance of each such Monitoring plan through this process shall be completed prior to the commencement of each Industry Participants' 2008 operations in the Beaufort or Chukchi Seas. Each completed, peer reviewed, and approved Monitoring Plan shall be part of the IHA issued by NOAA Fisheries for each Industry Participant who has applied for an IHA, or who is required to engage in monitoring pursuant to a North Slope Borough permit.

Each Industry Participant conducting site-specific monitoring will make raw data, including datasheets, field notes, and electronic data, available to the NSB at the end of the season.

Each Industry Participant conducting site-specific monitoring will permit and encourage open communications among their contractors and the AEWC and North Slope Borough.

Each Industry Participant will submit a summary of monitoring plan results and progress to the AEWC and North Slope Borough every two weeks during the operating season.

K. CUMULATIVE NOISE IMPACTS STUDY

Each Industry Participant further agrees to provide its Monitoring Plan and sound signature data for use in a cumulative effects analysis of the multiple sound sources and their possible relationship to any observed changes in marine mammal behavior, to be undertaken pursuant to a Cumulative Noise Impacts Study.

The study design for the Cumulative Impacts Study shall be developed through a Cumulative Impacts Workshop to be organized by the North Slope Borough in the fall of 2008. The results of this workshop will be presented at the 2009 Open Water Meeting.

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III. OPEN WATER SEASON COMMUNICATIONS EQUIPMENT AND PROCEDURES

A. COMMUNICATIONS EQUIPMENT

1. Communications Equipment to be Provided to Subsistence Whale Hunting Crews

The Industry Participants will provide (or participate in the provision of) the communications equipment described in Sections III.A.1.a. and III.A.1.b. The Industry Participants conducting operations in the Beaufort Sea will fund the provision of communications equipment for the whaling captains of Kaktovik and Nuiqsut. The Industry participants conducting operations in the Chukchi Sea will fund the provision of communications equipment for the whaling captains of Barrow, Wainwright, Pt. Hope, and Pt. Lay.

a. All-Channel, Water-Resistant VHF Radios:

i) Kaktovik Subsistence Whaling Boats: 8
ii) Kaktovik Base and Search and Rescue: 2
iii) Nuiqsut Subsistence Whaling Boats: 12
iv) Nuiqsut Base and Search and Rescue: 3
v) Barrow Base and Search and Rescue: 2
vi) Wainwright base and Search and Rescue: 2
vii) Wainwright Subsistence Whaling Boats: 4
viii) Pt. Hope Base and Search and Rescue: 2
ix) Pt. Hope Subsistence Whaling Boats: 10
x) Pt. Lay Base and Search and Rescue: 2
xi) Pt. Lay Subsistence Whaling Boats: 4

These VHF radios are specifically designed for marine use and allow monitoring of Channel 16 while using or listening to another channel. The whaling boats from each of the two villages have been assigned individual VHF channels for vessel-to-vessel and vessel-to-Com-Center communications. The Nuiqsut whaling crews will use Channel 68. Channel 69 will be used by the Kaktovik whaling crews. Channel 72 will be used by Barrow whaling crews. The Wainwright Whaling Crews will use Channel 12. The Pt. Lay Whaling Crews will use Channel 72. The Pt. Hope Whaling Crews will use Channel 68..

b. Satellite Telephones:

i) Kaktovik Base Phones: 2

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ii) Kaktovik Subsistence Whaling Boats: 8
iii) Nuiqsut Base Phones: 2
iv) Nuiqsut Subsistence Whaling Boats: 12
v) Barrow Subsistence Whaling Boats: 2
vi) Wainwright Subsistence Whaling Boats: 4
vii) Pt. Lay Subsistence Whaling Boats: 2

The satellite telephones are to be used as backup for the VHF radios. The satellite telephones for use on subsistence whaling boats are for emergency use only and should be programmed for direct dial to the nearest Com-Center.

c. Distribution and Return of Equipment: the distribution of the VHF radios, and satellite telephone equipment to whaling captains for use during the 2008 fall bowhead subsistence whale hunting season shall be completed no later than August 15, 2008. All such units and telephone equipment provided under this Agreement, whether in this Section or otherwise, will be returned by the Subsistence Participants promptly to the Industry Participant or the person providing such units and equipment at the end of each Village's 2008 fall bowhead whale subsistence hunt.

2. Communications Equipment on Vessels Owned or Operated by the Industry Participants and/or their Contractors

The Inupiat Communicators onboard source vessels owned or operated by the Industry participants and/or their contractors will also be supplied with all-channel VHF radios. The on-board communicators have been assigned Channel 7 for their exclusive use in communicating with the Com-Center.

3. Radio Installation and User Training

The Whaling captains of Nuiqsut, Kaktovik, Wainwright and Pt. Hope with assistance from the Industry Participants, will be responsible for the Installation of the VHF radio equipment. The Industry participants will provide (or participate in the provision of) on-site user training for the VHF equipment on or before August 15, 2008, as scheduled by the Whaling Captains' Associations of Nuiqsut, Kaktovik, Barrow, Wainwright, Pt. Lay, Pt. Hope and the Industry Participant operating the Com-Centers.

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B. THE COMMUNICATIONS SYSTEM COORDINATION CENTERS (COM-CENTERS) Note: The communications scheme shall apply in the Chukchi Sea lead system, as identified and excluded from leasing in the current MMS Five-Year Leasing Program, 2008-2012.

1. Set Up and Operation

Subject to the terms of Section II.B. of this Agreement, the Industry Participants conducting operations in the Beaufort Sea jointly will arrange for the funding of Com-Centers in Deadhorse and Kaktovik, and the Industry Participants conducting operations in the Chukchi Sea jointly will arrange for the funding of Com-Centers in Barrow, Wainwright, and Pt. Hope. All five Com-Centers will be staffed by Inupiat operators. **GROUND TRANSPORTATION MUST BE PROVIDED FOR COM-CENTER OPERATIONS IN KAKTOVIK FOR POLAR BEAR AND BROWN BEAR SAFETY**. The Com-Centers will be operated 24 hours per day during the 2008 subsistence bowhead whale hunt. One of the Industry Participants or its contractor will be designated as the operator of the Com-Centers, then the operator shall be designated AEWC. Each Industry Participant shall contribute to the funding of the Com-Centers covering the areas in which it conducts operations. The level of funding for the Com-Centers provided by each of the Industry Participants is intended to be in proportion to the scale of their respective activities, and shall be mutually agreed by the Industry Participants. The procedure to be followed by the Com-Center Operators are set forth below.

2. Staffing

Each Com-Center shall have an operator ("Com-Center Operator") on duty 24 hours per day from the third week of August until the end of the bowhead whale subsistence hunt in Kaktovik for the Kaktovik Com-Center; Nuiqsut for the Deadhorse Com-Center; Barrow for the Barrow Com-Center; Wainwright for the Wainwright Com-Center; **Pt. Lay for the Pt. Lay Com-Center, which will be located in the Pt. Lay Whaling Captains' Association building; and Pt. Hope for the Pt. Hope Com-Center, which will be located in the Pt. Hope Whaling Captains' Association building.** All Com-Center staff shall be local hire.

3. Duties of the Com-Center Operators

The Com-Center Operators shall be available to receive radio and telephone calls and to call vessels as described below. A record shall be made of all calls from every vessel covered by Section II.C., Section II.D.

or Section II.E of this Agreement. The record of all reporting calls should contain the following information:

a. Industry Vessel:

i) Name of caller/vessel.
ii) Vessel location/speed/direction.
iii) Time of call.
iv) Anticipated movements between this call and the next report.
v) Reports of any industry/subsistence whale hunter activities.

b. Subsistence Whale Hunting Boat:

i) Name of caller.
ii) Location of boat or camp.
iii) Time of call.
iv) Plans for travel.
v) Any special information such as caught whale, whale to be towed, or industry/whale or whaler conflict.

c. Report of Industry/Subsistence Whale Hunter Conflict:
In the event an industry/subsistence whale hunter conflict is reported, the appropriate Com-Center Operator shall record:

i) Name of industry vessel.
ii) Name of subsistence whaling captain.
iii) Location of vessels.
iv) Nature of conflict.

If all Vessels and boats covered by Section II. C., Section II.D. or Section II.E of this Agreement have not reported to the appropriate Com-Center within one hour of the recommended time, that Com-Center Operator shall attempt to call all non-reporting vessels to determine the information set out above under the Duties of the Com-Center Operator.

As soon as location information is provided by a Vessel or boat covered by Section II.C., Section II.D. or Section II.E of this Agreement, the appropriate Com-Center Operator shall plot the location and area of probable operations on the large map provided at the Com-Center.

If, in receiving information or plotting it, a Com-Center Operator observes that operations by Industry Participants might conflict with subsistence whaling activities,

such Com-Center Operator should attempt to contact the industry Vessel involved and advise the Industry Participant's Local Representative(s) and the Vessel operators of the potential conflict.

C. COM-CENTER GENERAL COMMUNICATIONS SCHEME

1. Reporting Positions for Vessels Owned or Operated by the Industry Participants

All Vessels shall report to the appropriate Com-Center at least once every six hours commencing with a call at 06:00 hours. Each call shall report the following information:

a. Vessel name/operator of vessel/charter of vessel/project.

b. Vessel location/speed/direction.

c. Plans for movement between the time of the call and the time of the next call; furthermore, the final call of the day shall include a statement of the Vessel's general area of expected operations for the following day, if known at that time.

EXAMPLE: This is the Arctic Endeavor, operated by _____ for _____ at Northstar Island. We are currently at ___'___ north ___'___ west, proceeding SE at ____ knots. We will proceed on this course for ___ hours and will report location and direction at that time.

The appropriate Com-Center also shall be notified if there is any significant change in plans, such as an unannounced start-up of operations or significant deviations from announce course, and such Com-Center shall notify all whalers of such changes. A call to the appropriate Com-Center shall be made regarding any unsafe or unanticipated ice conditions.

2. Reporting Positions for Subsistence Whale Hunting Crews

a. All subsistence whaling captains shall report to the appropriate Com-Center at the time they launch their boats from shore and again when they return to shore. All subsistence whaling captains shall report to such Com-Center the initial GPS coordinates of their whaling camps. Additional communications shall be made on an as needed basis. Each call shall report the following information:

i) The crew's location and general direction of travel:

EXAMPLE: This is _____. We are just starting out. We will be traveling north-east from _____ to scout for whales. I will call if our plans change.

ii) The presence of any vessels or aircraft owned or operated by any of the Industry Participants, or their contractors that are not observing the specified guidelines set forth below in Section V, on Avoiding Conflicts.

iii) The final call of the day shall include a statement of the whaling captain's general area of expected operations for the following day, if known at the time.

b. Any subsistence whale hunter preparing to tow a caught whale shall report to the appropriate Com-Center before starting to tow.

EXAMPLE: This is Archie Ahkiviana. I am ___'___ north, ___'___ west. I have a whale and am towing it into _____.

c. Each time a subsistence whaling camp is moved, it shall be reported promptly to the appropriate Com-Center, including the new GPS coordinates.

d. Subsistence whale hunters shall notify the appropriate Com-Center promptly if, due to weather or any other unforeseen event, whaling is not going to take place that day.

e. Subsistence whaling captains shall contact the appropriate Com-Center promptly and report any unexpected movements of their vessel.

D. OBTAINING INFORMATION

1. Monitoring VHF Channel 16

All vessels covered by parts II.C., II.D., and II.E. of this Agreement should monitor marine VHF Channel 16 at all times.

2. Avoidance of Whale Hunting Crews and Areas

It is the responsibility of each Vessel owned or Operated by any of the Industry Participants and covered by Section II.C. or Section II.D. of this Agreement to determine the positions of all of their vessels and to

exercise due care in avoiding any areas where subsistence whale hunting is active.

3. Vessel-to-Vessel Communication

After any Vessel owned or operated by any of the Industry Participants and covered by Section II.C. or Section II.D. of this Agreement has been informed of or has determined the location of subsistence whale hunting boats in its vicinity, the On-Board Communicator is encouraged to contact those boats in order to coordinate movement and take necessary avoidance precautions.

E. THE ON-BOARD INUPIAT COMMUNICATOR

1. Employment and Duties of the Communicator

Each Vessel owned or operated by each of the Industry Participants other than those limited exclusively to vessel traffic, shall employ an On-Board Inupiat Communicator (Communicator). Industry Participants whose seismic acquisition operations are limited to an area exclusively within the barrier islands need employ a Communicator on its sound source vessel only. Each Communicator is to be employed as a Marine Mammal Monitor for the duration of the 2008 operating season on the source Vessel on which he or she is stationed.

As a member of the crew, the Communicator will be subject to the regular code of employee conduct on board the Vessel and will be subject to discipline, termination, suspension, layoff, or firing under the same conditions as other employees of the Vessel operator or appropriate contractor.

Once the source Vessel on which the Communicator is employed is in the vicinity of a whaling area and the whalers have launched their boats, the Communicator's primary duty will be to carry out the communications responsibilities set out in these guidelines. At all other times, the Communicator will be responsible for keeping a lookout for bowhead whales and/or other marine mammals in the vicinity of the Vessel to assist the Vessel captain in avoiding harm to the whales and other marine mammals.

2. Communications

It is the Communicator's responsibility to call the appropriate Com-Center as set out in Section III.B. above. The Communicator will be responsible for all radio contacts between Vessels owned or operated by

each of the Industry Participants and whaling boats covered under Sections II.C. and D. of this Agreement and shall interpret communications as needed to allow the Vessel operator to take such action as may be necessary pursuant to this Agreement.

The Communicator is encouraged to contact directly subsistence whaling boats that may be in the vicinity to ensure that conflicts are avoided to the greatest possible extent.

The Communicator will maintain a record of his or her communications with each Com-Center and the subsistence whaling boats.

F. STANDARDIZED LOG BOOKS

The Industry Participants will provide the Com-Centers and Communicators with identical log books to assist in the standardization of record keeping associated with communications procedures required pursuant to this Agreement.

IV. AVOIDING CONFLICTS DURING THE 2008 OPEN WATER SEASON

Federal law requires that offshore oil and gas activities **will not have an unmitigable adverse impact on the availability of marine mammal resources for taking for subsistence uses**. (MMPA §§ 100 (a)(5)(A), (D)).

To assist the Industry Participants in meeting this statutory requirement, the following Operating Guidelines apply throughout the bowhead whale migration in the Beaufort and Chukchi Seas, except as otherwise specified and in all cases with due regard to environmental conditions and operational safety. These Operating Guidelines are in addition to any permit restrictions or stipulations imposed by the applicable governmental agencies.

A. GENERAL PROVISIONS FOR AVOIDING INTERFERENCE WITH BOWHEAD WHALES OR SUBSISTENCE WHALE HUNTING ACTIVITIES

1. Routing Vessels and Aircraft

a. All Vessel and aircraft routes shall be planned so as to minimize any potential conflict with bowhead whales or subsistence whaling activities. All Vessels shall avoid areas of active or anticipated (as reported pursuant to Section III.C.2. above) whaling activity.

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b. Beaufort Sea

Beginning with spring break-up and until fall freeze-up, all vessels transiting east of Bullet Point, to the Canadian border should remain at least five (5) miles offshore during transit along the coast.

c. Chukchi Sea

Vessels should remain a minimum of 30 miles offshore during transit.

2. Aircraft Altitude Floor and Flight Path

AIRCRAFT SHALL NOT OPERATE BELOW 1500 FEET unless approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or other emergency situations.

Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least five (5) miles inland until the aircraft is directly south of its offshore destination, then at that point it shall fly directly north to its destination.

3. Vessel Speeds

Vessels shall be operated at speeds necessary to ensure no physical contact with whales occurs, and to make any other potential conflicts with bowhead whales or whalers unlikely. Vessel speeds shall be less than 10 kts in the proximity of feeding whales or whale aggregations.

4. Vessels Operating in Proximity to Migrating Bowhead Whales

If any Vessel inadvertently approaches within 1.6 kilometers (1 mile) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the Vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

a. reducing vessel speed within 900 feet of the whale(s);

b. steering around the whale(s) if possible;

c. operating the Vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

d. operating the Vessel(s) to avoid causing a whale to make multiple changes in direction; and

e. checking the waters immediately adjacent to the Vessel(s) to ensure that no whales will be injured when the propellers are engaged.

5. Good Faith Understanding of Vessel Traffic after August 15, 2008

After August 15, 2008 an Industry Participant conducting Vessel traffic within the bowhead migration route shall first consult with the AEWC and affected village whaling captains when the bowhead whale migration is in motion. It is understood that any supply vessels that are caught in the ice or the circulating ice pack will stay close to the ice edge or 35 miles offshore, whichever distance is closer to shore, throughout the migration route and during the subsistence whaling activities. As used in this paragraph, "migration route" means the fall bowhead whale migration beginning in the Canadian Beaufort Sea and extending to St. Lawrence Island, Alaska. If any operator requires emergency vessel movement, the Operating Guidelines set forth in this Section IV. of this Agreement will dictate the procedures to be followed.

B. OPERATING LIMITATIONS

1. Geophysical Operations

The AEWC agrees to this 2008 CAA with the understanding that **only** two (2) geophysical operations will occur at any one time in either the Beaufort or the Chukchi Seas. The Industry Participants conducting geophysical operations agree to coordinate the timing and location of such operations so as to reduce, by the greatest extent reasonably possible, the level of noise energy entering the water from such operations at any given time and at any given location. The following operating limitations are to be observed and the operations are to be accompanied by a Monitoring Plan as set forth in Section II.J. and Attachment III. of this Agreement.

a. Beaufort Sea

All geophysical activity in the Beaufort Sea shall be confined

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as set forth below.

(i) Kaktovik: No geophysical activity from the Canadian border to the Canning River (~146 deg. 4 min. W) from 10 August to close of fall bowhead whale hunt in Kaktovik and Nuiqsut.[1]

(ii) Nuiqsut:

a. Pt. Storkerson(~148 deg. 42 min. W) to Thetis Island **(~150 deg. 10.2 min. W)**

i. *Inside the Barrier Islands*: No geophysical activity prior to August 5, geophysical activity allowed from August 5 until completion of operations[2]

ii. *Outside the Barrier Islands:* No geophysical activity from 25 August to close of fall bowhead whale hunting in Nuiqsut; geophysical activity allowed at all other times.

b. Canning River (~146 deg. 4 min. W) to Pt. Storkerson (~148 deg. 42 min. W): No geophysical acquisition from August 25 to the close of bowhead whale subsistence hunting in Nuiqsut.

(iii) Barrow: No geophysical activity from Pitt Point on the east side of Smith Bay (~152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from 15 September to close of fall bowhead whale hunting in Barrow.

b. Chukchi Sea

(i) Geophysical activity may not commence in the Chukchi Sea prior to July 20, 2008.

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[1] Marine mammal subsistence hunting in any village shall be considered closed when the hunt in that village has ended, or in the case of the bowhead whale subsistence hunt, the village quota has been exhausted (as announced by the village Whaling Captains' Association or the AEWC).

[2] Geophysical activity allowed in this area after August 25 shall include a source array of no more than 12 air guns, a source layout no greater than 8 m x 6 m, and a single source volume no greater than 880 in^3.

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(ii) Geophysical activity may occur beginning July 20 and ending September 10, 2008, unless otherwise specifically authorized by the Whaling Captains' Associations of Wainwright, Pt. Lay, and Pt. Hope, and the AEWC, but in any case no closer than 60 miles from the Chukchi Sea coast at any point.

(iii) Geophysical exploration may resume following the close of the fall 2008 bowhead whale subsistence hunt in Barrow, Wainwright, Pt. Lay, and Pt. Hope, unless specifically authorized by the Whaling Captains' Associations of Barrow, Wainwright, Pt. Lay, and Pt. Hope, and the AEWC.

(iv) Safe harbor will not be taken within 50 miles of any village, except when human life is in danger, and then ships shall be moved to a distance of at least 50 miles from the village at the earliest possible opportunity, and shall be moved out to sea as soon as weather permits.

(v) Any vessel operating within 60 miles of the Chukchi Sea coast will follow the communications procedures set forth in Section III of this Agreement. All vessels will adhere to the conflict avoidance measures set forth in Section IV.A. of this Agreement.

(vi) If a dispute should arise, the dispute resolution process set forth in Section VI. of this Agreement shall apply.

2. Drilling Operations

a. Zero Discharge of Drilling Muds, Cuttings, Ballast Water, and Produced Water

For all drilling operations, whether for exploration, development, or production, in the Beaufort, Chukchi, and Bering Seas habitat of the bowhead whale, no discharge of drilling muds, cuttings, ballast water, or produced water shall be allowed into the marine environment. All such material shall be disposed of through reinjection or backhaul for onshore disposal.

b. Sampling of Drilling Muds and Cuttings

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For all exploratory drilling operations, in the Beaufort, Chukchi, and Bering Seas habitat of the bowhead whale, the operator, upon written request by the AEWC, shall cooperate with the AEWC and North Slope Borough in the collection of samples, by representatives of the NSB Department of Wildlife Managment, from all drilling muds and cuttings, irrespective of storage or disposal procedures.

c. Monitoring of Gray Water, Black Water, and Heated Water

For all exploratory drilling operations in the Beaufort, Chukchi, and Bering Seas habitat of the bowhead whale, the operator shall cooperate with the AEWC and North Slope Borough in the design and implementation of a program to monitor the composition or temperature and the fate of all discharged materials and impacts to migratory resources from any materials dumped into the Arctic Ocean.

d. Drilling Operations in the Beaufort Sea East of Cross Island

No drilling equipment or related vessels shall be onsite at any offshore drilling location east of Cross Island from 25 August until the close of the bowhead whale hunt in Nuiqsut and Kaktovik. However, such equipment may remain within the Beaufort Sea **north of 71.25 N or at the edge of the arctic ice pack, whichever is closer to shore, and west of 146.4 W.**

e. Beaufort Sea West of Cross Island

No drilling equipment or related vessels shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

C. SHORE-BASED SERVICE AND SUPPLY AREAS

Shore-based service and supply areas used by Industry Participants shall be located and operated so as to ensure compliance with the terms of this Agreement.

V. REGULATORY COMPLIANCE

A. UNITED STATES COAST GUARD REQUIREMENTS

The Industry Participants shall comply with all applicable United States

Coast Guard (USCG) requirements for safety, navigation and notice.

B. ENVIRONMENTAL REGULATIONS AND STATUTES

The Industry Participants shall comply with all applicable environmental regulations and statutes.

C. OTHER REGULATORY REQUIREMENTS

The Industry Participants shall comply with all applicable federal, state and local government requirements.

VI. DISPUTE RESOLUTION

Subject to the terms of Section II.B.7 of this Agreement, all disputes arising between any Industry participants and any Subsistence Participants shall be addressed as follows:

First between the affected Participant(s) in consultation with the affected village Whaling Captains' Association and the Industry Participant(s)' Local Representative.

It the dispute cannot be resolved to the satisfaction of all affected Participants, it shall be addressed by the affected Participants in consultation with the AEWC.

If the dispute cannot be satisfactorily resolved in this manner, it shall be addressed with the AEWC and the Participants in consultation with representatives of NOAA Fisheries.

VII. EMERGENCY AND OTHER NECESSARY ASSISTANCE

A. EMERGENCY COMMUNICATIONS

ALL VESSELS SHOULD NOTIFY THE APPROPRIATE COM-CENTER IMMEDIATELY IN THE EVENT OF AN EMERGENCY. The appropriate Com-Center Operator will notify the nearest Vessels and appropriated search and rescue authorities of the problem and advise them regarding necessary assistance. (See attached listing of local search and rescue organizations in Attachment I.)

B. EMERGENCY ASSISTANCE FOR SUBSISTENCE WHALE HUNTERS

33 U.S.C. 916c provides for the use of a vessel to tow a whale taken in a

traditional subsistence whale hunt permitted by Federal law and conducted in waters off the coast of Alaska is authorized, if such towing is performed upon a request for emergency assistance made by a subsistence whale hunting organization formally recognized by an agency of the United States government, or made by a member of such an organization, to prevent the loss of a whale.

VIII. OIL SPILL MITIGATION

Unless otherwise agreed with the AEWC, Industry Operators engaged in oil production or in drilling operations in or near known or suspected oil reservoirs will agree to adhere to the AEWC/NSB/Inupiat Community of the Arctic Slope oil spill mitigation agreement. **(GNP) This must be completed by Shell for this 2008 CAA for the drilling operations in Camden Bay.**

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SIGNATORIES:

Harry Brower Jr
Harry Brower
Chairman, AEWC
Dated: 6/4/08

Harry Brower Jr
Harry Brower
AEWC Commission for Barrow
Dated: 6/4/08

Archie Ahkiviana
AEWC Commissioner for Nuiqsut
Dated: _____

Joe Kaleak
AEWC Commissioner for Kaktovik
Dated: _____

Jack Panik
AEWC Commissioner for Wainwright
Dated: _____

Ray Koonook
AEWC Commissioner for Pt. Hope
Dated: _____

BP Exploration (Alaska), Inc.
Dated: 30 MAY 2008

Pioneer Natural Resources Alaska.
Dated: _____

ENI
Dated: _____

Shell Offshore, Inc.
Dated: _____

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Chuck Robinson	ASRC Energy Services
PGS Onshore, Inc.	
Dated: _____	Dated: _____

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ATTACHMENT I

LOCAL SEARCH AND RESCUE ORGANIZATIONS - CONTACT PERSONS
(IN EMERGENCIES, ALWAYS DIAL 911)

North Slope Borough			
Search and Rescue (Pilots)			
Director Richard Patterson		852-2822 WK	852-2496 Home
Hugh Patkotak		852-2822 WK	852-4844 Home
Barrow Volunteer			
Search and Rescue Station			852-2808 OFS
President	Oliver Leavitt	852-7032 WK	852-7032 Home
Vice-Pres.	Price Brower	852-8633 WK	852-7848 Home
Secretary	Lucille Adams	852-0250 Wk	852-7200 Home
Treasurer	Eli Solomon	852-2808 Wk	852-6261 Home
Coordinator	Arnold Brower, Jr.	852-0290 WK	852-5060 Home
Director	Jimmy Nayakik	852-0200 WK	852-JENS Home
Director	Johnny Adams	852-0250 WK	852-7724 Home
Nuiqsut Volunteer			
Search and Rescue Station		480-6613 (Fire Hall)	
Kaktovik Volunteer			
Search and Rescue Station		640-6212 (Fire Hall)	
President	Lee Kayotuk	640-5893 Wk	640-6213 Home
Vice-Pres.	Tom Gordon	640-	
Secretary	Nathan Gordon	640-6925	
Treasurer	Don Kayotuk	640-2947	
Fire Chief	George T. Tagarook	640-6212 WK	640-6728 Home
Wainwright Volunteer Search and Rescue			
President	Joe Ahmaogak Jr.	763-2826 Home	

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Vice President	John Hopson, Jr.	763-3464 Home
Secretary	Raymond Negovanna	763-2102 Home
Treasurer	Ben Ahmaogak, Jr.	763-3030 Home
Director	Artic Kittick	763-2534 Home
Director	John Akpik	Unlisted

Pt. Hope Volunteer Search and Rescue

Coordinator	Andrew Tooyak Jr.	368-2071 Home
Fire Chief	Willard Hunnicutt	368-2774 Wk (Note: Only contact for Pt. Hope)

North Slope Borough Disaster Relief Coordinator

Frederick Brower	852-0284 OFS

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ATTACHMENT II

VESSELS TO BE USED FOR AND IN SUPPORT OF INDUSTRY PARTICIPANTS' OPERATIONS AS IDENTIFIED IN SECTION II. C.1.

[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION ATTACHED TO THE ORIGINAL FOR SIGNATURE

CAA IDENTIFYING THE VESSELS TO BE USED FOR AND IN SUPPORT OF INDUSTRY PARTICIPANTS' OPERATIONS.

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ATTACHMENT III

VESSELS TO BE USED FOR AND IN SUPPORT
OF THE INDUSTRY PARTICIPANTS MONITORING PLANS
AS IDENTIFIED IN SECTION II. C. 2.
[ALL VESSELS TO BE IDENTIFIED BY COMPANY]

NOTE:

COPY OF PRESENTATION OF THE INDUSTRY PARTICIPANT ATTACHED IDENTIFYING VESSELS TO BE USED FOR AND IN SUPPORT OF THE INDUSTRY PARTICIPANTS MONITORING PLAN.

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APPENDIX D: VESSEL SPECIFICATIONS

M/V ALAGANIK BARGE AND HOOK POINT BOAT

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
M/V Alaganik	24 (80)	7 (24)	0.9 (3)	None	none
Hook Point	10 (32)	5 (15)	0.6 (2)	2 x Caterpiller 328T	315 each

The *M/V Alaganik* and *Hook Point* are commercial fishing vessels with oceanographic research certification. The *Hook Point* is a tugboat, used to power the *M/V Alaganik* barge. The *M/V Alaganik* was equipped for this seismic survey to be used for recording and equipment staging.

M/V ARCTIC WOLF

VESSEL	LENGTH M (FT))	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
M/V Arctic Wolf	41.2 (135)	11.6 (38)	1.4 (4.5)	3 x Caterpillar 3406	425 each

The *M/V Arctic Wolf* is a multipurpose, shallow-draft, ice strengthened landing craft with a steel hull. As a geophysical or geotechnical research platform, the vessel has an aft covered deck, helideck, an open archway, a moon pool, and a four point anchoring system. As a supply vessel or tug, the Arctic Wolf is equipped with a bow mounted ramp and a deck crane to facilitate cargo transfer and pushing knees to engage cargo barges. The comfortable staterooms generally accommodate 24 people; however the staterooms were modified for this survey to house more than 30 as the vessel was used primarily to accommodate seismic crew.

F/V CANVASBACK

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
F/V Canvasback	9.8 (32)	4.3 (42)	0.6 (2)	2 x Cummins	315 each

The *F/V Canvasback* is a modern Alaska aluminum bowpicker fishing vessel. The vessel's 11 x 11 foot cabin is offset 22 inches to port for a lead line shoot or walkway, and the vessel has a ladder on the stern to the fly ing 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, bo w anchor, steering station, and rain gear locker. Flush deck fish holds are amidships, and a. wheel house containing helm and acco mmodations is aft. A ccess to the cabin is t hrough a watertight alum inum companionway forward.

Forward to port in the cabin is the hel m station with bench seat and navigation equipment; next aft is galley containi ng oil sto ve, sink, coun ter, 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.

F/V CAPE FEAR

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
F/V Cape Fear	9.8 (32)	3.8 (12.5)	0.6 (2)	2 x Cummins	315 each

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 a midships and wheel house containing helm and accommodations aft. Access to cabin is through a watertight aluminum companionway forward.

Forward to port in the cabin is a helm station with bucket seat and navigation equipment; next aft is the 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 the back of the cabin.

NO PICTURE

F/V MARIAH B

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
F/V Mariah B.	10.4 (34)	4 (13)	0.4 (1.3)	2 x Cummins	440 each

The *F/V Mariah B* was used as HSE support and as a backup for crew transfers. The aft deck was equipped with swing-stations port and starboard for crew transfer and guardrails boarder the perimeter deck around the sides and bow. Forward-port is the helm with electronics and bucket seat. Next aft is galley area with sink and counter. The starboard cabin holds a mess table with bench seating and storage, with a marine head forward starboard. Forward-most of the cabin are two bunks for the crew.

M/V MISS DIANE

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
M/V Miss Diane	16.8 (55)	5.5 (18)	2 (0.6)	John Deere	300

The *M/V Miss Diane* is an all aluminum plate constructed landing craft style vessel with a semi-v bottom square transom stern and a raked bow. The bow has a gate that rises hydraulically with cable and pulley operations from port and starboard sides. The vessel can accommodate up to 6 people and has one complete head with shower. There is one aluminum channel H-frame on the stern. This articulates on lower aluminum brackets with two hydraulic rams.

M/V PEREGRINE

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
M/V Peregrine	27.4 (90)	7.3 (24)	0.9 (3)	3 x Cummins	405 each

The *M/V Peregrine* is an all aluminum plate constructed landing crafts style vessel with a semi-v bottom square transom stern and a raked bow. The bow has a bow gate that rises 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.

The *M/V Peregrine* can accommodate up to 13 people, but for this survey accommodated nine. There is a full galley, washer/dryer, and two complete heads with shower.

There are two aluminum channel H-frames on port and starboard sides of stern. These articulate on lower aluminum brackets with two each hydraulic rams. There is an 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. The roller assembly is operated by dual hydraulic rams on aluminum bar stock for thwart ship movements.

M/V QAYAQ SPIRIT

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
M/V Qayaq Spirit	12.8 (42	4.3 (14)	0.6 (2)	3 Yanmar Jet	1 x 440, 2 x 420

The *M/V Qayaq Spirit* has a beachable aluminum hull with seating for 34 people and a covered back deck. There are two swing stations, port and starboard, off the aft deck and a fold down ladder ramp for loading people from the beach. Cruise speed is approximately 30 kts when fully loaded. Forward starboard cabin is the helm with bucket seat and electronics. Forward center cabin is a window-door which opens to the forward deck which holds the anchor and ladder ramp.

F/V RUMPLE MINZE

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
F/V Rumple Minze	9.8 (32)	4.3 (14)	0.6 (2)	2 Caterpillar	505 each

The F/V Rumple Minze is a modern Alaska aluminum bowpicker fishing vessel with a house haft and self-bailing open deck forward containing net reel, steering station, and rain gear locker. Flush deck fish holds are a midships and wheel house containing helm and accommodations aft. Access to cabin is through a watertight aluminum companionway forward.

Forward to port in the cabin is a helm station with bucket seat and navigation equipment; next aft is the galley containing stoves, sink, counter, and storage. To starboard is the settee with bench seating and storage. Next aft is a marine head. Two stacking bunks are located at the back of the cabin.

F/V SLEEP ROBBER

VESSEL	LENGTH M (FT)	BEAM M (FT)	DRAFT M (FT)	ENGINE(S)	ENGINE(S) POWER (HP)
F/V Sleep Robber	9.8 (32)	4.3 (14)	0.6 (2)	2 x Volvo Penta	318 each

The *F/V Sleep Robber* has a welded aluminum hull and has one deck, hinged navigation mast, raked stern, transom stern, hard chined planning hull, self bailing open work deck forward, net reel and fish holds midships, and aft cabin.

The foredeck is surrounded by 28 x 32 inch bulwarks and contains a bow mounted power roller. Next aft is a flush deck hatch, to the forward a void/storage compartment, to the starboard forward is 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.

The flying bridge is accessed by steps from port aft and contains an engine removal hatch with aluminum cover, plastic seat/storage locker, and full width console with helm. The cabin is entered by a watertight aluminum door from midships forward and contains from port aft, the galley with cupboard and counter space. Next forward is the helm with seat, full engine controls and to starboard is a messing table with fore and aft seating. Three tiered bunks are aft. Hatches in cabin sole access the engine room.

APPENDIX E: HABITAT, ABUNDANCE AND CONSERVATION STATUS OF MARINE MAMMALS OCCURRING IN THE BEAUFORT SEA.

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] No	t 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]	Endangere d	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]	Threatened L	R-cd	–

* Not likely to occur in the Liberty survey area

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

APPENDIX F: DEFINITIONS OF BEAUFORT WIND FORCES

Wind Speed		Beaufort Wind Force	World Meteorological Organization Terms	Wave Height (m)	Description
kts	km/h				
<1	<1.9	0	Calm	0	Glassy like a mirror
1-3 1.	9-5.6	1	Light air	<0.1	Ripples with the appearance of scales but no whitecaps or foam crests
4-6 7.	4-11.1	2	Light breeze	0-0.1	Small wavelets, crests have a glassy appearance but do not break (no whitecaps)
7-10 13.0-18.5		3	Gentle breeze	0.1-0.5	Smooth large wavelets, crests begin to break, occasional/scattered whitecaps
11-16 20.4-29.6		4	Moderate breeze	0.5-1.2	Slight; small fairly frequent whitecaps
17-21 31.5-38.9		5	Fresh breeze	1.2-2.4	Moderate waves becoming longer, some spray, frequent moderate whitecaps
22-27 40.7-	50 6		Strong breeze	2.4-4	Rough, larger waves, longer-formed waves, many large whitecaps
28-33 51	.9-61.1	7	Near gale	4-6	Very rough, large waves forming, white foam crests everywhere, spray is present
34-40 63	.0-74.1	8	Gale		
41-47 75	.9-87.0	9	Strong gale		
48-55	88.9-101.9	10 St	orm	6-9	High
56-63	103.7-116.7	11	Violent storm	9-14	Very high

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APPENDIX G: LOG OF CALLS TO THE COM.CENTERS BY THE MMOS ABOARD THE *ARCTIC WOLF* DURING ITS TRANSIT FROM THE PORT OF ANCHORAGE TO WEST DOCK, 26 JUNE – 20 JULY 2008.

Date	Time	Caller's Name	Com.Center Contacted	Vessel Speed (kts)	Latitude	Longitude	Planned Destination or Activities & Comments
30-June 1	010	William Aguvluk	Barrow	8.6	57.07431	164.16184	Nome
2-July	555	William Aguvluk	Wainwright	5	64 27.510	165 28.347	Nome. There's ice in Wainwright moving out slow
3-July	1221	William Aguvluk	Pt. Hope	8.6	64 30.047	165 25.175	Left Nome 12:05, heading north.
3-July	1229	William Aguvluk	Wainwright	8.6	64 30.047	162 25.175	Left Nome 12:05, heading north towards Pt. Hope
5-July	500	William Aguvluk	Wainwright	7	69 53.124	166 06.505	There's ice north of Wainwright. Heading to Wainwright.
6-July	804	William Aguvluk	Wainwright	6.1	70 29.742	162 36.318	Towards Icy cape. Ice beach up at Wainwright.
6-July	1418	William Aguvluk	Barrow	0.2	70 20.132	162 45.603	Towards Icy cape. Barrow com-center working off vhf radio
7-July	817	William Aguvluk	Wainwright	1.2	70 20.589	163 29.679	Ice info: 0.5 mile off Wainwright.
7-July	1715	William Aguvluk	Wainwright	8.2	70 24.105	163 31.751	Towards Icy cape. Leaving at 1630.
9-July	1905	David Hopson	Wainwright	0	70 27.304	162 00.967	Anchored in Icy Cape. Still no open water near Wainwright.
10-July	1337	William Aguvluk	Wainwright	0	70 27.304	162 00.967	Anchored in Icy Cape. "Give location 4 miles of Icy Cape."
11-July	1344	William Aguvluk	Wainwright	0	70 27.282	162 01.119	Anchored in Icy Cape. Wainwright com-center line busy
11-July	1607	William Aguvluk	Wainwright	0	70 27.275	162 01.115	Ice 1.5 miles from shoreline from Wainwright
12-July	814	William Aguvluk	Barrow	0	70 37.332	160 08.179	Anchored at Wainwright. Received ice info at Barrow.
14-July	0:00	William Aguvluk	Wainwright	2.4	70 45.931	159 43.911	Heading back to Wainwright
15-July	2118	William Aguvluk	Barrow	0	70 46.115	159 42.783	Gave location 8 miles South of Atanik
16-July	1702	William Aguvluk	Barrow	7.8	70 56 378	158 58.775	Ice here and there. Barrow com-center
17-July	808	William Aguvluk	Barrow	0	70 53.036	159 05.638	Anchored by Franklin Pt. Gave info on ice from Franklin Pt to Pearl Bay.
17-July	1025	David Hopson	Barrow	0	70 53.038	159 05.642	Get pass pt. Barrow and on to Prudhoe Bay
17-July	1155	David Hopson	Barrow	0	70 53.038	159 05.642	Called Barrow com-center on VHF and they didn't respond
17-July	1220	William Aguvluk	Barrow	4.6	70 56.256	158 48.523	Arctic Wolf Moving toward Peard Bay or Barrow
17-July	1605	William Aguvluk	Barrow	6.8	70 06.059	157 55.486	23 miles from Pt. Franklin. Heading to Barrow.
19-July	1623	William Aguvluk	Barrow	6.7	71 05.521	154 23.6	Gave info that we're near Smith Bay
20-July	1420	William Aguvluk	Barrow	7.8	70 30.668	148 42.817	Gave info that Arctic Wolf is at Prudhoe Bay.

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APPENDIX H: ENVIRONMENTAL MONITORING AND MITIGATION END-OF-SURVEY REPORT (AERTS & BLEES 2008).

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ENVIRONMENTAL MONITORING AND MITIGATION DURING BPXA 2008 LIBERTY SHALLOW WATER SEISMIC SURVEY IN FOGGY ISLAND BAY, BEAUFORT SEA, JULY-AUGUST 2008

END-OF-SURVEY REPORT

Prepared by

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

For

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

ENVIRONMENTAL MONITORING AND MITIGATION DURING BPXA 2008 LIBERTY SHALLOW WATER SEISMIC SURVEY IN FOGGY ISLAND BAY, BEAUFORT SEA, JULY-AUGUST 2008

END-OF-SURVEY REPORT

Prepared by:

Lisanne A.M. Aerts & Megan K. Blees

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

for

BPXA EXPLORATION (ALASKA) INC.
Dept. of Health, Safety & Environment
900 East Benson Blvd.
P.O. Box 196612
Anchorage, Alaska 99519-6612

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EXECUTIVE SUMMARY

BPXA Exploration Alaska Inc. (BPXA) conducted a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea during July/August 2008. During the planning and design phase of the seismic survey, BPXA worked with LGL to develop monitoring and mitigation plans for marine mammals, marine and coastal birds, fish, and the Boulder Patch area. This report describes the monitoring activities that were conducted and presents the results of those activities to satisfy the MMS G&G permit requirement for a completion report.

Bird nest searches were conducted along the Endicott causeway and Duck Island. In these two areas, seismic cable laying activities were planned during periods when common eider nests could still be present. A total of 3 active nests were found along the causeway. All 3 nests were abandoned in early August and no cable laying activities were conducted on the Endicott causeway and Duck Island. None of these nests were therefore disturbed by the seismic activities.

To obtain information on potential damage to marine biota in the Boulder Patch area, the number of kelp fronds that were entangled in seismic cables were collected or estimated during retrieval activities. The estimated number of kelp fronds was highly variable and there was no clear pattern in the number of kelp fronds and the presence of known Boulder Patch areas. Stormy weather conditions seemed to have a higher influence on the estimated amount of kelp collected than density of boulders and cobbles.

A basic survey was conducted to determine if mortality or injury could be observed in fish exposed to airgun sounds at a very close range. For this purpose, one of the support vessels opportunistically followed two seismic source vessels while operating a 440 in^3 airgun array. Results showed that airguns operating in the conditions and locations of the Liberty seismic survey do not result in obvious fish mortality or injury.

During the seismic survey there were a total of 18 seal sightings, 5 whale sightings and 2 in-water polar bear sightings. A total of 3 seal carcasses were encountered. More details of the marine mammal and acoustic monitoring and mitigation program will be provided in the 90-day report to NMFS and USFWS.

1. BACKGROUND AND INTRODUCTION

BPXA Exploration Alaska Inc. (BPXA) conducted a 3D, ocean bottom cable (OBC) seismic survey in the Liberty area of the Alaskan Beaufort Sea during July/August 2008. The Liberty 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).

During the planning and design phase of the Liberty OBC Seismic survey, BPXA worked with LGL Alaska Research Associates, Inc. (LGL) to develop biological assessments that address potential impacts to marine and coastal birds, fish, and the Boulder Patch and to identify mitigation and monitoring measures to minimize those impacts. These three biological assessments provided input to the permitting process for the Geological & Geophysical Permit (G&G permit) issued by the Mineral Management Service (MMS), permits issued by the Corps of Engineers (COE), and by the North Slope Borough Planning Department (NSB-PD). In addition to the biological assessments, authorizations were issued under the Marine Mammal

Protection Act: (1) an Incidental Harassment Authorization for whales and seals by the National Marine Fisheries Service, (NMFS), and (2) a Letter of Authorization for polar bears and walrus by the US Fish and Wildlife Service (USFWS).

As part of the seismic data acquisition several environmental monitoring surveys were conducted. These surveys included: a) observations of marine mammals by marine mammal observers (MMOs) on both seismic source boats; b) acoustic measurements of the airgun arrays, of all vessels used and of the combined acoustic footprint inside and outside the barrier islands; c) surveys to search for bird nests; d) a fish survey to identify potential for immediate fish mortality due to proximity to seismic sounds; and e) monitoring of potential Boulder Patch damage. The objective of these environmental surveys was to minimize impacts and/or increase understanding of potential impacts identified.

1.1 Purpose of this Report

The main purpose of this end-of-survey report is to satisfy the MMS G&G permit requirement to submit a final report within 30 days after the completion of operations on September 1, 2008. This specific final report focuses on the environmental studies of the project and mainly contains information on monitoring activities related to birds, Boulder Patch and fish.

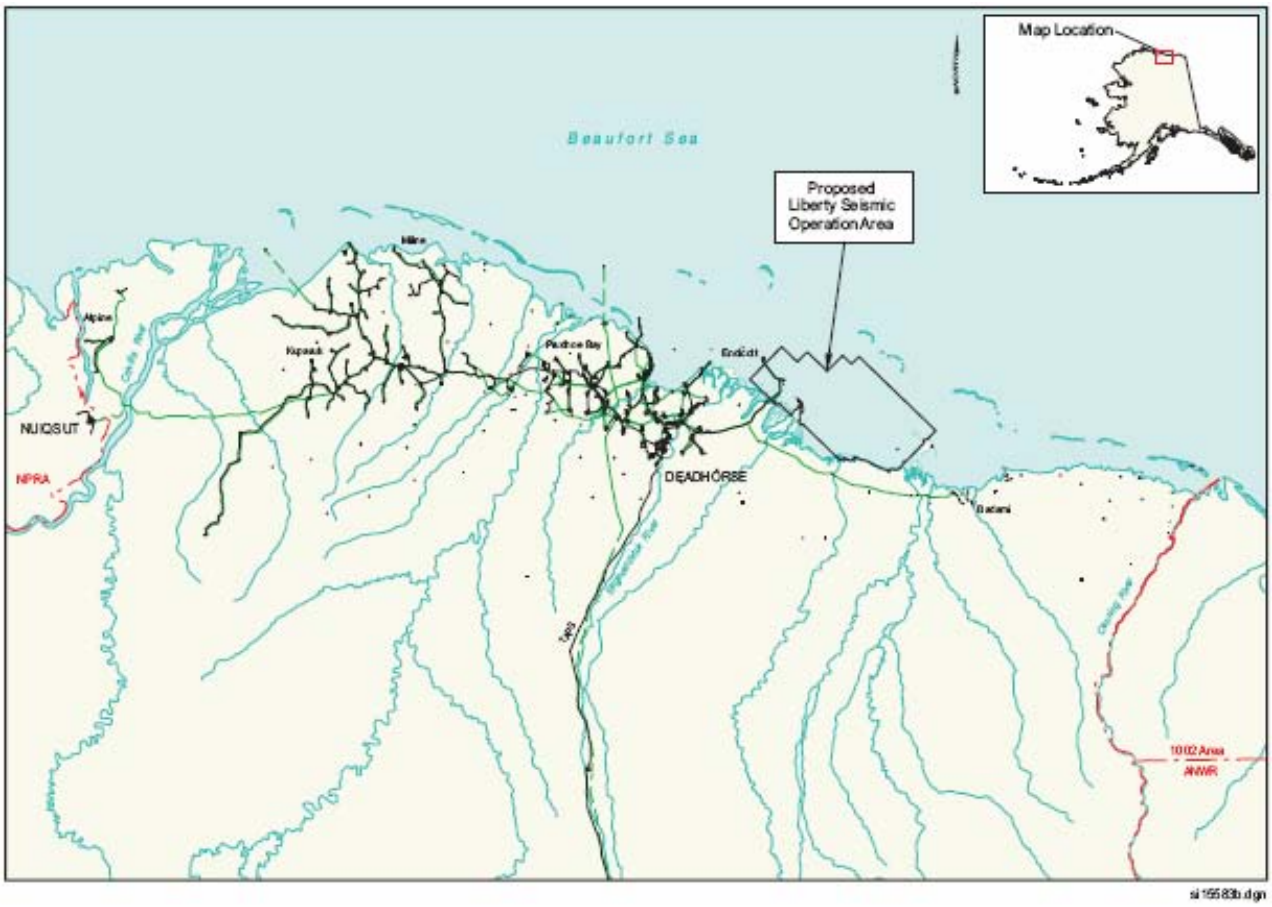

FIGURE 1. OVERVIEW OF THE LIBERTY SEISMIC SURVEY AREA (BACK SQUARE) WITHIN THE EASTERN ALASKAN BEAUFORT SEA.

2. SEISMIC SURVEY DESCRIBED

An OBC seismic survey involves the lowering of seismic cables from the cable boats for placement on the ocean bottom within the targeted seismic acquisition area. Attached to the cable are sensors (hydrophones/geophones) which detect seismic energy data reflected from underground rock strata. The collected seismic data is transmitted to the recorder vessel for recording. The energy sources used during this survey are airguns towed by the source vessels traveling orthogonally over the patch of hydrophones.

The OBC seismic survey conducted by BPXA in the Liberty prospect area was conducted by 2 seismic source boats (*M/V Peregrine* and *M/V Miss Diane*), 4 cable boats (*Canvasback*, *Cape Fear*, *Rumple Minze* and *Sleep Robber*), a recorder boat/barge combination (*Alaganik/Hook Point*), 2 crew boats/support vessels (*Qayaq Spirit* and *Mariah B*) and a housing vessel (*M/V Arctic Wolf*). The ACS boat *Gwydyr Bay* substituted for a crew boat for several days when crew boat repairs were required. All vessels operated in accordance with the provisions of the permits.

2.1 Operating areas, Dates and Navigation

The geographic region where the OBC seismic survey occurred was located in Foggy Island Bay, Beaufort Sea in water depths between a few inches and 25 ft (7.6 m). The project area encompassed about 135.8 mi^2 (351.8 km^2), with the approximate boundaries between N70°11' and N70°23' and W147°10' and W148°02' (Figure 2).

All vessels, except the housing vessel *M/V Arctic Wolf*, were trucked to the North Slope during the week of 23 June. The vessels were rigged and equipment was loaded at West Dock and the West Dock Staging Pad. The Arctic Wolf mobilized from the Port of Anchorage on June 26, with a planned 2 week travel to West Dock. Due to ice conditions in the Chukchi Sea and around Barrow, the total transit time took about 3 weeks and the *Arctic Wolf* arrived at West Dock on July 20. Here she took on new provisions, water and fuel before proceeding to the project area on July 22.

The seismic survey in the Liberty area started July 15 with the lay-out of the first cable. Seismic data acquisition started July 24 and ended at 03:40 AM on August 25 in accordance with the Conflict Avoidance Agreement (CAA). The two source boats and crew vessels transited to West Dock for demobilization on August 25. The cable boats, the housing boat and the recorder operated in the survey area for another day, until August 26, to retrieve the last cables. The Peregrine was released to another operator after August 25 and the Arctic Wolf was released from duty on the project and picked up another contract effective August 26, 2008. All remaining vessels demobilized at West Dock and were trucked south. On August 29, a boat with divers transited to and from the survey area and recovered a battery that the crew had been unable to retrieve. Operations were completed September 1, 2008.

2.2 Airgun Description

Two source boats were used during this seismic survey, the *M/V Peregrine* and the *M/V Miss Diane.* The *M/V Peregrine* was mainly used for the deeper parts of the survey area (mostly >10 ft or 3 m) and the *M/V Miss Diane* for the shallower areas (<10 ft or 3 m). Both source boats were towing two arrays. The *M/V Peregrine* towed two 440 in^3 arrays comprised of four airguns in clusters of 2 x 70 in^3 and 2 x 150 in^3. The *M/V Miss Diane* towed two 220 in^3 arrays, comprised of two guns of 1 x 70 in^3 and 1 x 150 in^3. Aside from some test runs with the 880 in^3

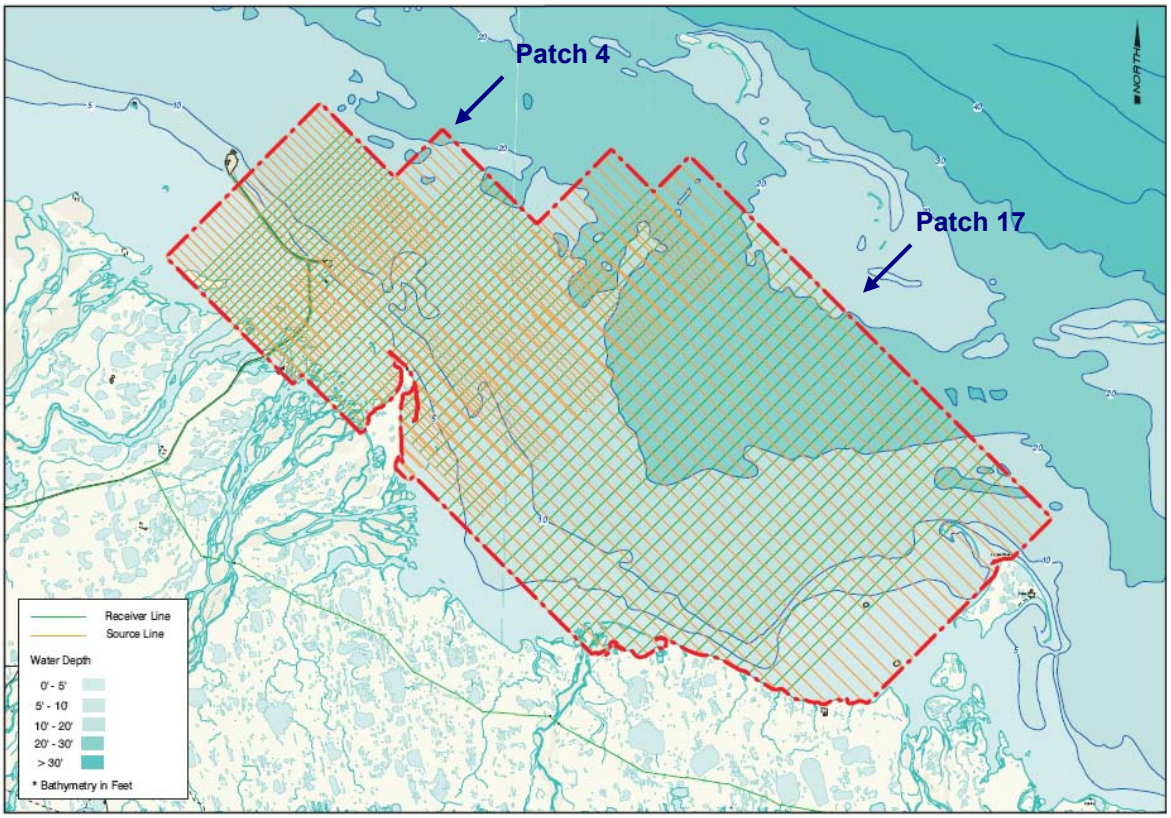

FIGURE 2. LIBERTY SEISMIC SURVEY AREA WITH PRE-SURVEY RECEIVER AND SOURCE LINES. SEISMIC DATA WERE ACQUIRED FROM PATCH 4 TO 17 AND IN ONLY A VERY SMALL PORTION OF PATCH 18.

array of the *M/V Peregrine*, the maximum volume used by both boats during seismic data production was 440 in^3.

The arrays were towed at a distance of ~26-32 ft (~8-10 m) from the source vessel at depths of 6 ft (1.8 m) on the *M/V Peregrine* and 3.5 ft (1.1 m) on the *M/V Miss Diane*. Both vessels traveled along pre-determined lines at an average speed of 3 knots. Each source vessel fired shots every 12 seconds, resulting in 6 second shot intervals in situations where both vessels were operating simultaneously (ping-pong). When weather and operational conditions allowed, seismic data acquisition was a 24 hr/day operation.

2.3 Short Summary of Work Performed

Seismic data acquisition

Seismic data were acquired on Patches 4 to 17 and on Patch 18 in only a small portion in the center (Figure 2). On Patch 4 to 6, seismic data were only acquired in water depths greater than 2 ft. Geophones were used to collect some shallow water portions of patches 7, 8 and 9. No seismic data were acquired in the remaining patches 1 to 3 and 19 to 22.

Approximately 91.8 mi^2 (237.8 km^2) of data acquisition was completed or approximately 70% of the originally permitted survey area. A total of 107,469 source shot points were taken with seismic data acquired for 93,104 shots. Approximately 360 miles (580 km) of cable were deployed and retrieved. Approximately 61.1 mi^2 (158.2 km^2) or 66.5% of data was collected in state waters with approximately 30.7 mi^2 (79.5 km^2) or 33.5% of the data collected in federal OCS waters.

Wildlife interactions

All OBC activities were conducted in accordance with the marine mammal monitoring and mitigation program as outlined in the IHA and LOA applications and issued authorizations. Each source vessel had designated marine mammal observers (MMOs) onboard with the authority to implement shut down and ramp up procedures. Safety zones for marine mammals were slightly different for both source vessels, mainly due to a different tow depth of the seismic array. On the *M/V Peregrine*, all operations with the 440 in^3 airgun were halted if seals and polar bears where sighted within 250 m or whales and walruses were sighted within 550 m. On the *M/V Miss Diane*, the marine mammal safety distances for the 440 in^3 array were 150 m for seals and polar bears and 300 m for whales and walruses. During the seismic survey there were a total of 18 seal sightings, 5 whale sightings and 2 polar bear sightings in water. A total of 3 seal carcasses were encountered during the survey period. More details of the marine mammal and acoustic monitoring and mitigation program will be provided by LGL Alaska in the 90-day report to NMFS and USFWS, due end of November 2008. The results of the bird, fish, and Boulder Patch surveys are described in Chapter 3, 4 and 5 below.

3. BIRD SURVEY

3.1 Introduction

To ensure that the seismic survey activities complied with requirements of the Endangered Species Act and the Migratory Bird Treaty Act, BPXA worked with LGL during the planning and design phase of the seismic survey to prepare a biological assessment of the potential impacts of seismic activities on marine and coastal birds. The overall conclusion of this assessment was that the nesting bird population on Howe Island was not expected to be impacted because the seismic activities on Howe Island would occur after completion of the nesting season. The seismic activities on the Endicott causeway and Duck Island 1 & 2, however, were planned around mid July when some eiders may still have been nesting at these locations. It was determined that disturbance to these nesting birds could be minimized or eliminated by locating and marking active nests prior to cable deployment/retrieval, allowing the crews to avoid operating near active nests. Disturbance from vessel and seismic activity in open-water habitats may temporarily displace some birds from preferred habitats but this was not expected to cause significant impacts to molting or brood-rearing birds. No specific mitigation measures were identified in this case. The effects of seismic activities on food sources for marine and coastal birds was expected to be negligible, and collision risk of birds with vessels was expected to be very low and without any significant impacts.

3.2 Nest Search: Monitoring Methods & Results

Based on the planned cable deployment and retrieval activities during the actual survey, nest searches were deemed necessary in two areas: i.e. Endicott Causeway and Duck Island.

Endicott Causeway

The bird nest search at Endicott causeway was conducted on July 12, just prior to the start of the seismic survey. The length of the causeway within the seismic survey area was ~9 miles (14.5 km). A total of 5 people systematically searched for eider nests on both sides of the causeway, specifically in the driftwood accumulations. These people were: Megan Blees and Lisanne Aerts (LGL), Bill Streever (BPXA Environmental Studies Lead), Todd Winkel (BPXA

Environmental Specialist for Endicott) and Larry Wyman (BPXA Liberty Seismic Program Manager). A car was always present within 0.5 mile distance as a safety measure in the event a bear would be encountered.

Three active nests were found during this search. Two nests were located at the south beach of the SDI Causeway (Nest 1 and 2) and an additional nest was located close to MPI, about 500 ft (152 m) north from the floating dock (Nest 3) (Figure 3). It appeared that earlier in the season more nesting activity had taken place as evidenced by empty nests that were found (Figure 4). The three active nests were marked with survey stakes at 65 ft (20 m) on both sides of the nest, and also along the causeway perpendicular to the nest. Also, GPS coordinates of the active nest locations were recorded and provided to the Project Navigation Supervisor for entry in the Tiger Navigation system (TigerNav). This information allowed on-site cable crews to easily identify and avoid bird nests.

Regular checks on breeding activity were conducted from a distance at Nest 3, the nest location closest to MPI. On July 28 the nest was abandoned. There were no signs of eggs. It looked like the nest was damaged during bad weather on July 26 and 27. Nest 1 was also abandoned when it was checked on July 28. There was down present in the nest and also an empty egg shell (Figure 5). Nest 2 was not visited on that same date, but a check on August 2 revealed that it was abandoned, with no signs of eggs or down.

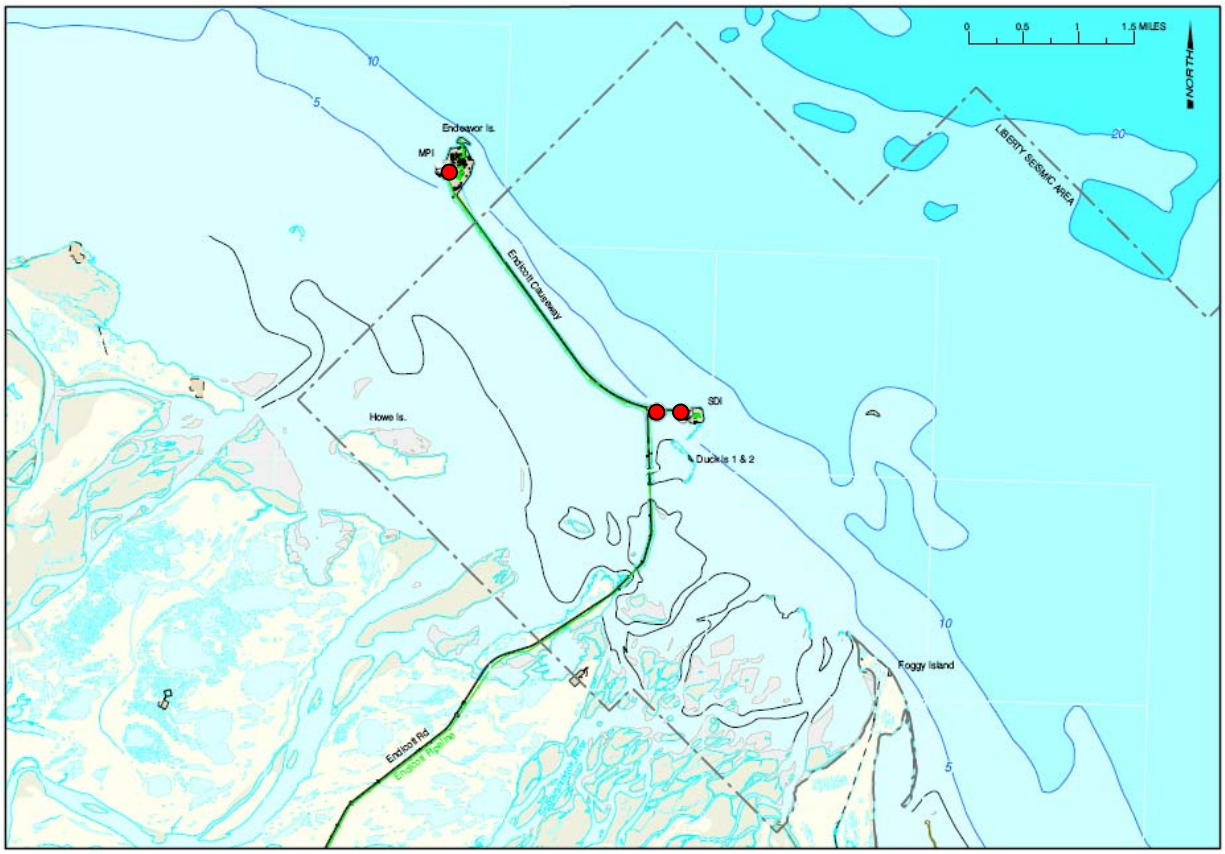

FIGURE 3. LOCATIONS OF NESTING EIDERS ALONG THE ENDICOTT CAUSEWAY (RED DOTS).

FIGURE 4. SOME PHOTO'S TAKEN DURING THE BIRD SURVEY ALONG THE ENDICOTT CAUSEWAY. A TOTAL OF THREE ACTIVE NESTS WERE FOUND.

FIGURE 5. REMAINS OF NEST 1. THE YELLOW CIRCLE INDICATES THE EMPTY EGG SHELL.

Duck Island

A bird nest search at Duck Island was conducted on August 6. The length of the island is ~1 mile. Three people (Megan Blees, Lisanne Aerts and Bill Streever) systematically searched for eider nests on foot over the entire width of Duck Island. Transport to and from the island took place with the Endicott airboat (Figure 6).

No active nests were found. Empty nests indicated the likely presence of eiders earlier in the season. At the southernmost part of the island some polar bear prints were encountered.

FIGURE 6. NEST SEARCH AT DUCK ISLAND. THE SEARCH WAS CONDUCTED ON FOOT, THE AIRBOAT WAS USED FOR TRANSPORTATION TO AND FROM DUCK ISLAND.

3.3 Seismic survey activity

No cable laying activities were conducted on the Endicott causeway and Duck Island 1 and 2 during the seismic survey period, so none of the nests were disturbed by the seismic activities. No bird-vessel collisions occurred.

3.4 Summary

Nest searches were conducted along the Endicott Causeway and Duck Island. A total of three active nests were found along the causeway. None of these nests were impacted by the Liberty seismic survey activities. Also no bird-vessel collisions were observed.

4. BOULDER PATCH SURVEY

4.1 Introduction

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. Because the deployment and retrieval of seismic cables has the potential to affect the Boulder Patch flora and fauna, BPXA worked with LGL to conduct a biological assessment of the potential impacts on the Boulder Patch area from its activities. The main conclusion of this assessment was that the footprint of the seismic equipment (cables and batteries) is very small relative to the part of the Boulder Patch that occurs within the seismic survey area (~0.012 %). Permanent damage to the ecosystem from cable deployment/retrieval is therefore not likely to be substantial and probably not distinguishable from factors that cause natural disturbances (such as storm damage or ice scour).

This conclusion was partly based on several measures that were developed during the design and planning of the survey, such as no anchoring in the Boulder Patch area, which automatically excludes refueling in the Boulder Patch. Other measures were based on raising awareness amongst the crew by showing a video of the marine life on the Boulder Patch, briefings during the field season, and adding the Boulder Patch outline and exclusion zones on TigerNav, the navigation system used by the seismic crew on all vessels.

In the biological assessment a basic monitoring plan was proposed, with the main purpose to obtain information about the potential damage of cable deployment and retrieval activities to the marine biota on the Boulder Patch. All measures and the monitoring plan identified in the biological assessment were part of the stipulations set forth by the MMS and the Corps of Engineers to ensure compliance with the National Environmental Policy Act (NEPA).

Most of the stipulations were of an operational nature, i.e. they required implementation as part of the operational plans for the seismic crew (see P1014-1 Boulder Patch Operations & Monitoring Plan). Two permit stipulations applied specifically to the monitoring of potential damage of the Boulder Patch. During the field season these stipulations were amended twice as summarized below.

The original stipulations of the G&G permit issued to BPXA on May 13, 2008 relevant to monitoring potential damage to kelp plants are as follows:

- *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.*
- *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.*

Experience during the first few weeks of the survey showed that sometimes little cobbles with intact kelp plants came up with the seismic cables. A new procedure specific for this situation was developed and discussed with MMS. This resulted in a modification of the original permit stipulation, effective July 22.

- *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.*
- *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.*

Some of the kelp plants that were collected by the seismic crew were provided to a scientist working for MMS. These samples showed that some plants contained reproductive tissue and that it was considered more appropriate to throw these back into the sea. This triggered a new permit requirement, replacing the previous modification dated July 22, 2008. The new stipulation became effective as of August 1, 2008 and was implemented in the field accordingly.

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

4.2 Monitoring/Methods

The operators of the bow pickers, responsible for the retrieval of cables, collected and recorded kelp plants and other marine biota that came up with the cables. These plants were sampled, placed in a plastic bag and provided with coordinates and/or line numbers and a date. A marine biologist was present in the field to collect these samples and also to regularly talk to the bow picker captains and crew to obtain a better understanding of what was encountered in the field and to answer questions. Pictures were taken of each of these samples during July.

During August, after the 2nd permit amendment, collection of kelp was no longer required. The captain and crew of each bow picker provided an estimate of the number of kelp plants (fronds) found entangled in the cables for each receiver line to the BP HSE representative.

4.3 Results

The total number of estimated kelp fronds entangled in receiver lines during retrieval varied from 0 to 738 per line, with a maximum of 79.4 estimated fronds per line mile and a median of 7.8 fronds per line mile (Figure 7, Table 1 and Table 2). Highest quantities were estimated for patch 14, which covers the easternmost part of the known Boulder Patch area. Typically, just after periods with heavy winds, more kelp fronds were floating in the water column and trapped by the receiver lines during retrieval. Figure 8 shows some examples of kelp collected in July.

4.4 Summary

There was no clear pattern observed in the estimated number of kelp fronds collected for each line and the presence of known Boulder Patch areas. Stormy weather conditions seemed to have a higher influence on the estimated amount of kelp than density of boulders and cobbles.

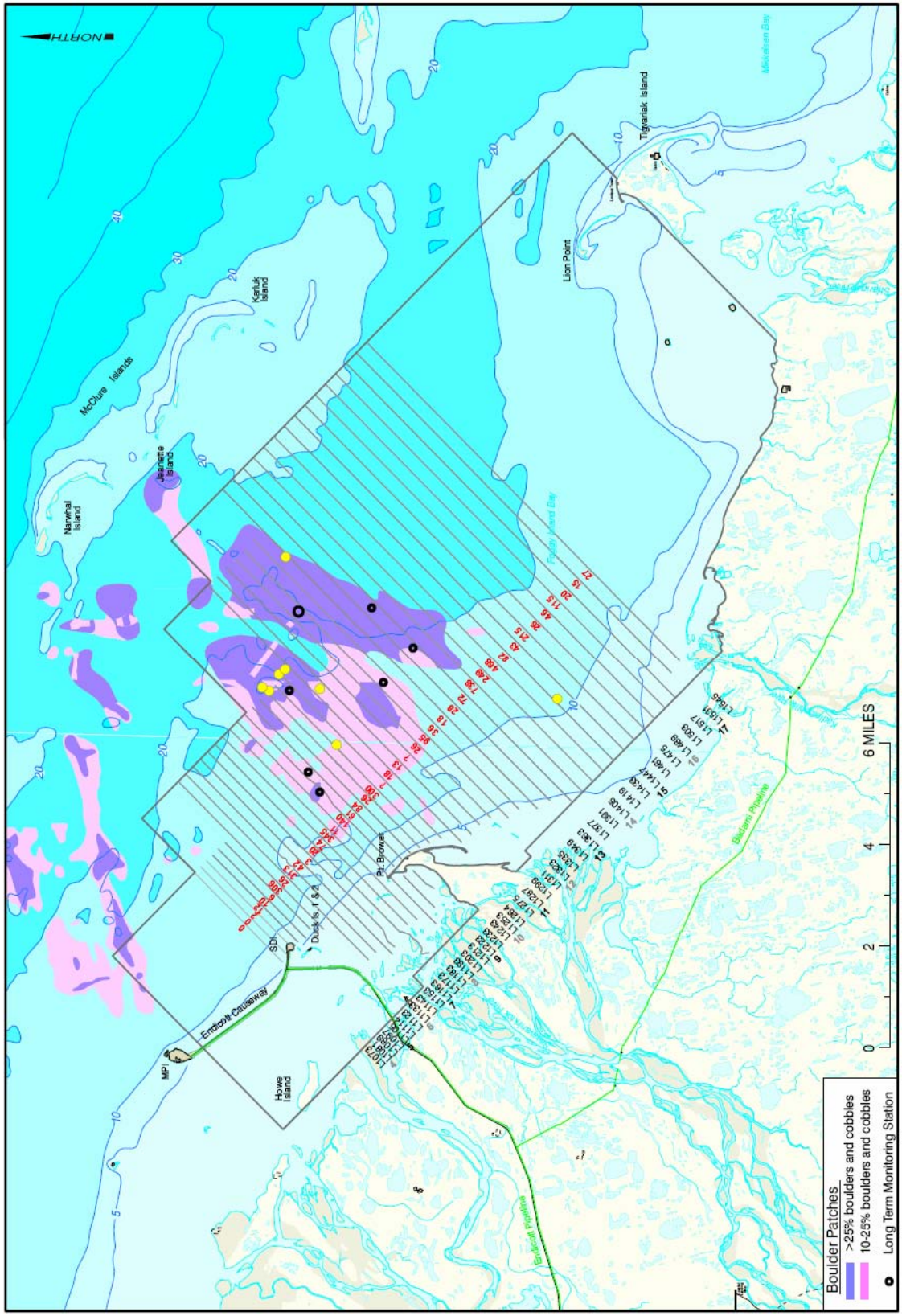

FIGURE 7. NUMBER OF ESTIMATED KELP PLANTS PER RECEIVER LINE ENCOUNTERED BY THE BOW PICKERS DURING LINE RETRIEVAL. THE PATCH NUMBERS AND LINE NUMBERS OF EACH PATCH ARE DEPICTED AT THE BOTTOM OF THE SURVEY AREA. THE RED NUMBERS IN THE MIDDLE ARE THE ESTIMATED NUMBER OF KELP PLANTS FOR EACH LINE.

TABLE 1. SUMMARY OF KELP FRONDS COLLECTED DURING JULY 2008, COVERING A PERIOD OF ONE WEEK UNDER THE ORIGINALPERMIT STIPULATIONS AND ONE WEEK UNDER THE FIRST MODIFICATION TO THE PERMIT (EFFECTIVE AS OF JULY 22, 2008). LOCATION INFO IS PROVIDED IN DECIMAL MINUTES AND SIZE REFERS TO THE LENGTH OF THE KELP FROND, UNLESS OTHERWISE NOTED.

Date	Vessel name	Patch #	Depth (m)	Latitude	Longitude	Receiver line ID#	# Fronds	Size (cm)	ID#	Description
16-Jul	Cape Fear	15	7.9			1433	3		01CF0716	Small cobble with one kelp plant attached
16-Jul	Cape Fear	15	7.9			1433	4		02CF0716	Small cobble with one kelp plant, red algae and some unidentified biota attached
17-Jul	--	15	--	--	--	--	--	--	--	
18-Jul										
19-Jul					No activites due to weather					
20-Jul										
21-Jul	--	10	--	--	--	--	--	--	--	
22-Jul	Alaganik	10	4	--	--	1243	1	40	03AH0722	Jumperline, kelp plant with root
22-Jul	Alaganik	10	4	--	--	1243	1	20	04AH0722	Smaller kelp plant, only leaf no root
22-Jul	Sleep Robber	10	4/5.6	7019642	14738171	1243/1253	2	--	00SR0722	
22-Jul	Sleep Robber	10	4/5.6	7019537	14737913	1243/1253	2	--	00SR0722	
22-Jul	Sleep Robber	10	4/5.6	7018925	14738847	1243/1253	5	--	00SR0722	
22-Jul	Sleep Robber	10	4/5.6	7019806	14739024	1243/1253	2	--	00SR0722	
23-Jul	Sleep Robber	10	4	7019577	14732193	1243	1	100	05SR0723	Long kelp plant of ~100 cm with root
23-Jul	Sleep Robber	10	4	7019577	14732193	1243	1	5	06SR0723	Small colony of red algae, size refers to height
23-Jul	Sleep Robber	10	4	7010642	14738124	1243	1	60	07SR0723	only leaf, no root
23-Jul	Sleep Robber	10	4	7014806	14739024	1243	1	10	08SR0723	Small colony of red algae, size refers to height
23-Jul	Sleep Robber	10	4	7019925	14738847	1243	1	20	09SR0723	kelp root ~0.5 mm thick + parts of leaf
23-Jul	Sleep Robber	10	4	7019925	14738847	1243	1	5	10SR0723	Small kelp plant with root of ~2mm thick
24-Jul	Rumple Minze	10	5.6			1253	5	50	11RM0724	Cluster of 4 kelp fronds with roots + 1 separate kelp frond
24-Jul	Rumple Minze	10	5.6			1253	1	2	12RM0724	Small colony of red algae, size refers to height
24-Jul	Unknown	10	4/5.6	701861	1474166	1253	4	20	13UK0724	Only small part of kelp frond
25-Jul	--	10	--	--	--	--	--	--	--	
25-Jul	--	15	--	--	--	--	--	--	--	
26-Jul					No activities due to weather					
27-Jul										
28-Jul		15	--	--	--	--	--	--	--	
29-Jul										
30-Jul					No activities due to weather					
31-Jul										

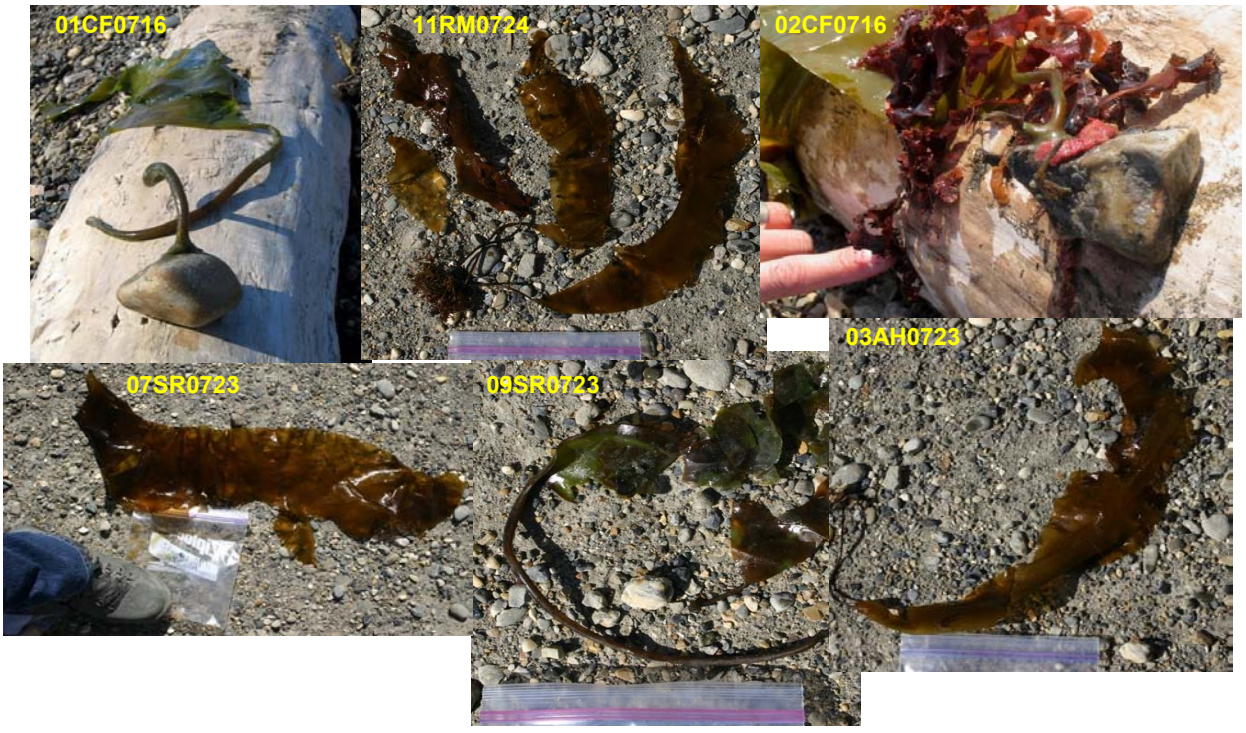

FIGURE 8. PHOTOGRAPHS OF SOME KELP COLLECTED DURING JULY 2008.

TABLE 2. NUMBER OF KELP PLANTS PER RECEIVER LINE COLLECTED DURING AUGUST 2008, COVERING THE SECOND MODIFICATION TO THE PERMIT STIPULATIONS (EFFECTIVE AS OF AUG 1, 2008).

						Bow Picker Vessel Name			
Patch	Receiver Line ID#	Dates	Line Length (miles)	# Fronds	# Fronds / mile	Cape Fear	Rumple Minze	Sleep Robber	Canvas-back
	1073	23/24-Aug	2.5	0	0.0			X	
4	1081	23/24-Aug	2.5	0	0.0			X	
	1089	23/24-Aug	2.5	2	0.8			X	
	1097	23/24-Aug	1.5	12	8.0	X		X	
5	1105	23/24-Aug	2.5	10	4.0		X	X	
	1114	23/24-Aug	2.4	6	2.5			X	X
	1123	16-Aug	4.1	306	74.6			X	
6	1133	16-Aug	2.7	26	9.6			X	
	1143	16-Aug	4.2	313	74.5				
	1153	19 & 23-Aug	4.4	42	9.5				
7	1163	15-Aug		3		X			
	1173	16-Aug		20					
	1183	16-Aug	4.4	74	16.8	X			X
8	1193	10 & 16-Aug	4.5	345	76.7	X	X		X
	1203	16-Aug	4.2	11	2.6	X			
	1213	5-Aug	3.3	140	42.4	X			X
9	1223	5-Aug	3.5	61	17.4		X		X
	1233	5-Aug	3.6	84	23.3			X	X
	1243	5-Aug	4	26	6.5				X
10	1253	5-Aug	5.6	300	53.6	X			
	1264	2-Aug	5.5	--		X		X	
	1275	6/7-Aug	7.2	18	2.5	X	X		X
11	1287	7-Aug	6.9	13	1.9		X		
	1299	4-Aug		--		X		X	
	1311	4-Aug	3.5	26	7.4				X
12	1323	4/5-Aug	4.6	95	20.7		X		
	1335	4-Aug	4.7	36	7.7	X		X	
	1349	10/11-Aug	8.9	18	2.0			X	X
13	1363	11-Aug	8.7	28	3.2		X	X	X
	1377	10/12-Aug	9.1	72	7.9	X		X	
	1391	16 & 17-Aug	9.3	738	79.4	X		X	X
14	1405	16/18-Aug	9.3	249	26.8	X	X		X
	1419	17/19-Aug	9.3	468	50.3	X	X	X	X
	1433	8/9-Aug	7.9	82	10.4				X
15	1447	9/10-Aug	9.3	43	4.6	X	X	X	X
	1461	5 & 8/10-Aug	8.3	215	25.9	X	X	X	X
	1475	19/21-Aug	6.9	26	3.8	X	X		X
16	1489	19 & 21-Aug	9.3	46	4.9		X	X	X
	1503	20 & 21-Aug	9.3	115	12.4	X			X
	1517	25-Aug	8.9	20	2.2	X		X	
17	1531	26-Aug	9.3	15	1.6		X		
	1545	26-Aug	9.3	27	2.9	X			X

5. FISH SURVEY

5.1 Introduction

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 summer seasons, with seven species constituting 97% of all fish caught (results from BPXA fish surveys conducted by Bob Fechhelm of LGL). Because seismic sounds can affect the various life stages of fish, BPXA worked with LGL to conduct a biological assessment of the potential impacts on fish in the Liberty area. The main conclusions were that mortality and/or injury to fish only occurs in very close proximity to the source and was not expected to be distinguishable from natural mortality. Impacts to eggs and larvae were 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 were not expected to have significant impacts on the fish populations because the acoustic footprint of the sound source in the very shallow nearshore waters is small (< 0.2 mi^2 or 0.5 km^2) compared to the available habitat. Other than a continuation of BPXA's Beaufort Sea Long Term Fish Monitoring Program, no other monitoring activities were identified and there were also no particular permit requirements related to fish. However, during a meeting on May 13, 2008 in Barrow with the NSB Wildlife Department, concern was expressed about the potential impact of airgun sound on mortality of fish that are more or less resident, such as those present in the Boulder Patch. BPXA agreed to conduct a basic fish mortality survey in the direct vicinity of the airguns. The sections below describe the details of this initiative.

5.2 Monitoring Methods

During seismic line shooting and on an opportunistic basis, a support vessel followed one of the two source boats at close distance (i.e. 75-250 ft or 23-76 m). Target effort of about 20 hours was considered representative for this initiative. Any fish that was killed or severely injured when in close range to the airguns, e.g. within 5 m, and that floated was collected from the water surface with a dipnet. In addition several trawls with the dipnet were made to allow fish not visible from the surface to be sampled. The latter turned out to be rather difficult and several methods were tried as summarized below:

- The dipnet was tied to the boat and pulled along while continuing to follow the source vessel. This was not very successful because there was too much draw on the net, even at speeds as low as 1 to 2 knots (the dipnet used had a very small mesh size of about 0.02 ft or 0.005 m).
- The dipnet was used about once every 15 min for a minute with the boat in neutral. This only worked in very calm water, because even in neutral the drift was often too strong and resulted in a substantial pull on the net. However, under very calm conditions it was possible to see glimpses of the seafloor. Under these conditions it seemed less necessary to use the dipnet.
- The dipnet was used while the boat held its position. This worked a little bit better, but it was not possible to cover a lot of area because the boat was not moving (and in the meantime the source vessel was moving away, continuing along its track).
- Other net types that were present at Endicott were considered and looked at. Most of these nets were pretty large in size, with larger mesh sizes and would likely require a permit to be towed behind the boat.

5.3 Results

A total of 22 hours of fish surveys was conducted, as described above. The *M/V Peregrine* was followed for a total of 17 hours and the *M/V Miss Diane* was followed for 5 hours. Both source boats were operating the 440 in^3 array during these surveys (Table 3). Some photos taken during the fish survey, and tracklines along which the seismic source boats were followed are shown in Figure 9 and 10. No fish mortality or injury was observed.

5.4 Summary

A basic survey was conducted to determine if mortality or injury could be observed in fish exposed to airgun sounds at a very close range. For this purpose a dedicated vessel opportunistically followed two seismic source vessels operating a 440 in^3 airgun array. The results showed that airguns operating in the conditions and locations of the Liberty seismic survey do not result in fish mortality or injury.

FIGURE 9. SOME PHOTOGRAPHS TAKEN DURING THE FISH SURVEY.

TABLE 3. DETAILS OF THE FISH SURVEYS CONDUCTED DURING THE 2008 LIBERTY SEISMIC SURVEY. THE OBSERVERS ARE: BS= BILL STREEVER, MB = MEGAN BLEES, LA = LISANNE AERTS, JF= JAY FRIBERG, RG= RON GERVASON AND KK= KURT KINDEN.

Date	Start	End	# min	Source Vessel	Array volume	Water depth (m)	Sea State (Beaufort scale)	Observers
29-Jul	07:20	08:30	70	Miss Diane	2x220	5.5	4.5	BS
05-Aug	15:30	17:38	128	Peregrine	1x440	4.5	1	MB, LA, JF, RG
06-Aug	18:05	18:41	36	Miss Diane	2x220	4	2	MB, LA
06-Aug	19:09	20:14	65	Peregrine	1x440	4.2	2	MB, LA
08-Aug	09:27	10:44	77	Miss Diane	2x220	2	1.5	LA, RG
08-Aug	16:05	18:05	120	Peregrine	1x440	4.7	3	RG
09-Aug	1:57	03:57	120	Peregrine	1x440	4.5	3	KK
09-Aug	09:50	10:05	15	Peregrine	1x440	7	2	RG
09-Aug	10:17	11:00	43	Miss Diane	2x220	3	1	RG
10-Aug	02:50	04:50	120	Peregrine	1x440	5.5	0-1	KK
10-Aug	9:50	10:45	55	Peregrine	1x440	3.5	1	RG
10-Aug	10:55	11:15	20	Peregrine	1x440	3.5	1	RG
16-Aug	14:57	16:38	101	Peregrine	1x440	5.7	2-3	MB
18-Aug	14:53	16:18	85	Miss Diane	2x220	1.8	1-2	MB
19-Aug	07:56	09:56	120	Peregrine	1x440	4	2-3	MB
19-Aug	14:45	17:12	147	Peregrine	1x440	5.5	1-2	MB

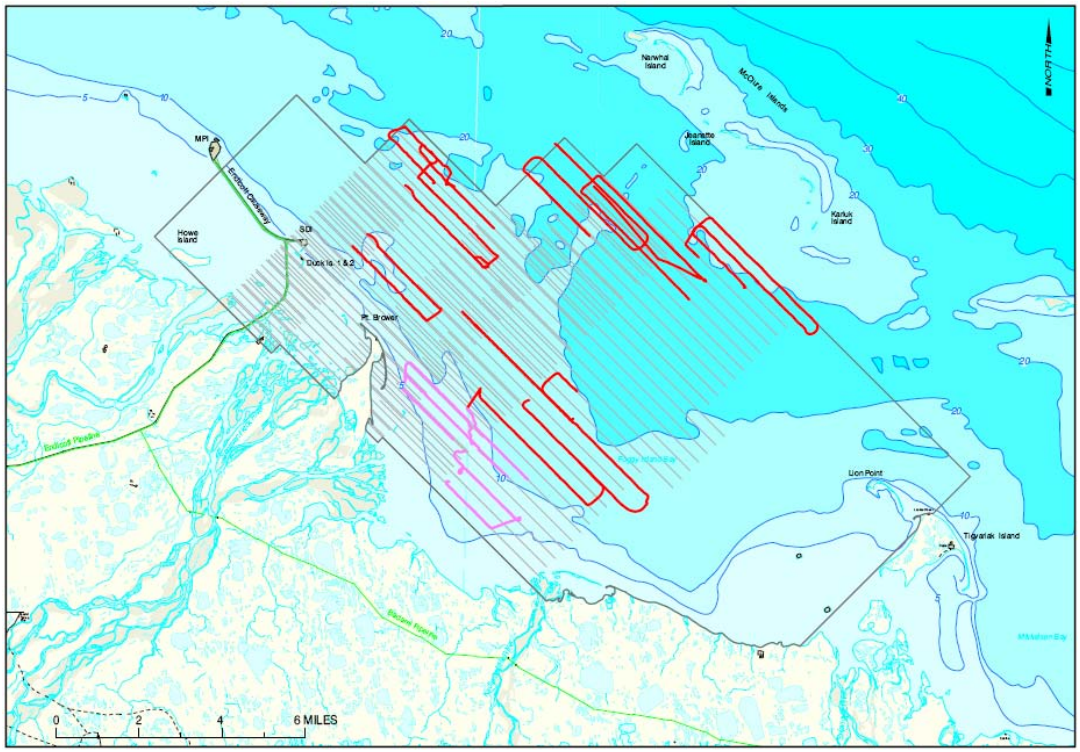

FIGURE 10. TRACKLINES ALONG WHICH A SUPPORT VESSEL FOLLOWED ONE OF THE TWO SOURCE BOATS TO LOOK FOR FISH THAT MIGHT HAVE BEEN IMPACTED BY THE AIRGUN SOUNDS (RED TRACKS = M/V PEREGRINE, PINK TRACKS = M/V MISS DIANE). GRAY LINES ARE THE PRE-SURVEY SOURCE LINES ALONG WHICH SEISMIC DATA WERE ACQUIRED.