MARINE MAMMAL MONITORING AND MITIGATION DURING OPEN WATER SEISMIC EXPLORATION BY STATOIL E&P INC. IN THE CHUKCHI SEA, AUGUST–OCTOBER 2010: 90-DAY REPORT

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~	approximately
Bf	Beaufort Wind Force
CITES	Convention on International Trade in Endangered Species
cm	centimeter
CPA	Closest (Observed) Point of Approach
CTD	Conductivity, Temperature, Depth
dB	decibel
ESA	(U.S.) Endangered Species Act
$f(0)$	sighting probability density at zero perpendicular distance from survey track; equivalently, 1/(effective strip width)
ft	feet
GIS	Geographic Information System
GPS	Global Positioning System
$g(0)$	probability of seeing a group located directly on a survey line
h	hours
hp	horse power
Hz	Hertz (cycles per second)
IHA	Incidental Harassment Authorization (under U.S. MMPA)
in^3	cubic inches
IUCN	International Union for the Conservation of Nature
kHz	kilohertz
km	kilometer
km^2	square kilometers
km/h	kilometers per hour
kt	nautical mile(s) per hour
LOA	Letter of Authorization (under U.S. MMPA)
μPa	micro Pascal
m	meters
MBB	Multibeam Bathymetric (sonar)
min	minutes
MMO	Marine Mammal Observer
MMPA	(U.S.) Marine Mammal Protection Act
n	sample size
NMFS	(U.S.) National Marine Fisheries Service
No.	number
OCS	Outer Continental Shelf
PD	Power down of the airgun array to one airgun (in this study, from an output of 3000 in^3 to 60 in^3)

PZ	Power down of the airgun array to one airgun because of a marine mammal sighting near or within the safety radius (in this study, from an output of 3000 in^3 to 60 in^3)
re	in reference to
rms	Root-Mean-Square: an average, in the present context, over the duration of a sound pulse
RSL	Received Sound Level
s	seconds
SD	Shut down of airguns not associated with mitigation
s.d.	standard deviation
SEL	Sound Exposure Level: a measure of energy content, in dB re 1 $\mu Pa^2 \cdot s$
SPL	Sound Pressure Level; the SPL for a seismic pulse is equivalent to its rms level
SZ	Shut down of all airguns because of a marine mammal sighting near or within the safety radius
TTS	Temporary Threshold Shift
UNEP	United Nations Environmental Programme
yd	yard(s)

EXECUTIVE SUMMARY

Background and Introduction

Statoil USA E&P, Inc. (Statoil) collected marine seismic data in the Chukchi Sea during the open–water period of 2010 in support of potential future oil and gas exploration and development. 3D and 2D seismic acquisition for Statoil was conducted in the Chukchi Sea by Fugro Geoteam, Inc. (Fugro) using the M/V *Geo Celtic*, a seismic vessel that towed an airgun array as well as hydrophone streamers to record seismic data.

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. The effects could consist of behavioral or distributional changes, and perhaps (for animals close to the sound source) temporary or permanent reduction in hearing sensitivity. Potential effects, however, may be reduced by marine mammals moving away from approaching sound sources. Either behavioral/distributional effects or auditory effects (if they occur) could constitute "taking" under the provisions of the U.S. Marine Mammal Protection Act (MMPA) and the U.S. Endangered Species Act (ESA), at least if the effects are considered to be "biologically significant."

The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share jurisdiction over the marine mammal species that could have been encountered during the project. Statoil's seismic survey was conducted under the jurisdiction of an Incidental Harassment Authorization (IHA) issued by NMFS and a Letter of Authorization (LOA) issued by the USFWS. The IHA and LOA included provisions to minimize the possibility that marine mammals might occur close to the seismic source and be exposed to levels of sound high enough to cause hearing damage or other injuries, and to reduce behavioral disturbances that might be considered as "take by harassment" under the MMPA.

A mitigation program was conducted to avoid or minimize potential effects of Statoil's seismic survey on marine mammals, and to ensure that Statoil was in compliance with the provisions of the IHA and LOA. This required that marine mammal observers (MMOs) onboard the seismic vessel detect marine mammals within or about to enter the designated safety radii, and in such cases initiate an immediate power down (or shut down if necessary) of the airguns. Mitigation was also required for larger disturbance radii which were monitored by MMOs onboard monitoring vessels.

The primary objectives of the monitoring and mitigation program were to:

1. provide real-time sighting data needed to implement the mitigation requirements;
2. estimate the numbers of marine mammals potentially exposed to strong seismic pulses; and
3. determine the reactions (if any) of marine mammals potentially exposed to seismic sound impulses.

This 90-day report describes the methods and results for the monitoring work specifically required to meet the above primary objectives.

Seismic Surveys Described

The source vessel, *Geo Celtic*, collected seismic data in the Chukchi Sea from 20 Aug through 1 Oct. Statoil completed ~4482 km (2714 mi) of seismic data acquisition in the Chukchi Sea in 2010. Two other vessels, the M/V *Tanux I* and the R/V *Norseman I*, were the monitoring vessels associated with the *Geo Celtic*.

The seismic source used by Statoil and Fugro consisted of a pair of 3000 in^3 three-string arrays of Sodera G-type airguns towed approximately 394 m (431 yd) behind the *Geo Celtic* for its seismic survey

operations. The arrays were fired alternately on consecutive shots as the vessel traveled along the survey line. Each array was comprised of three Sodera G-type airgun sub-arrays, and had a total volume of 3,000 in^3. A 60-in^3 airgun was used as a mitigation source during power downs when marine mammals were observed within or about to enter the applicable full array safety radius and during turns. The system also included 12 hydrophone streamers, each 4050 m (4429 yd) long, with hydrophones spaced 100 m apart over the entire length of each streamer.

Sound Source Verification

Statoil USA E&P Inc. (Statoil) conducted a 3-D marine seismic survey at Statoil's Posey prospect in the Alaskan Chukchi Sea in August and September 2010. As required by the Incidental Harassment Authorization (IHA) for this survey program, in-field sound source verification measurements were performed. JASCO Applied Sciences was contracted by Statoil (through LGL) to perform field measurements of sound from the program's seismic sources: two identical 3000 in^3 airgun arrays fired in flip-flop mode (*i.e.*, fired alternately on consecutive shots) and a 60 in^3 mitigation gun. Calibrated underwater acoustic measurements of survey-related sounds were carried out on 22-24 August 2010 at Statoil's Posey prospect. The purpose of the measurements was to quantify sound levels as a function of distance from Statoil's 2010 marine seismic survey sources, and to verify and possibly revise pre-survey estimates of the size of marine mammal safety exclusion zones. The exclusion zones are defined by the maximum distances at which sound levels reach specific thresholds. These zones were monitored by marine mammal observers (MMO's) stationed on the R/V *Geo Celtic,* M/V *Tanux I,* and R/V *Norseman I* during the surveys. MMO's could direct rapid shut-down of the acoustic survey sources when animals were observed within or if they were likely to enter the zones. A second purpose of these measurements was to provide sound level information used to calculate actual marine mammal takes during a post-field analysis.

Three calibrated JASCO Ocean Bottom Hydrophone (OBH) acoustic recording stations were deployed on the seabed near each of the operations monitored at Statoil's exploration lease area in the Chukchi Sea. Measurements of sound produced by the 3000 in^3 airgun arrays were made at distances 50 m, 10 km, and 80 km in the broadside (perpendicular to survey line) direction and up to 50 km in the endfire direction (parallel to survey line). The two-direction measurement approach allowed for the determination of possible directive characteristics of sound emissions from the airgun arrays. Measurements of sound produced by the 60 in^3 mitigation gun were made with an OBH at the middle of a 20 km mitigation turn.

Distances to root-mean-square (*rms*) sound pressure thresholds in 10 dB increments from 120 dB re 1 µPa to 190 dB re 1 µPa for both sources were determined from the measurements. Further analysis of the airgun array data was performed to calculate M-weighted cumulative sound exposure levels (SEL) and to compare measured levels with recently proposed criteria for assessing auditory injury to marine mammals from pulsed sound sources (Southall *et al.*, 2007). The SEL thresholds for the airgun arrays were reached at shorter distances than the *rms* based thresholds and are provided in this report.

The IHA stipulated specific exclusion and monitoring safety zones to be observed during airgun operations. The pre-season marine mammal safety radii for the *Geo Celtic's* full (3000 in^3) airgun array was 700 m, 2500 m, and 13,000 m for the ≥190, ≥180, and ≥160 dB (rms) zones, respectively.

The SSV results indicate that the pre-season estimated radii in the IHA for the *Geo Celtic*'s 3000 in^3 airgun arrays were conservative for the 190 dB and 180 dB re 1 µPa radii and that the measured 160 dB and 120 dB re 1 µPa safety radii were greater than the pre-season estimates. The SSV results also showed smaller safety radii for all SPL_{rms90} thresholds for the 60 in^3 mitigation airgun than the estimated

radii in the IHA. The measured marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays was 520 m, 1600 m, and 13,000 m for the ≥190, ≥180, and ≥160 dB (rms) zones, respectively.

Marine Mammal Monitoring

The *Geo Celtic* traveled along a total of 10,717 km (6659 mi) of trackline in the Chukchi Sea survey area. Airgun operations occurred along 8069 km (5014 mi) of that trackline. The full airgun array was ramping up or active along 5387 km (3347 mi) of trackline. The single mitigation airgun operated along 2681 km (1666 mi), including turns and power downs. The airguns did not operate along the remaining 2648 km (1645 mi) of trackline in the Chukchi Sea.

MMOs aboard the three vessels were on watch for a total of 28080 km (17,448 mi; 2741 h). Of this total, 10,477 km (6510 mi; 1223 h) of observation effort was from the *Geo Celtic*, 9250 km (5748 mi; 784 h) from the *Norseman I*, and 8353 km (5190 mi; 734 h) from the *Tanux I*. Of the total observation effort on all three vessels, 3564 km (2215 mi; 399 h) occurred during darkness

During the Statoil seismic survey, MMOs recorded a total of 310 sightings of 534 marine mammals from the *Geo Celtic* and 428 groups of 939 marine mammals from the monitoring vessels. Eight marine mammal species were identified, including bowhead whale, gray whale, minke whale, ribbon seal, ringed seal, spotted seal, bearded seal, and Pacific walrus.

MMOs recorded 32 sightings of 45 individual cetaceans from the *Geo Celtic* and its monitoring vessels. More than half of the cetaceans sightings were unable to be identified to species. One cetacean was observed from the *Geo Celtic* during seismic activities and resulted in a power down of the seismic array. Sighting rates from the *Geo Celtic* when the full array was active and during non-seismic periods were over three times higher than those from the monitoring vessels in areas where RSLs were ≥160 and <120 dB (rms).

There were 362 seals sightings of 388 individuals recorded by MMOs on the *Geo Celtic* and its monitoring vessels. Bearded seal was the most frequently identified seal species, although nearly half of the seals sighted could not be identified to species. Nine power downs of the airgun array were requested by *Geo Celtic* MMOs due to seals sighted within or approaching the ≥190 dB (rms) safety radius of the active array during Statoil's seismic survey. The sighting rate during full array activity was 2.5 times greater than during only mitigation airgun activity and non-seismic periods.

There were 346 Pacific walrus sightings of 1042 individuals recorded by MMOs on the *Geo Celtic* and its monitoring vessels. The majority (72%) of these sightings were observed between 28 and 31 August 2010 (250 sightings of 823 individuals) as a large number of Pacific walrus moved from the receding ice edge towards land. Twenty-nine power downs were requested and implemented for Pacific walruses observed within or about to enter the ≥180 dB (rms) safety radius around the full 3000 in^3 airgun array. Ten power downs occurred during the 4-day period, 28–31 Aug, when walrus sightings were most numerous. In addition to the power downs, three complete shut downs were implemented during the seismic survey as a result of Pacific walrus sightings.

No cetaceans were observed by MMOs within areas where received seismic sound levels were ≥180 dB (rms). Ten seals were observed within the ≥190 dB (rms) safety radius and potentially exposed to received sound levels ≥190 dB (rms). Forty Pacific walruses (in 21 separate sightings) were observed in areas where received sound levels were ≥180 dB (rms).

The number of marine mammals visually detected by MMOs likely underestimated the actual numbers that were present. Marine mammal densities were based on data collected from the *Geo Celtic* and its monitoring vessels (*Tanux I, Norseman I*) during Statoil's seismic operations in the Chukchi Sea. Based on estimates extrapolated from density calculations, 18 cetaceans may have been exposed to sound

levels ≥160 dB (rms). Similar calculations indicated that 2180 seals and 963 Pacific walruses may have been exposed to sound levels ≥160 dB (rms).

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We thank the captains and crews of the *Geo Celtic, Norseman I,* and *Tanux I* for their support during this project. We also thank representatives of the National Marine Fisheries Service, U.S. Fish & Wildlife Service, North Slope Borough Department of Wildlife Management, Alaska Eskimo Whaling Commission and Minerals Management Service for their comments and suggestions during the "open-water meetings" convened by NMFS in February 2010 and at various other times. Jon Kåre Hovde, Karin Berentsen, Martin Cohen, and April Parsons of Statoil; Sigbjorn Vigeland and Christopher Stanfield of Fugro-Geoteam; Bud Hodgson, Peter Chen, Gary Streff, and Andy Voland of RPS Energy; and Caren Mathis and Meghan Larson of ASRC Energy Services all provided valuable support prior to and during the field season.

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1. BACKGROUND AND INTRODUCTION[1]

Statoil USA E&P, Inc. (Statoil) collected marine seismic data in the Chukchi Sea during the open–water period of 2010 in support of potential future oil and gas exploration and development. 3D and 2D seismic acquisition for Statoil was conducted in the Chukchi Sea by Fugro Geoteam, Inc. (Fugro) using the M/V *Geo Celtic*, a seismic vessel that towed an airgun array as well as hydrophone streamers to record seismic data.

Marine seismic surveys emit sound energy into the water (Greene and Richardson 1988; Tolstoy et al. 2004a,b) 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). The effects could consist of behavioral or distributional changes, and perhaps (for animals close to the sound source) temporary or permanent reduction in hearing sensitivity. Potential effects, however, may be reduced by marine mammals moving away from approaching sound sources (Reiser et al. 2009; Richardson et al. 1995, 1999; Stone 2003; Gordon et al. 2004; Smultea et al. 2004). Either behavioral/distributional effects or auditory effects (if they occur) could constitute "taking" under the provisions of the U.S. Marine Mammal Protection Act (MMPA) and the U.S. Endangered Species Act (ESA), at least if the effects are considered to be "biologically significant."

Numerous species of cetaceans and pinnipeds inhabit parts of the Chukchi Sea. The National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share jurisdiction over the marine mammal species that could have been encountered during the project. Three species under NMFS jurisdiction that are listed as "Endangered" under the ESA, including bowhead whale (*Balaena mysticetus*), humpback whale (*Megaptera novaeangliae*), and fin whale (*Balaenoptera physalus*), do or may occur in portions of the survey area. Additionally, NMFS initiated a status review to determine if listing as endangered or threatened under the ESA is warranted for four other species including ringed seal (*Phoca fasciata*), spotted seal (*P. largha*), bearded seal (*Erignathus barbatus*), and ribbon seal (*Histriophoca fasciata*; NMFS 2008a,b). Subsequently NMFS (2008a) announced that listing of the ribbon seal as threatened or endangered was not warranted at this time. More recently NMFS (2009) determined that no listing action was warranted for the Bering Sea and Okhotsk populations of spotted seal. The USFWS manages two marine mammal species occurring in the Chukchi Sea, the Pacific walrus (*Odobenus rosmarus*) and polar bear (*Ursus maritimus*). The polar bear was recently listed as threatened under the ESA (USFWS 2008) and a petition to list Pacific walrus as threatened or endangered was recently submitted to USFWS (CBD 2008).

Statoil submitted an application to NMFS on 24 December 2009 for an Incidental Harassment Authorization (IHA) to authorize non-lethal "takes" of marine mammals incidental to Statoil's planned seismic survey in the Chukchi Sea during the 2010 open-water season. A notice announcing Statoil's request for an IHA was published in the *Federal Register* on 8 Jun 2010 and public comments were invited (NMFS 2010). An IHA allowing seismic activities in the Chukchi Sea was issued to Statoil by NMFS on 6 Aug 2010 which allowed operations to be conducted through 30 November 2010 (Appendix A). The IHA authorized "potential take by harassment" of various cetacean and seal species during the seismic survey described in this report.

On 18 Dec 2009, Statoil requested a Letter of Authorization (LOA) from USFWS for the incidental "take" of polar bears and walrus during open–water exploration activities in the Chukchi Sea in 2010. The USFWS issued a LOA on 15 July 2010 allowing Statoil to "take" small numbers of polar bears and

[1] By Megan Blees, Kris Hartin and Darren Ireland (LGL).

Pacific walruses incidental to activities occurring during the 2010 Chukchi Sea open–water exploration program. The LOA was valid through 30 Nov 2010 (Appendix B).

This document serves to meet reporting requirements specified in the IHA and LOA. The primary purposes of this report are to describe project activities in the Chukchi Sea, to describe the associated marine mammal monitoring and mitigation programs and their results, and to estimate the numbers of marine mammals potentially exposed to levels of sound generated by the survey activities at or above presumed effect levels as prescribed by the respective agencies.

Incidental Harassment Authorization

IHAs issued to seismic operators include provisions to minimize the possibility that marine mammals close to the seismic source might be exposed to levels of sound high enough to cause short or long–term hearing loss or other physiological injury. During this project, sounds were generated by the *Geo Celtic*'s airgun array in order to collect seismic data on and near Statoil's lease holdings in the Chukchi Sea. Given the nature of the operations and mitigation measures, no serious injuries or deaths of marine mammals were anticipated as a result of the seismic survey. No such injuries or deaths were attributed to these activities. Nonetheless, the seismic survey operations described in Chapter 2 had the potential to "take" marine mammals by harassment. Behavioral disturbance to marine mammals is considered to be "take by harassment" under the provisions of the MMPA.

Under current NMFS guidelines (e.g., NMFS 2010), "safety radii" for marine mammals around airgun arrays are customarily defined as the distances within which received sound levels are ≥180 dB re 1 μPa (rms)[2] for cetaceans and ≥190 dB re 1 μPa (rms) for pinnipeds. Those safety radii are based on an assumption that seismic pulses at lower received levels will not injure these mammals or impair their hearing abilities, but that higher received levels might have some such effects. The mitigation measures required by IHAs are, in large part, designed to avoid or minimize the numbers of cetaceans and pinnipeds exposed to sound levels exceeding 180 and 190 dB (rms), respectively.

Disturbance to marine mammals could occur at distances beyond the safety radii if the mammals were exposed to moderately strong pulsed sounds generated by the airguns or perhaps by sonar (Richardson et al. 1995). The NMFS assumes that marine mammals exposed to airgun sounds with received levels ≥160 dB re 1 μPa (rms) are likely to be disturbed. That assumption is based mainly on data concerning behavioral responses of baleen whales, as summarized by Richardson et al. (1995) and Gordon et al. (2004). Dolphins and pinnipeds are generally less responsive than baleen whales (e.g., Stone 2003; Gordon et al. 2004), and 170 dB (rms) may be a more appropriate criterion of potential behavioral disturbance for those groups (LGL Ltd. 2005a,b). In general, disturbance effects are expected

[2] "rms" means "root mean square", and represents a form of average across the duration of the sound pulse as received by the animal. Received levels of airgun pulses measured on an "rms" basis (sometimes described as Sound Pressure Level, SPL) are generally 10-12 dB lower than those measured on the "zero-to-peak" basis, and 16-18 dB lower than those measured on a "peak-to-peak" basis (Greene 1997; McCauley et al. 1998, 2000a,b). The latter two measures are the ones commonly used by geophysicists. Unless otherwise noted, all airgun pulse levels quoted in this report are rms levels. Received levels of pulsed sounds can also be described on an energy or "Sound Exposure Level" basis, for which the units are dB re $(1\ \mu Pa)^2 \cdot s$. The SEL value for a given airgun pulse, in those units, is typically 10-15 dB less than the rms level for the same pulse (Greene 1997; McCauley et al. 1998, 2000a,b), with considerable variability (Madsen et al. 2006; see also Chapter 3 of this report). SEL (energy) measures may be more relevant to marine mammals than are rms values (Southall et al. 2008), but the current regulatory requirements are based on rms values.

to depend on the species of marine mammal, the activity of the animal at the time of exposure, distance from the sound source, the received level of the sound and the associated water depth. Some individuals may exhibit behavioral responses at received levels somewhat below the nominal 160 or 170 dB (rms) criteria, but others may tolerate levels somewhat above 160 or 170 dB (rms) without reacting in any substantial manner. For example, migrating bowhead whales in the Alaskan Beaufort Sea have shown avoidance at received levels substantially lower than 160 dB (rms; Miller et al. 1999; Richardson et al. 1999). However, recently acquired acoustic evidence suggests that some whales may not react as much or in the same manner as suggested by those earlier studies (Blackwell et al. 2008). Beluga whales may, at times, also show avoidance at received levels below 160 dB (rms; Miller et al. 2005). In contrast, bowhead whales on the summer feeding grounds tolerate received levels of 160 dB (rms) or sometimes more without showing significant avoidance behavior (Richardson et al. 1986; Miller et al. 2005; Lyons et al. 2008).

The IHA issued by NMFS to Statoil authorized incidental harassment "takes" of three ESA-listed species including bowhead, humpback, and fin whales, as well as several non-listed species including gray whale (*Eschrichtius robustus*), Minke whale (*Balaenoptera acutorostrata*), killer whale (*Orcincus orca*), beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and ringed, spotted, bearded, and ribbon seals.

NMFS granted the IHA to Statoil 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.

The LOA issued to Statoil by USFWS required Statoil to observe a 190 dB (rms) safety radius for polar bears and a 180 dB (rms) safety radius for walruses.

Mitigation and Monitoring Objectives

The objectives of the mitigation and monitoring program were described in detail in Statoil's IHA application (Statoil 2009) and in the IHA issued by NMFS to Statoil (Appendix A). An explanation of the monitoring and mitigation requirements was published by NMFS in the *Federal Register* (NMFS 2010).

The primary objectives of the monitoring program were to

- provide real–time sighting data needed to implement the mitigation requirements;
- estimate the numbers of marine mammals potentially exposed to strong seismic pulses; and
- determine the reactions (if any) of marine mammals potentially exposed to seismic sound impulses.

Specific mitigation and monitoring objectives and requirements were described in the IHA and LOA (Appendices A and B). Mitigation and monitoring measures that were implemented during the activities in the Chukchi Sea are described in detail in Chapter 4.

The purpose of the mitigation program was to avoid or minimize potential effects of Statoil's seismic survey on marine mammals and subsistence hunting. This required that shipboard personnel

detect marine mammals within or about to enter the designated safety radii [190 dB (rms) for pinnipeds and polar bears and 180 dB (rms) for cetaceans and Pacific walrus], and in such cases initiate an immediate power down (or shut down if necessary) of the airguns. A power down involves reducing the source level of the operating airguns, in this case by reducing the number of airguns firing. A shut down involves temporarily terminating the operation of all airguns. Additionally, the safety radii were monitored in good visibility conditions for 30 minutes prior to starting the first airgun and during the ramp up procedure to ensure that marine mammals were not near the airguns when operations began (see Appendix A and Chapter 4). The location and timing of survey activities was planned in coordination with representatives of the North Slope communities in order to avoid adverse impacts to subsistence harvest of marine mammals and other resources.

Mitigation measures within the 160 dB (rms) isopleth were also required, as described in the IHA issued by NMFS, for an aggregation of 12 or more non-migratory mysticete whales and in the LOA issued by USFWS for aggregations of 12 or more Pacific walruses. This area was monitored by vessels that accompanied the seismic vessel. Power down of the seismic airgun array was required if an aggregation of 12 or more non-migratory mysticete whales or Pacific walruses were detected a within the 160 dB (rms) isopleth.

Report Organization

This 90–day report summarizes the seismic survey activities and describes the methods and results of the mitigation and monitoring performed to meet the above objectives as required by the IHA and LOA (Appendices A and B). Various other marine mammal and acoustic monitoring and research programs not specifically related to the above objectives were also implemented by Statoil in the Chukchi Sea during 2010. Results of those additional efforts will be reported at a later date.

This report includes five chapters:

1. background and introduction (this chapter);
2. description of Statoil's seismic study;
3. acoustic sound source measurements during the field season;
4. description of the marine mammal monitoring and mitigation program and the data analysis methods;
5. results of the marine mammal monitoring program and estimates of potential "take by harassment";

In addition, there are 11 appendices that provide copies of relevant documents and details of field procedures and data analysis methods and results. The appendices include

A. copy of the IHA issued by NMFS in 2010 to Statoil for this study;
B. copy of the Chukchi Sea LOA issued by USFWS to Statoil for this study;
C. descriptions of vessels and equipment;
D. sound source verification Calibration Tables;
E. details of monitoring, mitigation, and analysis methods;
F. Beaufort wind force definitions;
G. background on marine mammals in the Chukchi Sea;
H. marine mammal monitoring results during the Chukchi Sea seismic survey;
I. list of all marine mammal detections;
J. weekly maps of vessel activity and marine mammal sightings;

K. NMFS Marine Mammal Stranding Reports for carcasses observed in 2010.

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2. SEISMIC SURVEY DESCRIBED[1]

Marine mammal monitoring was conducted from three vessels operated by Statoil in the Chukchi Sea in 2010 in support of seismic exploration. The seismic source vessel (M/V *Geo Celtic*) was the primary exploration vessel and used a 26-airgun array for seismic acquisition. Details of the seismic survey and marine mammal monitoring program for the Chukchi Sea are described below.

The *Geo Celtic* was used as the source vessel during Statoil's 3D and 2D seismic exploration activities in the Chukchi Sea in 2010. Two other vessels, the M/V *Tanux I* and the R/V *Norseman I*, were the monitoring vessels associated with the *Geo Celtic*. Detailed description of these vessels can be found in Appendix C. The results of the marine mammal monitoring program were based on observations by marine mammal observers (MMOs) aboard the *Geo Celtic* and the two monitoring vessels. All vessels operated in accordance with the provisions of the IHA issued by NMFS (Appendix A) and the LOA issued by USFWS (Appendix B).

Operating Areas, Dates, and Navigation

The geographic region where the seismic survey occurred was in or near specific Statoil lease holdings in the Chukchi Sea Planning Area designated as Oil and Gas Lease Sale 193 (Fig. 2.1). Seismic acquisition occurred in the Chukchi Sea ~240 km (150 mi) west of Barrow and ~160 km (100 mi) northwest of Wainwright in Outer Continental Shelf (OCS) waters averaging 30–50 m (100-165 ft) deep and outside the polynya zone (Fig. 2.1).

The *Geo Celtic* left Dutch Harbor on 8 Aug and entered the Chukchi Sea survey area (the area north of Point Hope, 68.34ºN latitude) on 11 Aug. Statoil's seismic contractor, Fugro, deployed the seismic acquisition equipment and JASCO Research Ltd. (JASCO) conducted measurements of the underwater sound produced by the airgun array and mitigation airgun on 22–24 Aug. Acoustic measurements were conducted at Statoil's exploration lease area in the Chukchi Sea, approximately 190 km (118 mi; see Chapter 3 for a complete description of the sound source measurements and analysis). JASCO calculated preliminary disturbance and safety radii within 5 days of completion of the measurements. These radii were the basis for implementation of mitigation by MMOs during seismic survey activities thereafter.

The *Geo Celtic* collected seismic data in the Chukchi Sea from 20 Aug through 1 Oct. The *Geo Celtic* departed the Chukchi Sea on 4 Oct arriving in Dutch Harbor on 6 Oct. Statoil completed ~4482 km (2714 mi) of seismic data acquisition in the Chukchi Sea in 2010.

On each seismic line, the airguns were firing for a period of time during ramp up, and during "lead in" periods before the beginning of seismic data acquisition at the start of each seismic line. The airguns were also firing during "lead out" periods after completion of each seismic line, before the full array was powered down to a single gun for transit to the next survey line. Periods of full array firing including periods of lead in, lead out, and ramp up occurred along 5388 km (3348 mi) of trackline. During turns from one seismic line to the next, or during power down periods for marine mammals observed within the safety radii of the full airgun array, the single mitigation gun was operated along 2700 km (1678 mi) of vessel trackline. Thus, one or more airguns were operated along 8073 km (5016 mi) of total trackline in the Chukchi Sea in 2010.

[1] By Megan Blees, Kris Hartin and Darren Ireland (LGL).

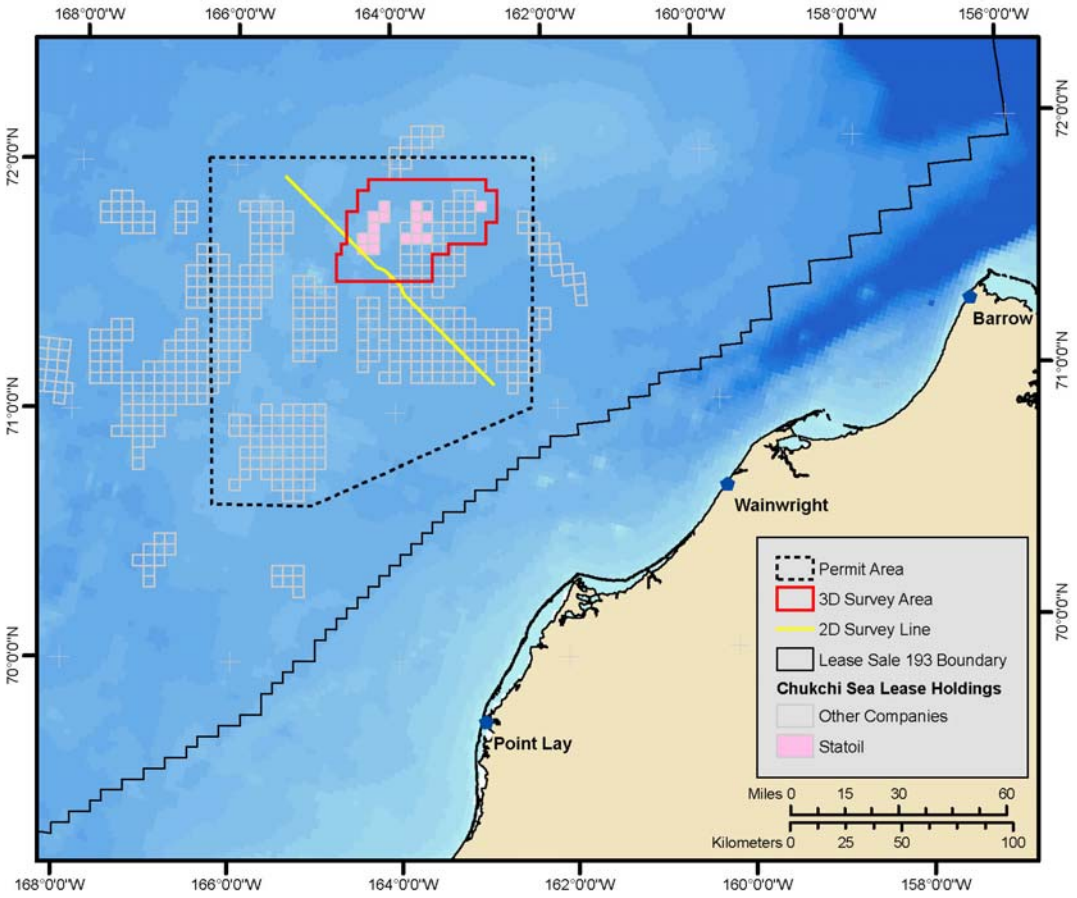


FIGURE 2.1. Location of the 3D seismic survey activity (red outline) and 2D trackline (yellow line). The boundary of the polynya is shown by the thin black line which also delineates the boundary of Lease Sale Area 193.

Throughout the survey, the *Geo Celtic's* position and speed were logged digitally every ~60 s. In addition, the position of the *Geo Celtic*, water depth, and information on the number and volume of airguns that were firing were collected by the marine mammal observers (MMOs) while on duty. This includes when the *Geo Celtic* was offline (e.g., prior to shooting at full volume) or was online but not recording data (e.g., during airgun or computer problems).

Airgun Description

The seismic source used by Statoil and Fugro consisted of a pair of 3000 in^3 three-string arrays of Sodera G-type airguns towed approximately 394 m (431 yd) behind the *Geo Celtic* for its seismic survey operations. The arrays were fired alternately on consecutive shots, sometime referred to as a flip-flop pattern, as the vessel traveled along the survey line. Each array was comprised of three Sodera G-type airgun sub-arrays, and had a total volume of 3,000 in^3. Airguns were operated at an air pressure of 2000 psi. Individual airguns in the sub-arrays ranged in volume from 60 to 250 in^3 and included four 60-in^3, eight 70-in^3, six 100-in^3, four 150-in^3, and four 250-in^3 airguns in two-gun clusters. A 60-in^3 airgun was used as a mitigation source during power downs when marine mammals were observed within or about to enter the applicable full array safety radius and during turns. Each string was 15 m (16 yd) in length, and was 10 m (11 yd) from the adjacent string(s). The airgun arrays were towed at a depth of 6 m (19.7 ft) and spacing between arrays was 50 m (55 yd). Air compressors aboard the *Geo Celtic* were the source of

high pressure air used to operate the airgun arrays. Seismic pulses were emitted at intervals of 25 m (27 yd); average time between shots was 10 sec) while the *Geo Celtic* traveled at a speed of 7.4–9.3 km/h (4 to 5 kt). The system also included 12 hydrophone streamers, each 4050 m (4429 yd) long, with hydrophones spaced 100 m apart over the entire length of each streamer. The hydrophone streamers recorded the reflected and refracted sound energy as it returned from the sub surface. In general, the *Geo Celtic* towed this system along a predetermined survey track, although adjustments were occasionally made during the field season to avoid obstacles or during repairs to the equipment. Characteristics of the airgun arrays are detailed in Appendix C.

Marine Mammal Monitoring

Vessel-based marine mammal monitoring and mitigation was conducted from the *Geo Celtic* and its associated monitoring vessels (*Tanux I* and *Norseman I*) throughout the seismic operations in the Chukchi Sea. Chapter 4 provides a detailed description of the methods and equipment used for monitoring and mitigation during the deep seismic survey, as well as the data analysis methodology. Results of the marine mammal monitoring program are presented in Chapter 5.

In addition to the visual marine mammal monitoring conducted by MMOs, Statoil tested two types of monitoring tools: *(1)* a vessel-mounted 360° infrared (IR) camera and whale blow-detection system, and *(2)* a towed passive acoustic monitoring (PAM) system. The IR camera system was installed on the *Geo Celtic* in order to test its ability to detect marine mammals and functionality as an aid to MMOs. Data were collected over the duration of the survey and recorded on hard drives for post-processing. Preliminary analysis confirms records of blow-signatures from mystecete and odontocete whales and body-signatures of Pacific walruses at the surface during calm conditions. The PAM system (JASCOs Cetacean Towed Array Sonar [CETAS]) was deployed from the *Norseman I* between 21 Sep and 8 Oct 2010 to test the ability to detect and localize marine mammal vocalizations. The ability of the PAM system to detect lower-frequency cetacean calls, such as the bowhead whale (*Balaena mysticetus*), was of particular interest as they are often difficult to detect due to extraneous noise (i.e. vessel noise). Preliminary analysis indicates that vocalizations of bowhead and beluga whales, as well as bearded seals and walrus were recorded. Results for both IR and PAM system trials are still preliminary and are not presented in this report. However, reports describing the equipment tested and the results are expected to be available for distribution in the spring of 2011.

Communication with Native Communities

While working in the Chukchi Sea, personnel contracted by Statoil (most often the MMOs) aboard the *Geo Celtic* and its monitoring vessels routinely contacted native communities via communication centers (comm. centers) established at Point Hope, Wainwright, and Barrow. These communications were intended to ensure that project activities did not interfere with subsistence hunting along the coast. The primary comm. center contacted during the survey was in Wainwright and communications were made via phone or email by each vessel every six hours. The current vessel location and activities were reported during each call. Additional contacts were made with the Wainwright comm. center on the two occasions when the *Norseman I* went to Wainwright to complete personnel transfers. There were no reported conflicts encountered during the survey.

3. SOUND SOURCE VERIFICATION[1]

Introduction

Sound Source Verification Overview

This chapter presents detailed results of the underwater sound measurements performed during Statoil's 2010 3-D marine seismic survey program in the Chukchi Sea, Alaska. The goal of the sound level measurements was to verify and refine the sizes of marine mammal exclusion safety zones that are defined by root-mean-square (*rms*) sound levels near the seismic survey airgun sources. The underwater sound measurements of the *Geo Celtic's* 3000 in^3 airgun arrays and 60 in^3 mitigation airgun were conducted by JASCO Applied Sciences during 22-24 August 2010. Preliminary analyses of the acquired acoustic data were performed in the field and distances to sound level thresholds 190, 180, 160 and 120 dB re 1 µPa (*rms*) were presented in a 5-day field report. Those results were used during the survey to set marine mammal exclusion zones that were monitored by marine mammal observers (MMOs) during active survey operations. A more detailed analysis of the acoustic data was performed since. This chapter presents the results of the more detailed analyses of the sound source verification (SSV) data.

Methods

Measurement Apparatus and Calibration

Underwater sound level measurements were obtained using three autonomous Ocean Bottom Hydrophone (OBH) recorder systems (see Fig. 3.1). The OBH units recorded two channels of acoustic data using two different hydrophone sensitivities. The lower sensitivity channel used a Reson TC4043 with nominal sensitivity -201 dB re V/µPa, and the higher sensitivity channel used a Reson TC4032 with nominal sensitivity -170 dB re V/µPa. The acoustic data were recorded on calibrated Sound Devices 722 24-bit audio hard-drive recorders at 48 kHz sampling rate. Upon retrieval of the recorders, the data were transferred to external hard drives for backup. The OBHs provided high-resolution, digital underwater sound recordings during the SSV tests.

All of the OBH systems were calibrated prior to deployment using a GRAS pistonphone calibrator which generated a 250 Hz reference tone played into the hydrophones of the OBH systems. The pressure calibration was obtained from the level of the reference signals in the digital recordings, thereby providing end-to-end calibrations of the complete monitoring systems. Calibration results are provided in Table D.1 through Table D.5 in Appendix D.

[1] By Caitlin O'Neill, Del Leary, and Andrew McCrodan (JASCO Applied Sciences)

FIGURE 3.1. Photograph of a JASCO Ocean Bottom Hydrophone (OBH) recorder with ballast anchor.

Field Measurement Procedures

SSV measurements were conducted at Statoil's exploration lease area in the Chukchi Sea, approximately 190 km (118 mi) northwest of Wainwright. Three calibrated OBH recorders were deployed from the monitoring vessel R/V *Norseman I* to measure *in situ* SPLs versus distance from the survey vessel's airgun arrays. Sound level measurements for the 3000 in^3 airgun arrays were measured in both the broadside (perpendicular to survey line) and endfire (parallel to survey line) directions, in order to capture their directivity. Omni-directional sound levels from the 60 in^3 mitigation airgun were measured using a single OBH recorder during the survey vessel's line turn.

Fig. 3.2 shows a diagram of the SSV test layout for *Geo Celtic*'s 3000 in^3 airgun arrays and 60 in^3 mitigation airgun. The *Geo Celtic* fired its airgun arrays along four track lines at its nominal survey speed of 4.4 knots (8.1 km/h). These seismic survey lines were approximately 45 km (28 mi) long with a 40 km (25 mi) approach and 5 km (3 mi) run out. All the track lines were oriented west-east, perpendicular to the line of OBHs. Measurements of sound levels from *Geo Celtic*'s 60 in^3 mitigation airgun were obtained by repositioning the OBH at station A1 to station A2, at the apex of a line change. The mitigation airgun turn was 20 km long. The OBH recorders at stations B and C were not used for the mitigation airgun measurements.

During 3-D surveying, *Geo Celtic*'s airguns fired every 18.75 m (20.5 yd) over ground (approximately every 10 seconds). Each OBH recorded approximately 24 hours of seismic data. After completion of the SSV test, the monitoring vessel *Norseman I* returned to the test area to recover the OBHs. Table 3.1 shows the start and end coordinates of each of the four SSV test lines and the mitigation turn. Table 3.2 shows the OBH locations and deployment and retrieval times.

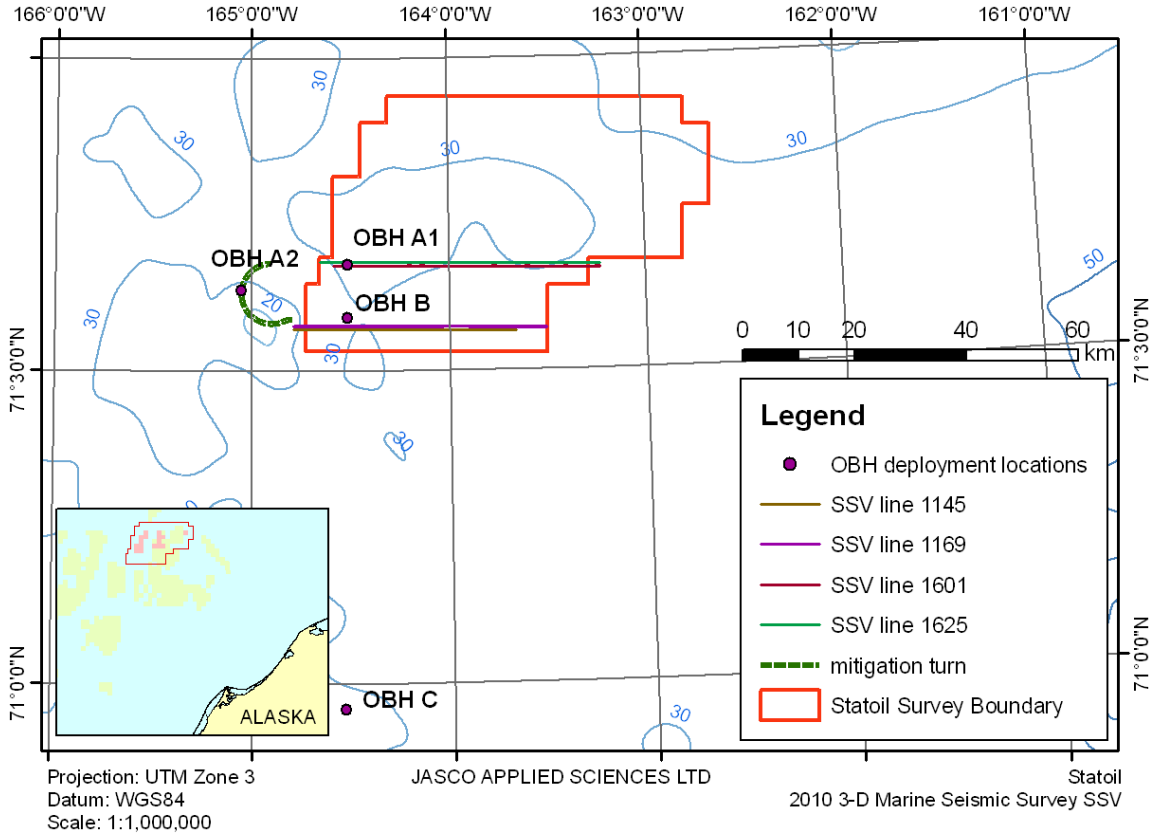


FIGURE 3.2. Map of Statoil's seismic survey area with the SSV survey lines and OBH deployment locations. Blue contours indicate water depth in meters.

TABLE 3.1. SSV survey line coordinates (WGS-84) and start and end times.

Survey Line	Start Time (UTC)	End Time (UTC)	Start Coordinates	End Coordinates
1145-68	23/Aug/10 21:26	24/Aug/10 01:34	71º 33.778'N 163º 40.508'W	71º 34.032'N 164º 47.336'W
1169-92	23/Aug/10 02:31	23/Aug/10 07:30	71º 34.014'N 163º 31.182'W	71º 34.349'N 164º 47.333'W
1601-24	24/Aug/10 04:36	24/Aug/10 10:00	71º 40.140'N 164º 34.510'W	71º 39.660'N 163º 08.756'W
1625-48	23/Aug/10 11:44	23/Aug/10 17:24	71º 40.481'N 164º 39.010'W	71º 40.028'N 163º 13.763'W
Mitigation Turn	24/Aug/10 19:26	24/Aug/10 22:10	71º 34.994'N 164º 48.419'W	71º 40.387'N 164º 53.751'W

TABLE 3.2. OBH location coordinates (WGS-84) and deployment and retrieval times for the SSV measurements.

Station	Deployment Time (UTC)	Retrieval Time (UTC)	Latitude	Longitude	Water Depth (m)
OBH A1	23/Aug/10 03:22	24/Aug/10 15:22	71º 40.205'N	164º 30.979'W	41
OBH A2	24/Aug/10 18:17	24/Aug/10 23:18	71º 37.776'N	165º 03.207'W	38
OBH B	23/Aug/10 02:02	25/Aug/10 01:21	71º 35.080'N	164º 31.091'W	43
OBH C	22/Aug/10 19:24	25/Aug/10 07:52	70º 57.459'N	164º 32.076'W	43

Acoustic Metrics

By convention, underwater noise is measured in decibels (dB) relative to a fixed reference pressure of 1 μPa (equal to 10^{-6} Pa or 10^{-11} bar). Sound pressure levels (SPL) from impulsive noise sources are commonly characterized by three acoustic metrics: peak SPL, root-mean-square (*rms*) SPL, and sound exposure level (SEL). The standard equations for computing these metrics are provided below. All acoustic pressures in these formulas are in units of μPa.

The peak SPL (symbol L_{pk}) is the maximum instantaneous sound pressure level attained from a pressure pulse, $p(t)$:

Peak SPL: $$L_{pk} = 20\log_{10}(\max|p(t)|) \quad (1)$$

The *rms* SPL (symbol L_P) is the mean square pressure level integrated over a specified time window T containing the pressure pulse, $p(t)$:

rms SPL: $$L_P = 10\log_{10}\left(\frac{1}{T}\int_T p^2(t)\,dt\right) \quad (2)$$

When computing *rms* SPLs for airguns and other impulse noise sources, the time interval is generally taken to be the 90% energy pulse duration, and is represented by T_{90} (Malme *et al.*, 1986; Greene 1997; McCauley *et al.*, 1998). The 90% energy pulse duration for each seismic pulse is computed as the time window defined by the times corresponding to receipt of 5% and 95% of SEL. *rms* SPLs computed in this way are consequently referred to as 90% *rms* SPLs (symbol L_{P90}). Because the window length acts as a divisor, pulses that are more spread out in time have a lower *rms* SPL for the same total SEL.

The SEL (symbol L_E) is a measure of the total sound energy contained in one or more pulses. SEL for a single pulse is computed from the time-integral of the squared pressure over a fixed time window, long enough to include the entire pulse:

SEL: $$L_E = 10\log_{10}\left(\int_{T_{100}} p^2(t)\,dt\right) \quad (3)$$

SEL has units of dB re 1 $\mu Pa^2 \cdot s$ and is a measure of sound exposure, rather than sound pressure. Species-specific SEL metrics may be computed by applying a frequency weighting filter to the pressure pulse data $p(t)$ in Equation (3) before computing the SEL, as discussed in the *Frequency M-Weighting* section below.

The cumulative SEL of a collection of *N* acoustic pulses is the sum of the SELs from the individual pulses:

$$\text{Cumulative SEL:} \quad L_E(\text{cumulative}) = 10\log_{10}\left(\sum_{i=1}^{N} 10^{L_E^{(i)}/10}\right) \tag{4}$$

where $L_E^{(i)}$ is the SEL of the i^{th} pulse.

To compute SPL and SEL of pulses in the presence of high levels of background noise, Equations 2 and 3 are modified to subtract the background noise contribution from the pulse energy:

$$\text{90\% } \textit{rms} \text{ SPL:} \qquad L_{P90} = 10\log_{10}\left(\frac{1}{T_{90}}\int_{T_{90}} p^2(t)\,dt - \overline{n^2}\right) \tag{5}$$

$$\text{SEL:} \qquad L_E^{(tot)} = 10\log_{10}\left(\int_{T} p^2(t)\,dt - \overline{n^2}T\right) \tag{6}$$

where $\overline{n^2}$ is the mean square pressure of the background noise, generally computed by averaging the squared pressure of a nearby segment of the acoustic recording during which pulses are absent (*i.e.*, between pulses).

Because the 90% *rms* SPL and SEL are both computed from the integral of square pressure, these metrics are related by a simple expression, which depends only on the duration of the 90% integration time window T_{90}:

$$L_E = L_{P90} + 10\log(T_{90}) + 0.458 \tag{7}$$

where the 0.458 dB factor accounts for the *rms* level containing 90% of the total energy from the per-pulse SEL.

Exposure Criteria and M-weighting

NMFS Criteria

Operational safety radii for the 2010 Statoil Seismic Survey Program were based on *rms* auditory injury criteria developed by the National Marine Fisheries Service (NMFS). NMFS has defined two noise exposure criteria, corresponding to Level A harassment (auditory injury) and Level B harassment (behavioral disturbance) as defined in the US Marine Mammal Protection Act (see Richardson *et al.*, 1995, §1.3). The NMFS criteria are based on the un-weighted *rms* SPL of single airgun pulses. The NMFS Level A criteria are based on estimates of marine mammal hearing damage thresholds extrapolated from known Damage Risk Criteria for humans (see discussion in Richardson *et al.*, 1995, §10.5). The NMFS Level A criteria, intended to represent cautionary estimates for the onset of auditory system injury, are 190 dB re 1 µPa (*rms*) for pinnipeds and 180 dB re 1 µPa (*rms*) for cetaceans (*e.g.*, US Federal Register 60:53753-60). The airgun array was to be powered down or shut down when marine mammal observers detected seals within the pre-defined 190 dB re 1 µPa safety radius and/or whales within the pre-defined 180 dB 1 µPa safety radius.

NMFS has also established a threshold criterion for behavioral responses (Level B harassment) to impulse noise sources. The threshold for the onset of behavioral response to seismic pulses is 160 dB re 1

µPa *rms* SPL, based on estimated received seismic noise levels during behavioral studies where baleen whales exhibited avoidance behavior around airgun pulses (*e.g.*, Malme *et al.*, 1984 and 1986). The airgun arrays were to be powered down or shut down when marine mammal observers detected aggregations of baleen whales (12 or more) within the≥160 dB re 1 µPa (*rms*) zone. The NMFS behavioral threshold criterion was also used to estimate the number of animals potentially affected by the seismic survey.

Southall Auditory Injury Criteria

Recent literature suggests that frequency dependence of marine mammal hearing should be considered when establishing safety radii for seismic surveys. Based on a review of literature on marine mammal hearing and on physiological and behavioral responses to anthropogenic sound, Southall *et al.* (2007) have recently proposed alternative injury criteria for marine mammals, based on the peak SPL and SEL metrics. These criteria account for the type of sound (non-pulse, single-pulse, or multi-pulse), as well as the approximate hearing ranges of the mammals involved. The Southall injury criteria are for the onset of PTS (permanent threshold shift) in marine mammals. PTS is associated with unrecoverable hearing loss and auditory organ tissue damage. For a multi-pulse source such as an airgun array, Southall *et al.* have proposed the following injury criteria:

- Peak SPL: 230 and 218 dB re 1 µPa (unweighted) for cetaceans and pinnipeds, respectively
- SEL: 198 and 186 dB re 1 µPa2·s (M-weighted) for cetaceans and pinnipeds, respectively

For a given situation, the more conservative of these two conditions should be applied. The Southall criteria were not mentioned in the Statoil IHA and these were not implemented to define exclusion zones. However, we have computed the Southall criteria metrics for the individual SSV survey lines to provide a comparison with the *rms* criteria implemented in the field.

Frequency M-Weighting

The M-weighting approach of Miller *et al.* (2005) is commonly applied to account for the different hearing abilities of different marine mammals groups. It is similar to the C-weighting method that is used for assessing impacts of loud impulsive sounds on humans. M-weighting accounts for decreased hearing sensitivity above and below the most sensitive hearing range of marine mammals. Weighting curves are defined for five marine mammal groups: low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, pinnipeds in air (not considered here), and pinnipeds underwater (see Table 3.3). The decibel weighting as a function of frequency, $W(f)$, is:

$$W(f) = -20\log_{10}\left(\frac{f^2 f_{hi}^2}{(f^2 + f_{lo}^2)(f^2 + f_{hi}^2)}\right) \quad (8)$$

where f_{hi} and f_{lo} are the estimated upper and lower hearing limits specific to each functional hearing group (Table 3.3). Fig. 3.3 shows the four underwater M-weighting curves as a function of frequency for each hearing group. M-weighted SELs are used for computing the Southall noise exposure criteria in a later section in this report.

TABLE 3.3. Functional marine mammal hearing groups and associated auditory bandwidths, as per Miller *et al.* (2005).

Functional hearing group	*Estimated auditory bandwidth*	
	f_{lo}	f_{hi}
Low-frequency cetaceans	7 Hz	22 kHz
Mid-frequency cetaceans	150 Hz	160 kHz
High-frequency cetaceans	200 Hz	180 kHz
Pinnipeds (underwater)	75 Hz	75 kHz

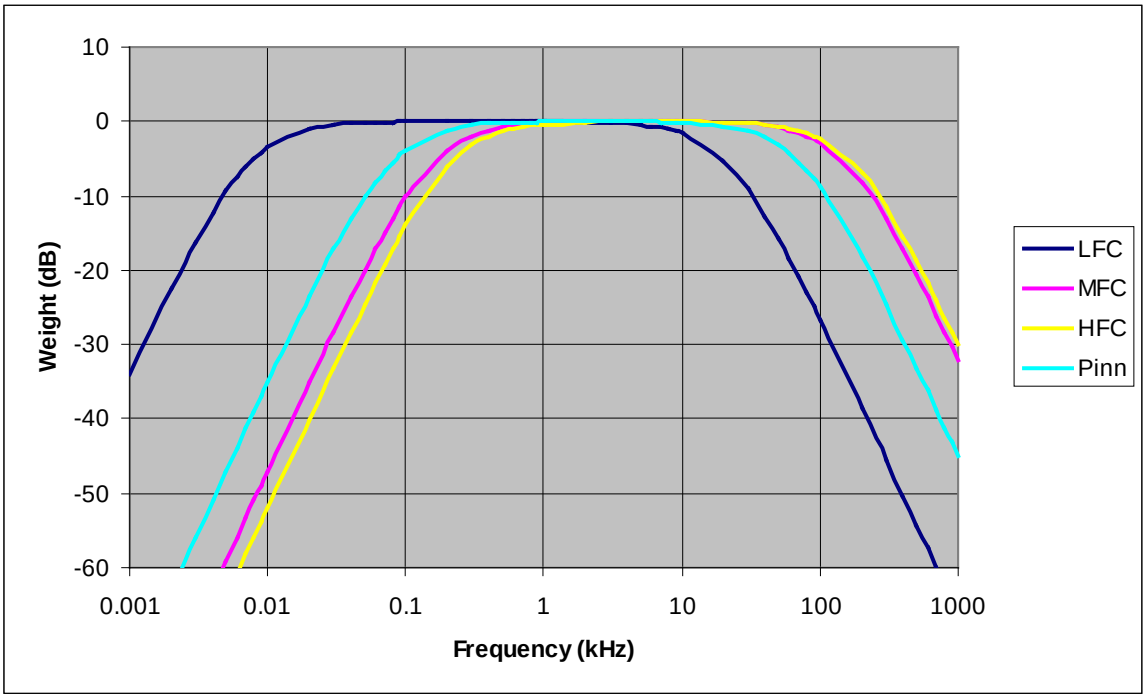


FIGURE 3.3. Decibel M-weighting versus frequency for underwater marine mammal functional hearing groups: low- (LFC), mid- (MFC), and high-frequency cetaceans (HFC), and pinnipeds underwater (Pinn).

Data Analysis Procedures

SPL Threshold Radii

Acoustic data were analyzed using custom processing software, to determine peak and *rms* SPLs and sound exposure levels (SELs) versus range from the airgun arrays. The data processing steps were as follows:

1. Airgun pulses in the OBH recordings were identified using automated detection algorithm.
2. Waveform data were converted to units of µPa using the calibrated hydrophone sensitivity of each OBH system.
3. For each pulse, the distance to the airgun array was computed from the GPS deployment coordinates of the OBH systems and the time referenced P1/90-S navigation logs of the survey vessel.

The airgun pulses were processed to determine peak sound pressure level (Peak SPL), 90% *rms* sound pressure level (SPL_{rms90}) and sound exposure level (SEL).

In order to estimate distances to the different *rms* SPL threshold levels, the SPL data were fit to an empirical propagation loss curve of the following form:

$$RL = SL - A\log_{10} R - BR$$

where *R* is the horizontal range from the source to the OBH, *RL* is the received sound level, *SL* is the estimated source level term, *A* is the geometric spreading loss coefficient and *B* is the absorptive loss coefficient. This equation was fit to the SPL data by minimizing (in the least-squares sense) the difference between the trend line and the measured level-range samples. In order to provide precautionary estimates of the threshold radii, the best fit line was shifted upwards (by increasing the constant *SL* term) so that the trend line encompassed 90% of all the data. The 90th percentile best-fit values for *SL*, *A*, and *B* are shown in the SPL plot annotations in the following sections.

Cumulative SEL

The M-weighted cumulative SEL metric considers the total SEL received from multiple pulses and also accounts for frequency-dependent hearing sensitivity of different species groups. The auditory injury cumulative SEL threshold is 198 dB re 1 μPa^2-s (M-weighted) for cetaceans and 186 dB re 1 μPa^2-s (M-weighted) for pinnipeds under water.

The cumulative SEL metric proposed by Southall *et al.* involves summing the single pulse SEL's for multiple pulses. They acknowledge that this approach is very conservative because it does not make any allowance for the recovery of hearing between pulse exposures. Their proposed cumulative SEL metric (flat weighted) is defined in Equation 4 above.

In the present study the cumulative SEL levels (both flat-weighted and M-weighted) were computed for all shots in a single seismic line. We computed these levels from data from both OBHs at both prospects. It is important to note that if these levels were to be used for assessing impact then one would assume the exposed animals remained stationary throughout the exposure (while the airguns operated along the entire survey line). It is more likely that an animal would move away from the survey line as the seismic vessel approached, resulting in lower cumulative SEL received. It is considered unlikely that an animal would swim parallel to a seismic survey at close distance thereby receiving the maximum possible SEL.

Ambient Sound Levels

Spectral analysis was used to determine the statistical distribution of ambient noise over the entire recording period. For each recording, sound spectra were computed from the acoustic data using a 1-second sliding analysis window (48,000 samples) with 50% overlap. The time-domain data were shaded using a normalized Hanning window in order to minimize spectral leakage. Sound power spectral levels were computed with 1 Hz frequency resolution up to the Nyquist frequency (24 kHz). The statistical distribution of the ambient noise was calculated by constructing a histogram of the spectral values. A bin width of 0.1 dB was used for the ambient noise histograms. The histogram distributions were used to calculate the 5th, 25th, 50th, 75th, and 95th percentile ambient noise spectral levels (note that the *n*th percentile level is defined as the sound level that was exceeded *n*% of the time, in compliance with ISO standard 1996-1:1982).

Results

CTD Data

CTD (conductivity, temperature, depth) profiles of the water column at each OBH location were sampled before and after the SSV test. The sound speed was calculated from these measurements using Coppens' formulae (Coppens, 1981). The water temperature and salinity casts obtained with the CTD profiler at stations OBH A1, OBH A2, and OBH B showed a well-mixed ~17-m (19 yd)-thick layer of warmer surface water (~4.2 °C) above a deeper layer of cold water (~–0.6 °C). The salinity of the well-mixed surface layer was ~3.0 ppt less than that of the deeper cold layer. These temperature and salinity conditions resulted in a two-layer sound speed profile, with a sharp transition from a higher speed surface layer (~1460 m/s) to a lower speed bottom layer (~1445 m/s) at 17 m (19 yd) depth. At OBH C, the water temperature was ~1.0 degrees warmer throughout the water column than at the other OBH locations. This increased the sound speed to ~1465 m/s in the surface layer and ~1450 m/s in the bottom layer.

The sound speed profiles measured before and after the SSV test at all OBH locations are shown in Fig. 3.4. These profiles, having higher sound speed near the sea-surface, are downward refracting. The sound speed minimum at the bottom could generate a sound duct that would trap sound energy, resulting in higher sound levels near the seabed than near the surface. However, this profile may also result in higher acoustic propagation loss due to increased interaction with the seabed.

SPL Measurements

Airgun Array

Peak SPL, 90% *rms* SPL and SEL for each shot were computed from acoustic data for all three OBHs. Fig. 3.5 shows plots of sound level versus range data from the SSV site for the endfire and broadside directions from the 3000 in^3 airgun array. The endfire SPL data in Fig. 3.5a were obtained from OBH A1, which was located directly on the longest survey vessel track line (track line 1601-24). The broadside SPL data in Fig. 3.5b were obtained by taking 3 to 5 points around the broadside lobe on OBH A1 and 11 points around the broadside lobe on OBH B and OBH C. Table 3.4 shows ranges to the 190 dB to 120 dB re 1 µPa *rms* SPL thresholds, in 10 dB increments, computed from the 90^{th} percentile empirical curve fits to the SPL versus distance data. The curve fit for endfire data Fig. 3.5a over-estimates radii at distances less than 200 m (219 yd) due to near-field effects that are not accounted for in the fitted approximation, however safety threshold set at 190 dB occurs at a distance greater than 200 m (219 yd) keeping the approximation valid.

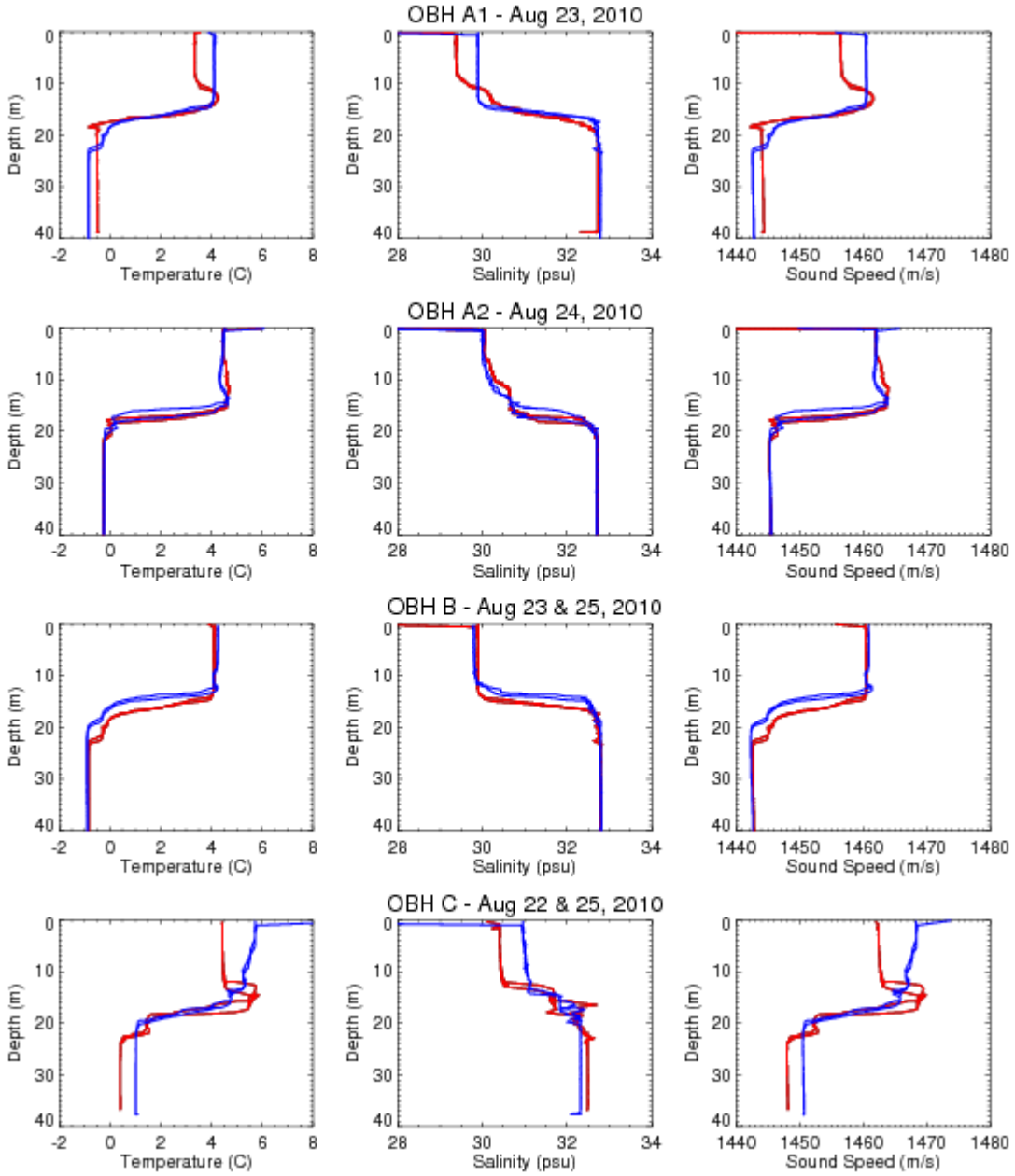


FIGURE 3.4. Ocean sound speed profiles measured before and after the SSV test. Note that sound speed in seawater was computed from *in situ* temperature and salinity measurements. Red lines are pre-deployment and blue lines are post-deployment. The double lines correspond to the upcast and downcast of the CTD profiler.

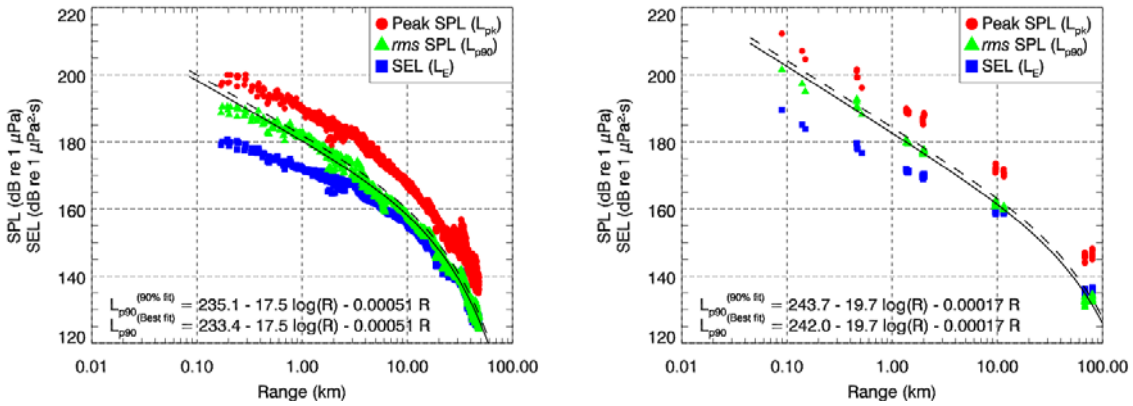


FIGURE 3.5. Peak SPL, *rms* SPL, and sound exposure level (SEL) versus range for 3000 in^3 array airgun pulses at the SSV site: (a) endfire on OBH A1, and (b) broadside on OBH A1, B, and C. Solid line is best fit of the empirical function to SPL_{rms90} values. Dashed line is the best-fit adjusted to exceed 90% of the SPL_{rms90} values.

TABLE 3.4. Threshold radii at the SSV site as determined from 90th percentile fit to SPL_{rms90} versus distance data in Fig. 3.5.

SPLrms90 Threshold (dB re 1 µPa)	Endfire		Broadside	
	Best-Fit Line Radius	90th Percentile Radius	Best-Fit Line Radius	90th Percentile Radius
190	300 m	370 m	430 m	520 m
180	1,000 m	1,300 m	1,400 m	1,600 m
170	3,300 m	4,000 m	4,100 m	4,900 m
160	8,600 m	10,000 m	11,000 m	13,000 m
150	18,000 m	19,000 m	27,000 m	30,000 m
140	30,000 m	32,000 m	52,000 m	57,000 m
130	43,000 m	46,000 m	85,000 m	91,000 m
120	59,000 m	61,000 m	123,000 m	130,000 m

Fig. 3.6 shows waveform and spectrum plots a single airgun pulse in the endfire direction at 460 m (503 yd; 183 dB re 1 µPa), 1359 m (1486 yd; 180 dB re 1 µPa), 1953 m (2136 yd; 178 dB re 1 µPa), and 9393 m (10,272 yd; 159 dB re 1 µPa). Fig. 3.7 shows waveform and spectrum plots for the same ranges in the broadside direction for comparisons with the corresponding endfire measurements. The waveforms show that pulse dispersion increases with distance from the source where the time length increases due to high frequencies traveling faster than lower frequencies. At greater ranges prominent low-frequency sub-bottom or head-waves (< 30 Hz), which travel through the seafloor sediments, can be detected before the water-borne pulse that travels through the water column. This phenomenon is due to the higher sound speeds within the marine sediments than in water. The red bars on the waveform plots indicate the 90% energy pulse duration. Fig. 3.7a includes a small pulse at the relative time of 1.7 seconds. This is likely an echosounder on the *Geo Celtic* that was operating during the SSV acquisition. It has a center frequency at approximately 8 kHz, as shown in the corresponding spectrum plot and in the spectrum plot of Fig. 3.8a.

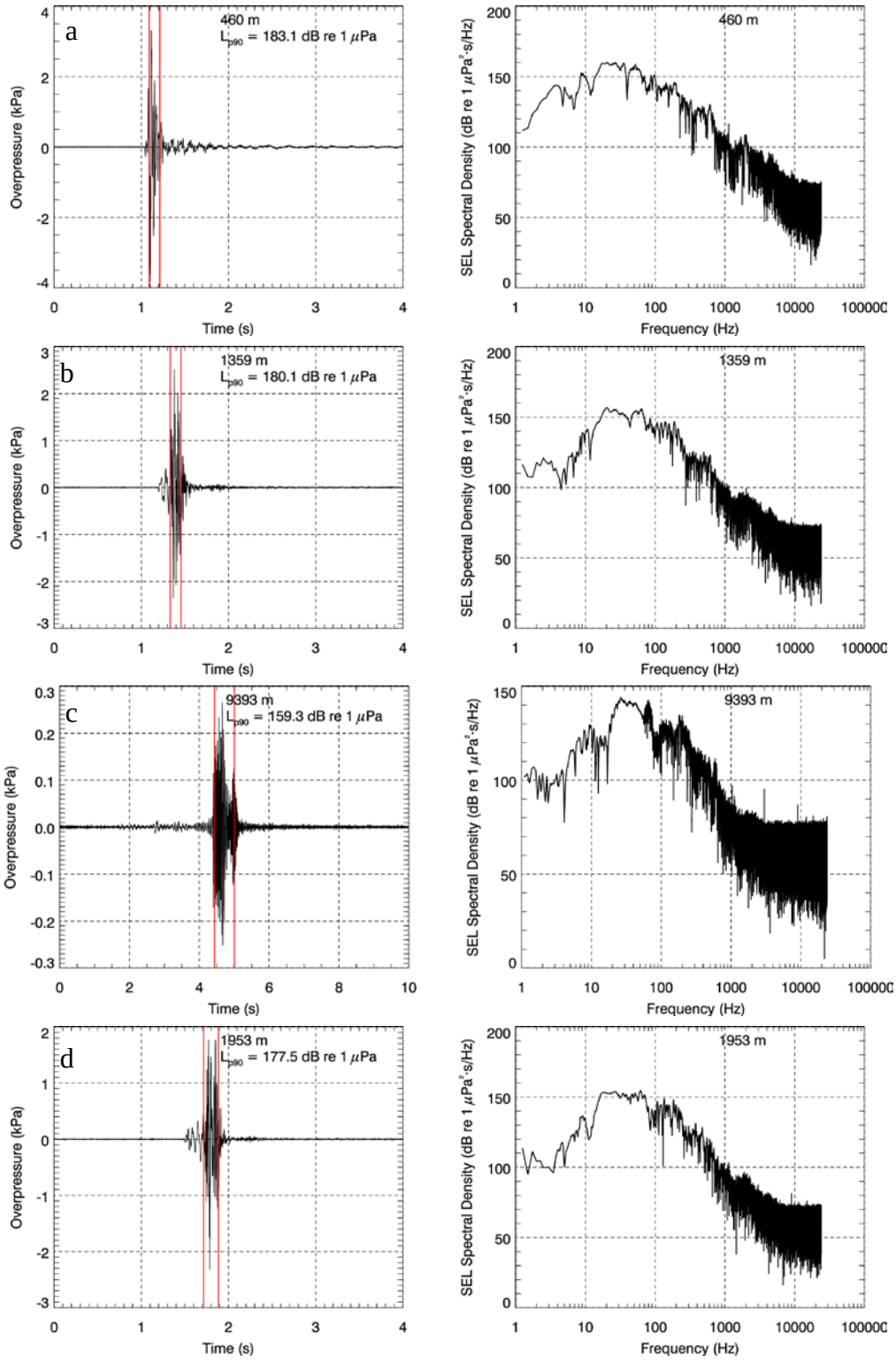


FIGURE 3.6. Waveform and corresponding spectrum plots of an airgun pulse at various distances (a) 460 m, (b) 1359 m, (c) 1953 m, and (d) 9393 m in the rear endfire direction. The red bars on the waveform plot indicate the 90% energy pulse duration.

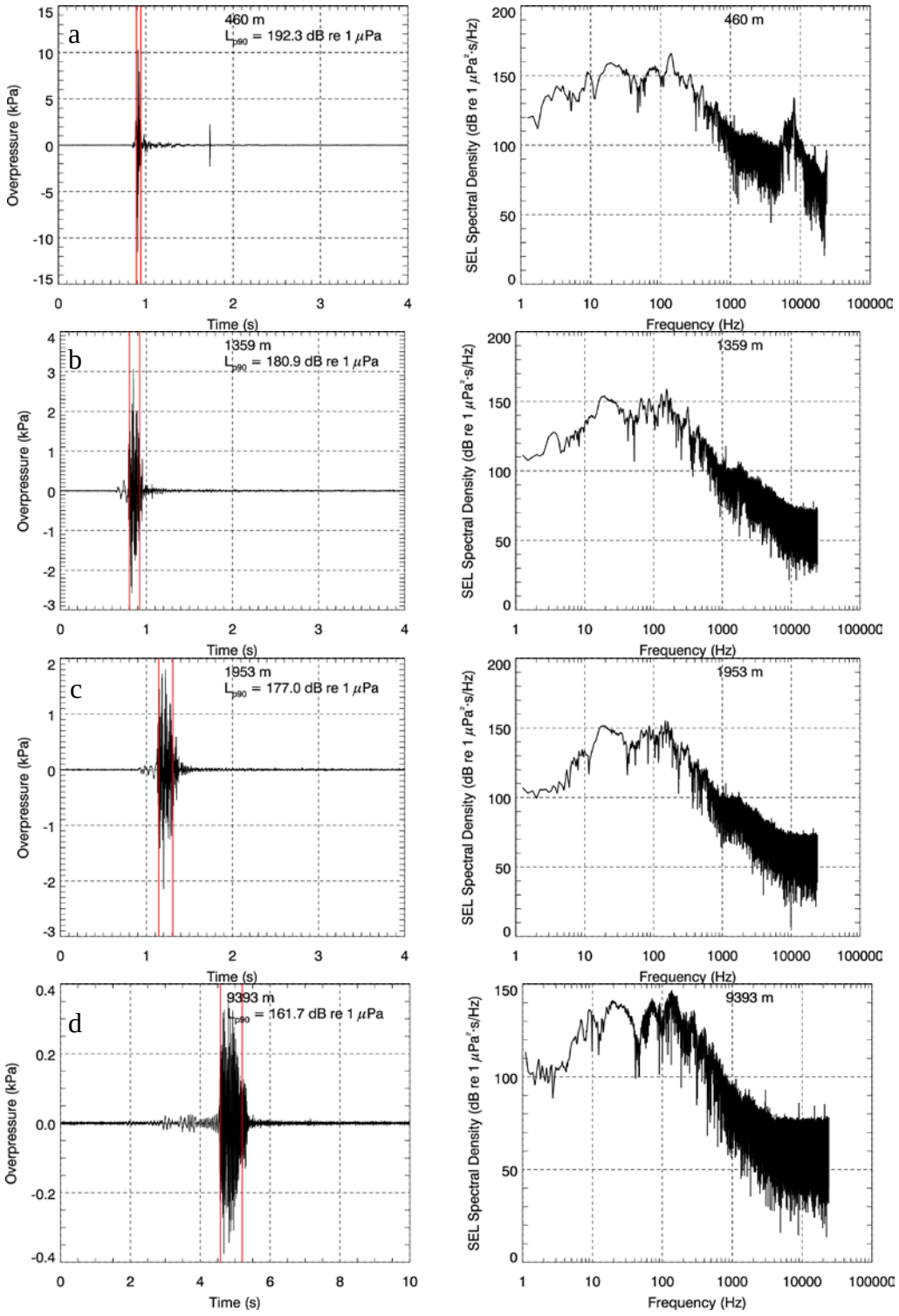


FIGURE. 3.7. Waveform and corresponding spectrum plots broadside direction of an airgun pulse at various distances (comparative to the endfire data) for (a) 460 m, (b) 1359 m, (c) 1953 m, and (d) 9393 m in the rear endfire direction. The red bars on the waveform plot indicate the 90% energy pulse duration. The red bars on the waveform plot indicate the 90% energy pulse duration

The most proximal and distal airgun array pulse acquisitions from the broadside direction are presented in Fig. 3.8. The proximal acquisition at distances 90 m (98 yd; 202 dB re 1 µPa) and 150 m (164 yd; 195 dB re 1 µPa) yield pulses with a short time duration and are more impulsive in nature. Conversely, the distal pulse acquired at 80 km (50 mi; 133 dB re 1 µPa) has a much longer pulse length due to the effects of dispersion that increase with distance.

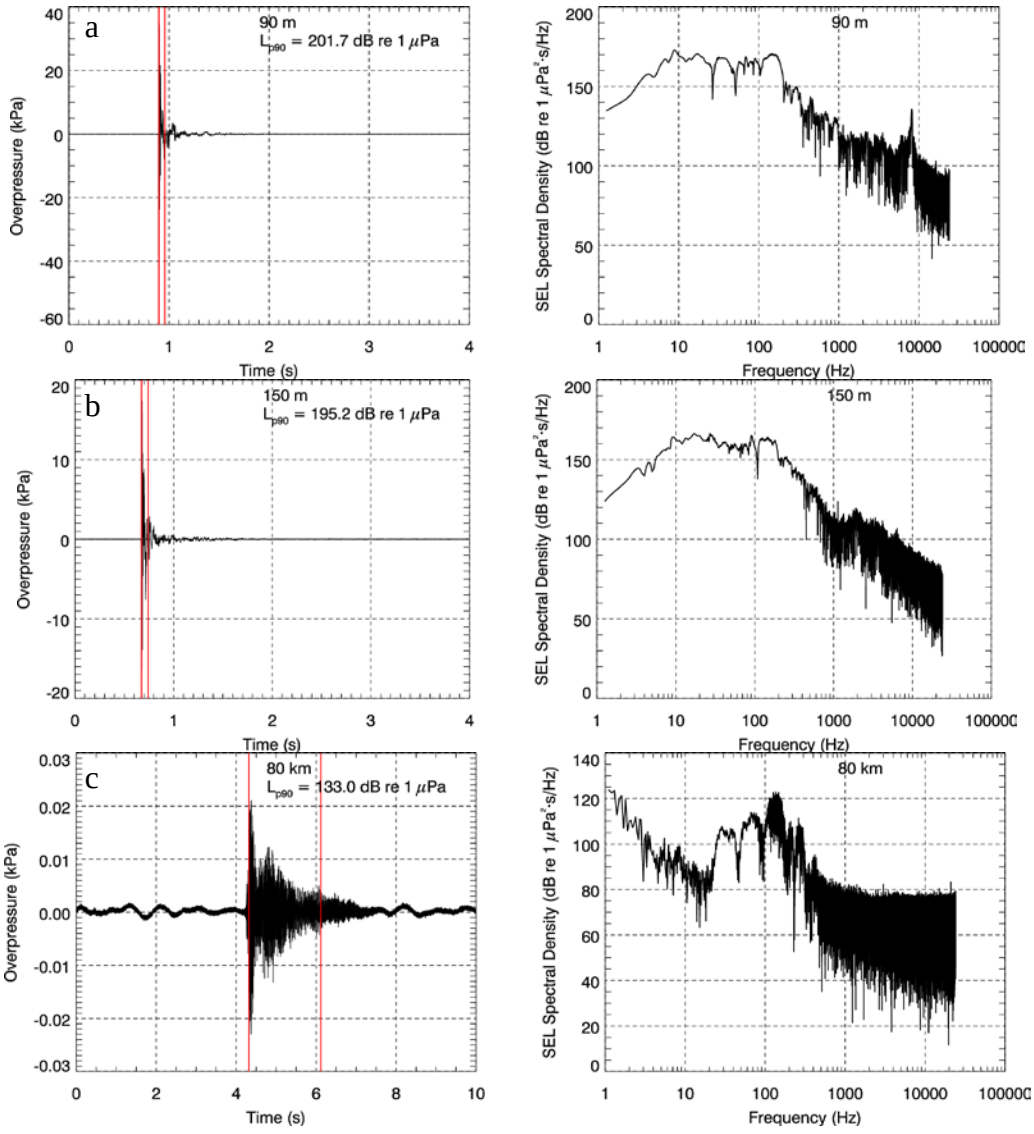


FIGURE 3.8. Additional waveform and corresponding spectrum plots for proximal (a) 90 m and (b) 150 m, and distal (c) 80 km spectra in the broadside direction.

Spectrograms

Spectrograms (plots of acoustic intensity versus time and frequency) were generated for selected pulses (see Fig. 3.9, Fig. 3.10, and Fig. 3.11) to show the time evolution of the spectra variation of the airgun pulses. This type of analysis highlights the time separation of the low frequency (< 30 Hz) ground refracted or head waves. This energy arrives in advance of the water borne pulse. Head waves and refracted waves propagate through the seabed where sound speeds are higher than in water. A clear

example of a head wave can be seen at 9393 m range, for both the endfire (see Fig. 3.9d) and broadside (see Fig. 3.10d) directions, arriving approximately 2.5 s before the water borne pulse. The airgun pulse length is shown to increase in time at increasing distance due to frequency dispersion of the sound energy, which can be most clearly seen in Fig. 3.11c.

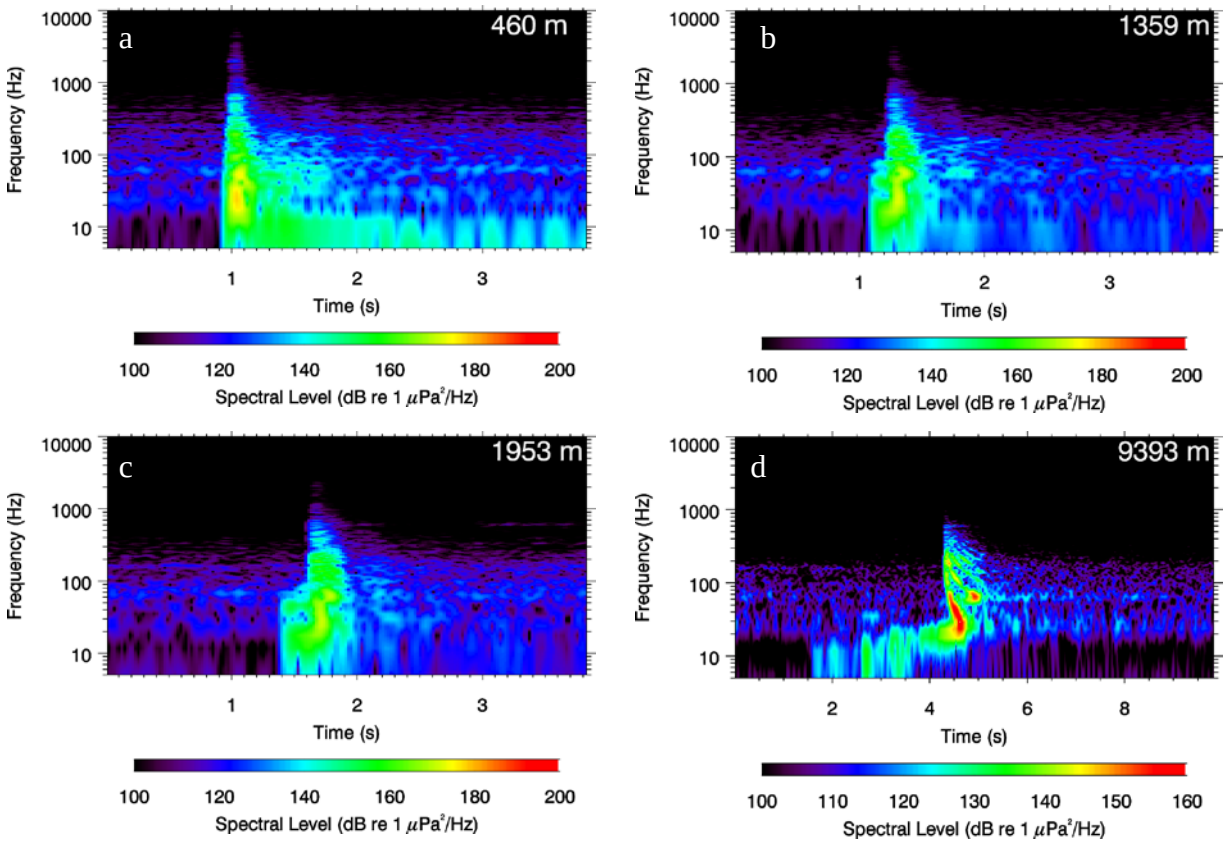


FIGURE 3.9. Spectrograms of airgun pulses at (a) 460 m, (b) 1359 m, (c) 1953 m, and (d) 9393 m range in the endfire direction. The data are spectrograms of the waveforms shown in Fig. 3.6.

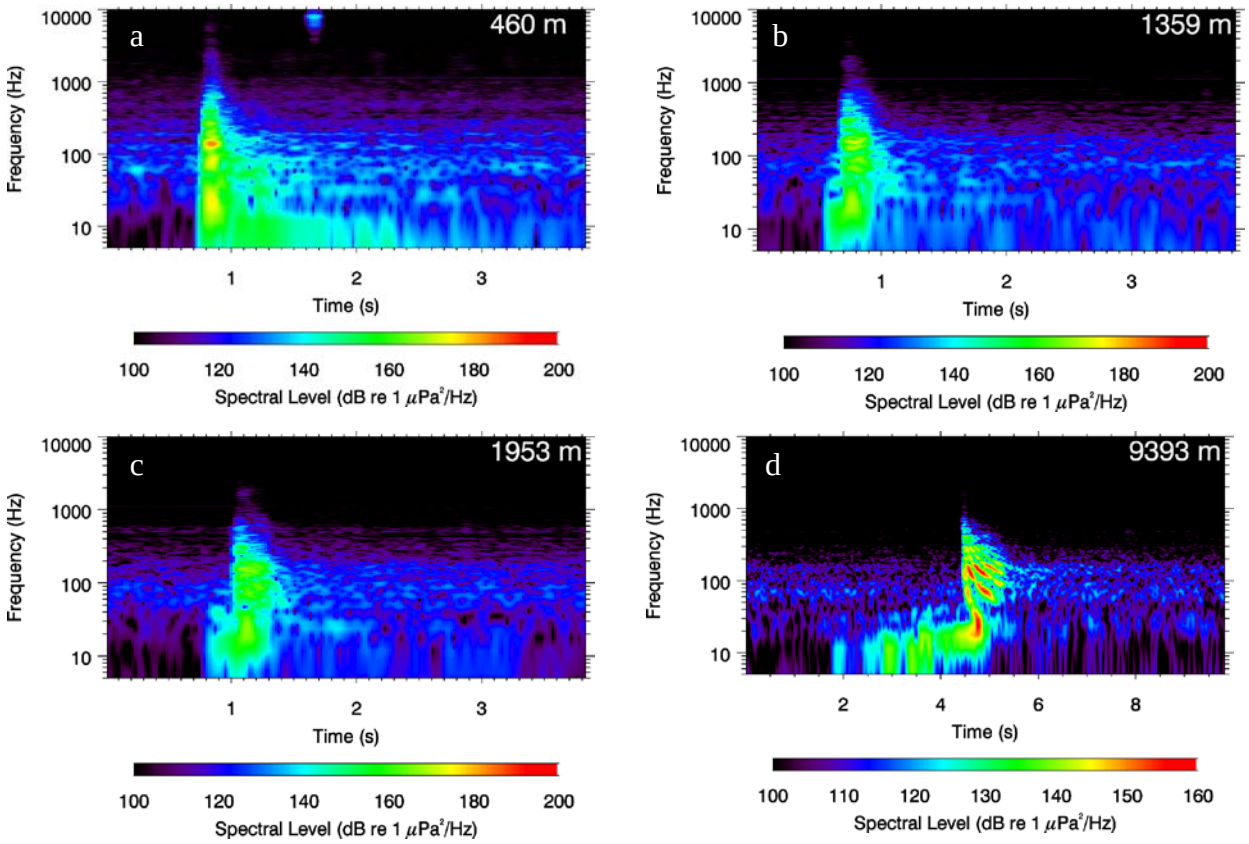


FIGURE 3.10. Spectrograms of airgun pulses at (a) 460 m, (b) 1359 m, (c) 1953 m, and (d) 9393 m range in the broadside direction. The data are spectrograms of the waveforms shown in Fig. 3.7.

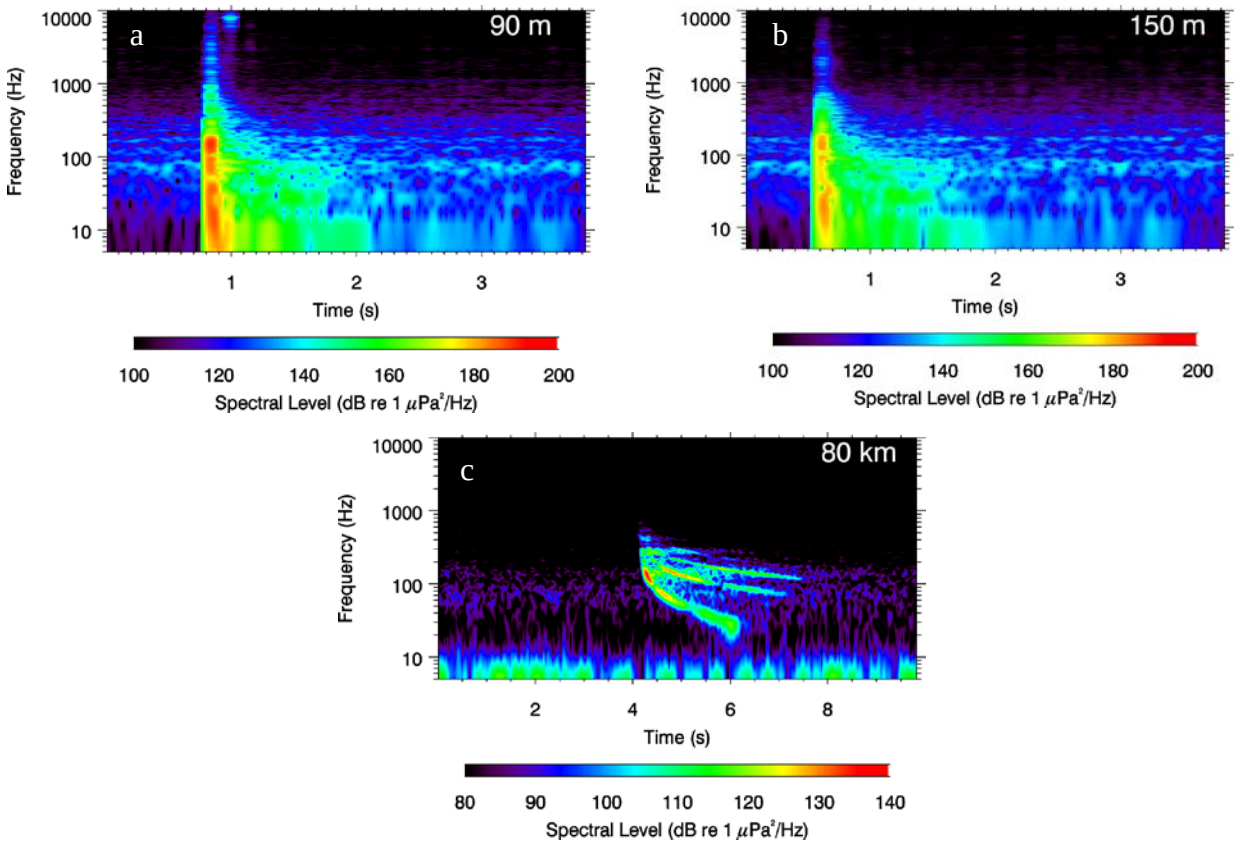


FIGURE 3.11. Spectrograms of airgun pulses at proximal (a) 90 m and (b) 150 m, and distal (c) 80 km ranges from the broadside direction. The data are spectrograms of the waveforms shown in Fig. 3.8.

Mitigation Airgun (60 in^3) Measurements

Peak SPL, 90% *rms* SPL and SEL for each mitigation gunshot were computed from acoustic data from OBH A2. Fig. 3.12 shows plots of sound level versus range data from the SSV site for the 60 in^3 mitigation airgun. Table 3.5 presents the ranges corresponding to levels of 190 dB to 120 dB (re 1 µPa *rms*) SPL, in 10 dB increments, computed from the 90th percentile empirical curve fits to the SPL versus distance data. Fig. 3.13 shows waveform and spectrum plots of a mitigation airgun pulse at 50 m (54 yd), 500 m (547 yd), and 5000 m (5468 yd). The red bars on the waveform plots indicate the 90% energy pulse duration.

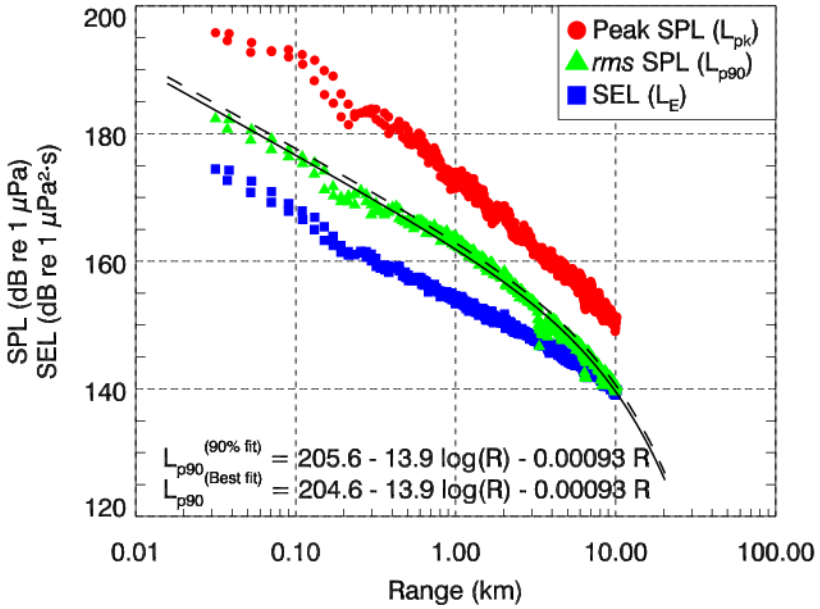


FIGURE 3.12. Peak SPL, *rms* SPL, and sound exposure level (SEL) versus range for 60 in^3 mitigation airgun pulses at the SSV site. Solid line is best fit of the empirical function to SPL_{rms90} values. Dashed line is the best-fit adjusted to exceed 90% of the SPL_{rms90} values.

TABLE 3.5. Threshold radii for the mitigation airgun at the SSV site as determined from 90th percentile fit to SPL_{rms90} versus distance data in Fig. 3.12.

SPL_{rms90} Threshold (dB re 1 µPa)	Best-Fit Line Radius	90th Percentile Radius
190	11 m	13 m
180	57 m	68 m
170	290 m	340 m
160	1,300 m	1,500 m
150	4,300 m	4,700 m
140	9,700 m	10,000 m
130	17,000 m	18,000 m
120	25,000 m	26,000 m

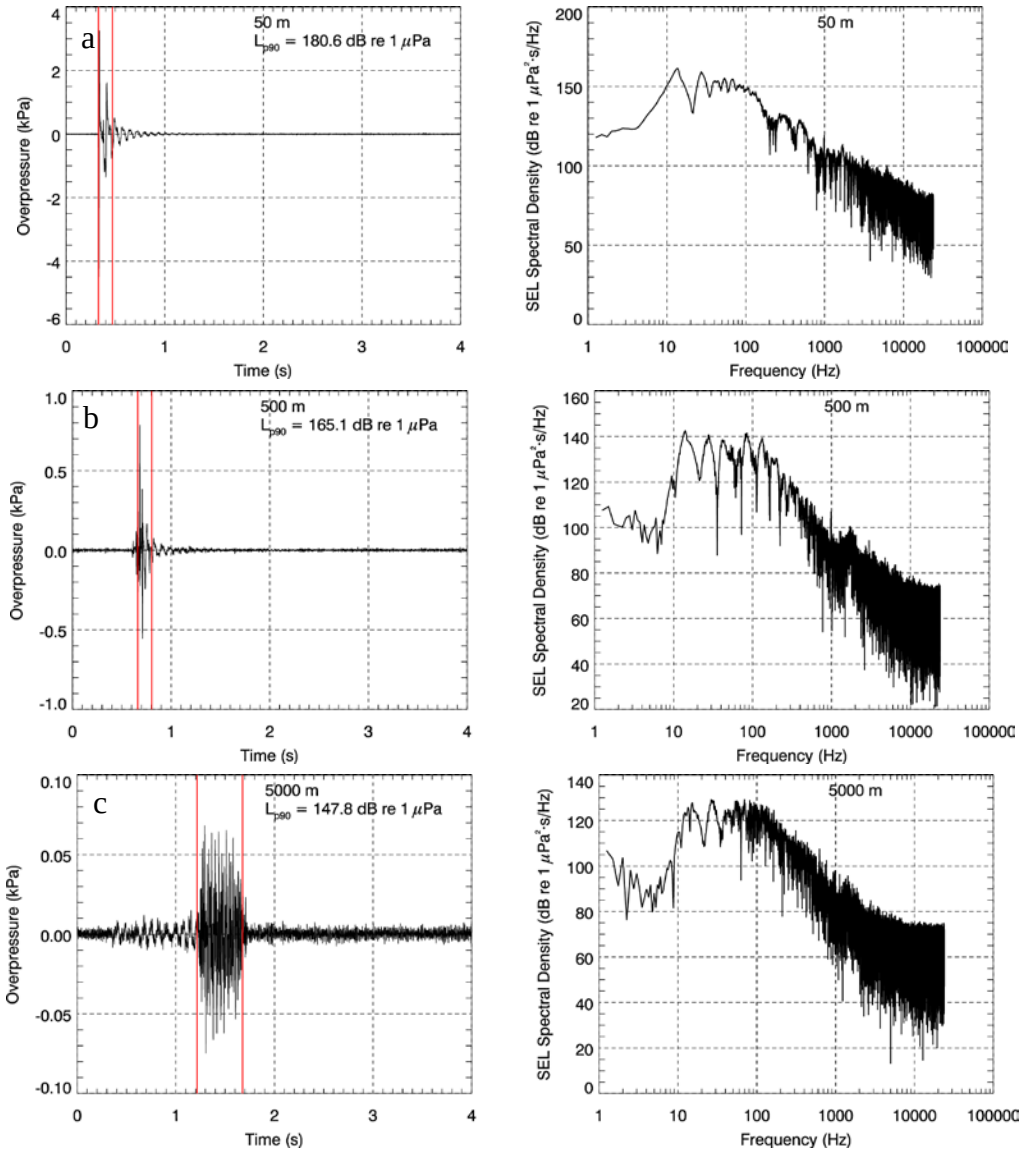


FIGURE 3.13. Waveform and corresponding spectrum plots of an airgun pulse at distances (a) 50 m, (b) 500 m, and (c) 5000 m of the mitigation airgun. The red bars on the waveform plot indicate the 90% energy pulse duration.

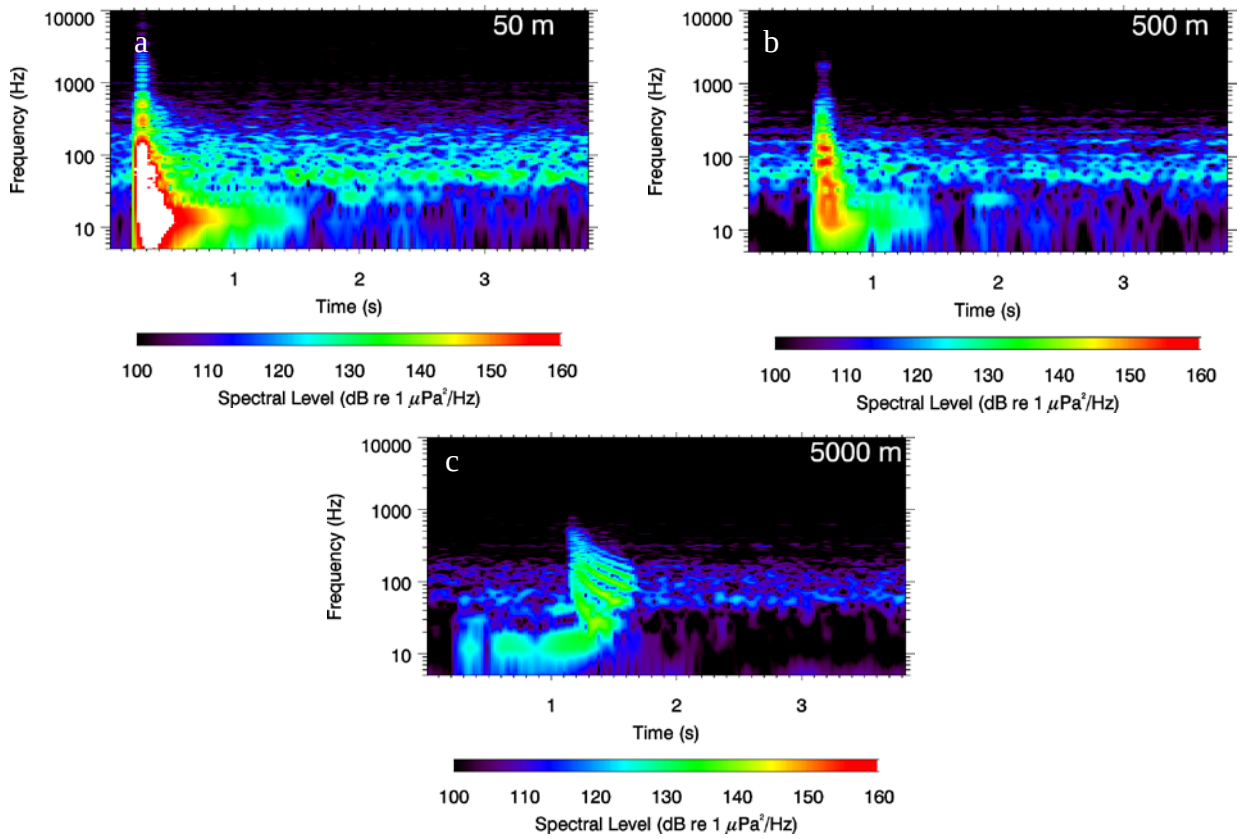
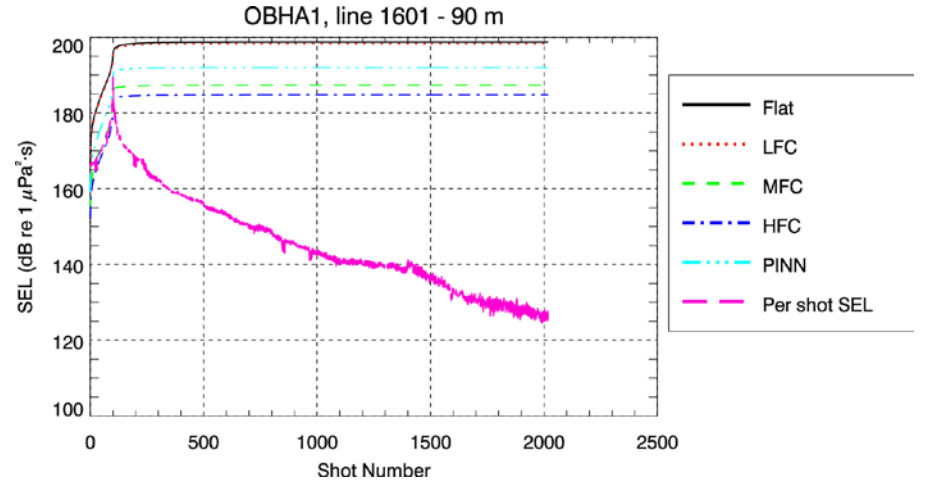


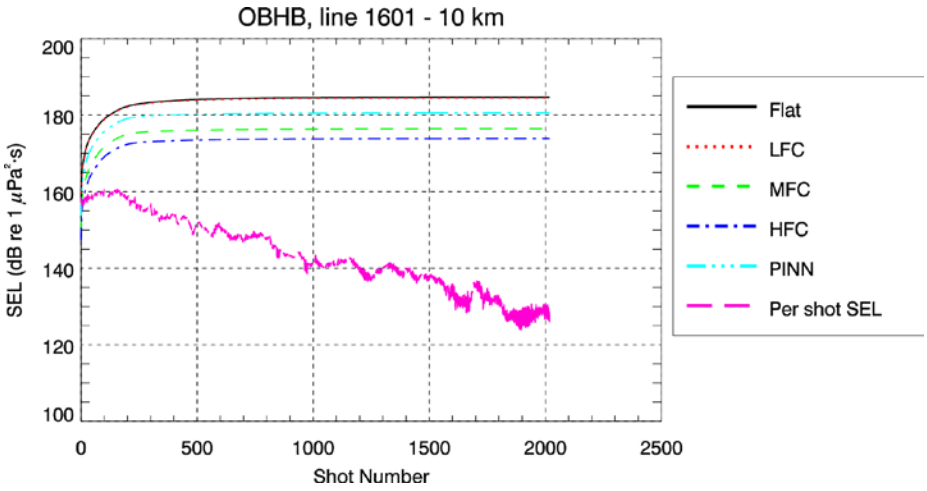
FIGURE 3.14. Spectrograms of airgun pulses at (a) 50 m, (b) 500 m, and (c) 5000 m range from the mitigation airgun. The data are spectrograms of the waveforms shown in Fig. 3.13.

Cumulative M-weighted SEL

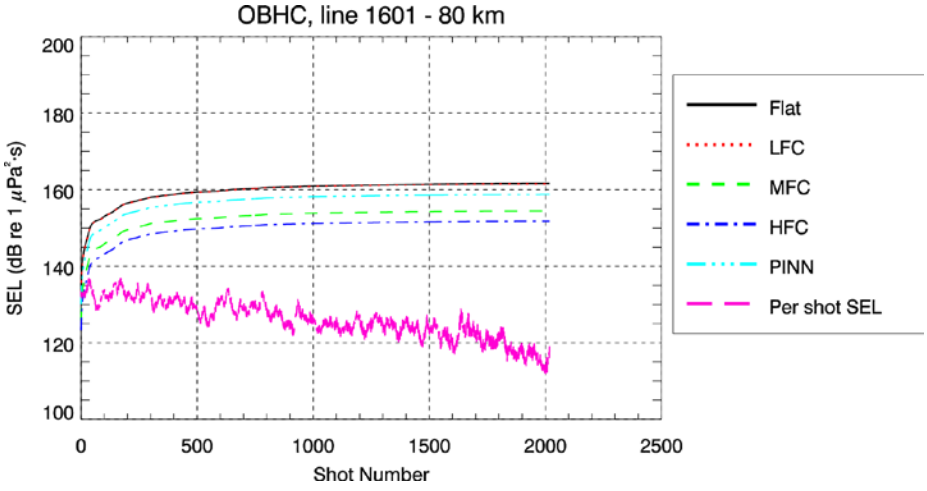
Cumulative SEL was calculated for each recorder along line 1601 according to the procedures in the *Field Measurement Procedures* section. Each pulse was M-weighted before computing and summing SEL, providing cumulative SELs specific to low- (LFC), mid- (MFC), and high-frequency (HFC) cetaceans, and pinnipeds (PINN). The cumulative flat- and M-weighted SEL at each OBH are shown in Fig. 3.15. Flat-weighted per pulse SEL was included for comparison. In aggregate, these data indicate the cumulative SEL at fixed positions at various distances from the survey line, increasing with the number of recorded pulses as the survey line was traversed until the line flattens out where the weak pulses travelling over long ranges have little contribution. Note that if these levels were to be used for assessing impact then one would be assuming the exposed animals remained stationary throughout the exposure (while the airguns operated along the entire survey line). The total cumulative SEL for each hearing group is listed in Table 3.6.



(a)



(b)



(c)

FIGURE 3.15. Cumulative SEL: Flat and M-weighted cumulative sound exposure level (SEL) with flatweighted per pulse SEL for OBHs (a) A1, (b) B, and (c) C, situated 90 m, 10 km, and 80 km respectively, from the survey line.

Received per-pulse SEL increased along the survey line with decreasing source-receiver distance, with maximum per-pulse SEL measured at the closest point of approach (CPA). Distances to the thresholds of the auditory injury criteria (see Table 3.7) proposed by Southall *et al.* (2007) were linearly interpolated from total cumulative SEL (see Table 3.6) at OBH A1 and OBH B for each species group. For the mid-frequency and high-frequency cetaceans, the total cumulative M-weighted SEL measured at the nearest recorder (OBH A1) was below the corresponding auditory injury criterion. Therefore the distance to that criterion threshold is less than the range to the nearest OBH (89 m as indicated in Table 3.7). The SEL thresholds suggested by Southall *et al.* 2007 corresponding to auditory injury from pulsed sound sources were therefore reached only at shorter distances than the *rms* based thresholds for the airgun arrays. This suggests that *rms* thresholds are more conservative than the Southall criteria for these sources in this environment.

TABLE 3.6. Total flat- and M-weighted cumulative sound exposure level (SEL) measured at fixed distances from the seismic survey line 1601.

		Total Cumulative SEL (dB re 1 µPa²s)			
Distance from survey track line	Flat-weighted	Low-frequency cetaceans	Mid-frequency cetaceans	High-frequency cetaceans	Pinnipeds Underwater
90 m	198.7	198.3	187.4	184.8	192.0
10 km	184.7	184.5	176.4	173.9	180.6
80 km	161.6	161.5	154.4	151.8	158.8

TABLE 3.7. Perpendicular distances off seismic survey line 1601 to auditory injury criterion thresholds proposed by Southall *et al.* (2007) for cumulative M-weighted sound exposure level (SEL).

Functional Hearing Group	Auditory Injury Criterion (dB_{MW} re 1 µPa²s)	Distance to Auditory Injury Threshold (m)
Low-frequency cetaceans	198	290
Mid-frequency cetaceans	198	< 89*
High-frequency cetaceans	198	< 89*
Pinnipeds	186	5,000
* SEL auditory injury criterion not reached at closest recorder (OBH A1).		

Airgun Spectral Levels

Contour plots of 1/3-octave band pressure levels, versus range and frequency, were produced for both endfire (see Fig. 3.16a) and broadside (see Fig. 3.16b) directions. These contour plots show the measured spectral distribution of sound energy from the airgun array versus distance as well as which frequencies dominated sound propagation for each direction. The endfire 1/3-octave band levels presented include both the forward and aft directions, and the broadside levels presented include 3 shots around the CPA at 100 m (109 yd), 5 shots around the CPA at 500 m (546 yd), and 10 shots around the CPA at all other measured ranges. Fewer shots were chosen at ranges less than 1 km (0.6 mi) to capture only the broadside data. Data was then interpolated between ranges. In the endfire direction, frequencies between 10 and 200 Hz were prominent at ranges less than 300 m (328 yd). At ranges greater than 1 km (0.6 mi), the dominant 1/3-octave bands were 20, 70, and 200 Hz. In the broadside direction, the dominant 1/3-octave bands were 20 and 150 Hz, evident at all ranges from the source. In both directions

there are elevated levels at 9 kHz at distances less than 2 km. This is from the echosounder operating on the *Geo Celtic* at the same time as the airgun shots.

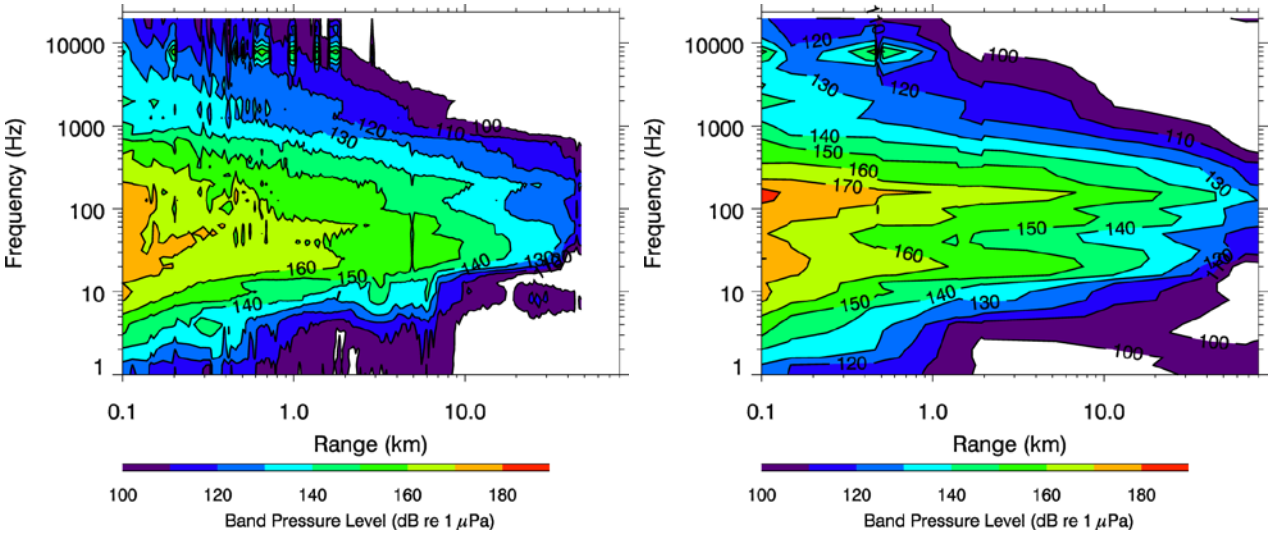


FIGURE 3.16. Spectral plot of the 1/3 octave band pressure levels as a function of range and frequency for the (a) endfire direction and (b) broadside direction.

Ambient Sound Levels

Percentiles are a statistical measurement of the relative frequency of occurrence of an event. The n^{th} percentile level is defined as the sound pressure level that was exceeded n % of the time. In other words, n-percent of the time, the measured SPL was equal to or above the n^{th} percentile. For example, the 95^{th} percentile will give the level above which the measured SPL falls 95% of the time, and 5% of the time, the SPL will be below this level.

For this report, *rms* SPL was computed within 1-second sliding analysis windows (48,000 samples) with 50% overlap for frequencies up to 24 kHz. Counts were made of the number of time windows for which specific SPL values were measured. Airgun shots at the furthest measured range (80 km; 50 mi) lasted approximately 4 seconds (see Fig. 3.11c) and airgun shots were fired every 10 seconds. This leaves a sufficient amount of data between airgun shots to compute the higher percentiles in the ambient noise level plots. Fig. 3.17 shows percentile noise spectral levels at each OBH location during the SSV study. Fig. 3.18 shows overall percentile levels for all four OBH locations during the SSV study.

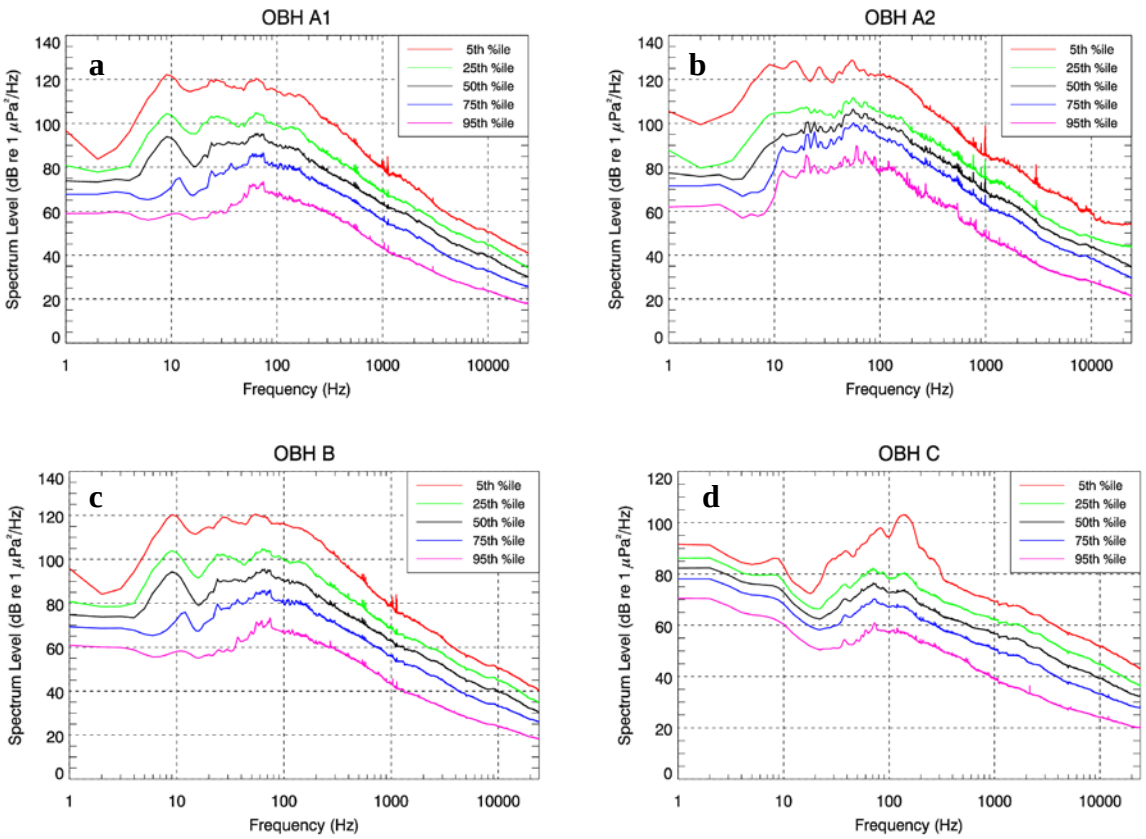


FIGURE 3.17. Percentile noise levels recorded during the SSV measurements at (a) OBH A1, (b) OBHA2, (c) OBH B, and (d) OBH C.

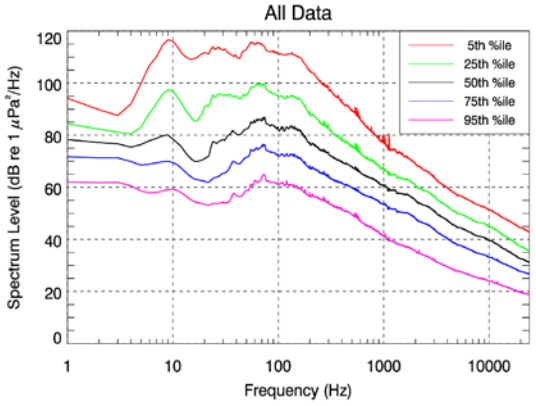


FIGURE 3.18. Percentile noise levels calculated from data recorded at all four OBH locations.

To examine the temporal dependence of the ambient noise at each OBH location, spectral levels from the entire study were analyzed in 10-minute windows and are presented below in Fig. 3.19 to Fig. 3.21. Plots of decade-band and broadband sound level pressures are paired with plots of ambient noise spectral levels, and all the plots use the same time window for comparison.

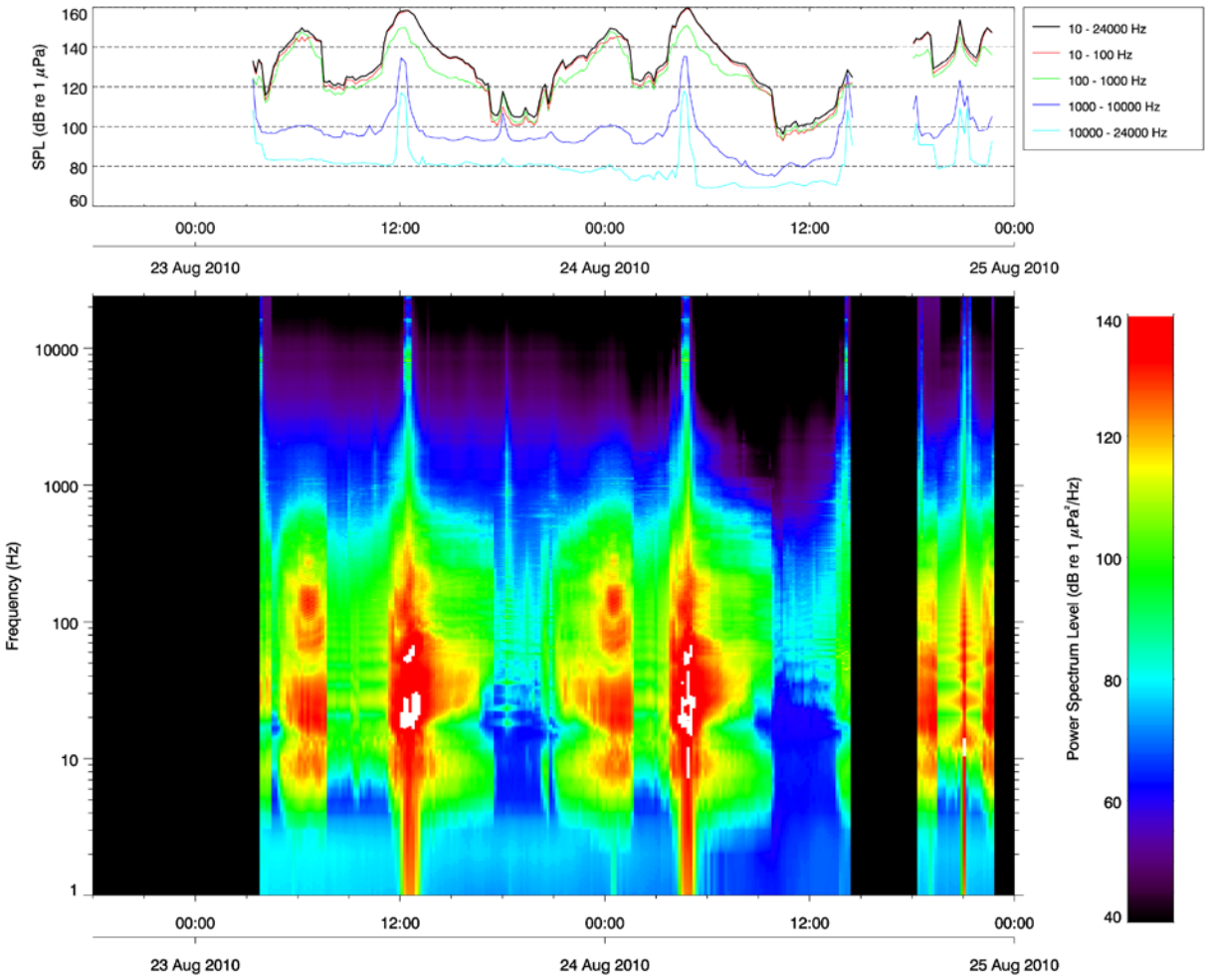


FIGURE 3.19. Decade band and broadband SPLs (top) and ambient noise spectral levels (bottom) measured at OBH A1 and OBH A2. White areas, the highest received levels, represent the closest points of approach for survey lines 1625 (left) and 1601 (right).

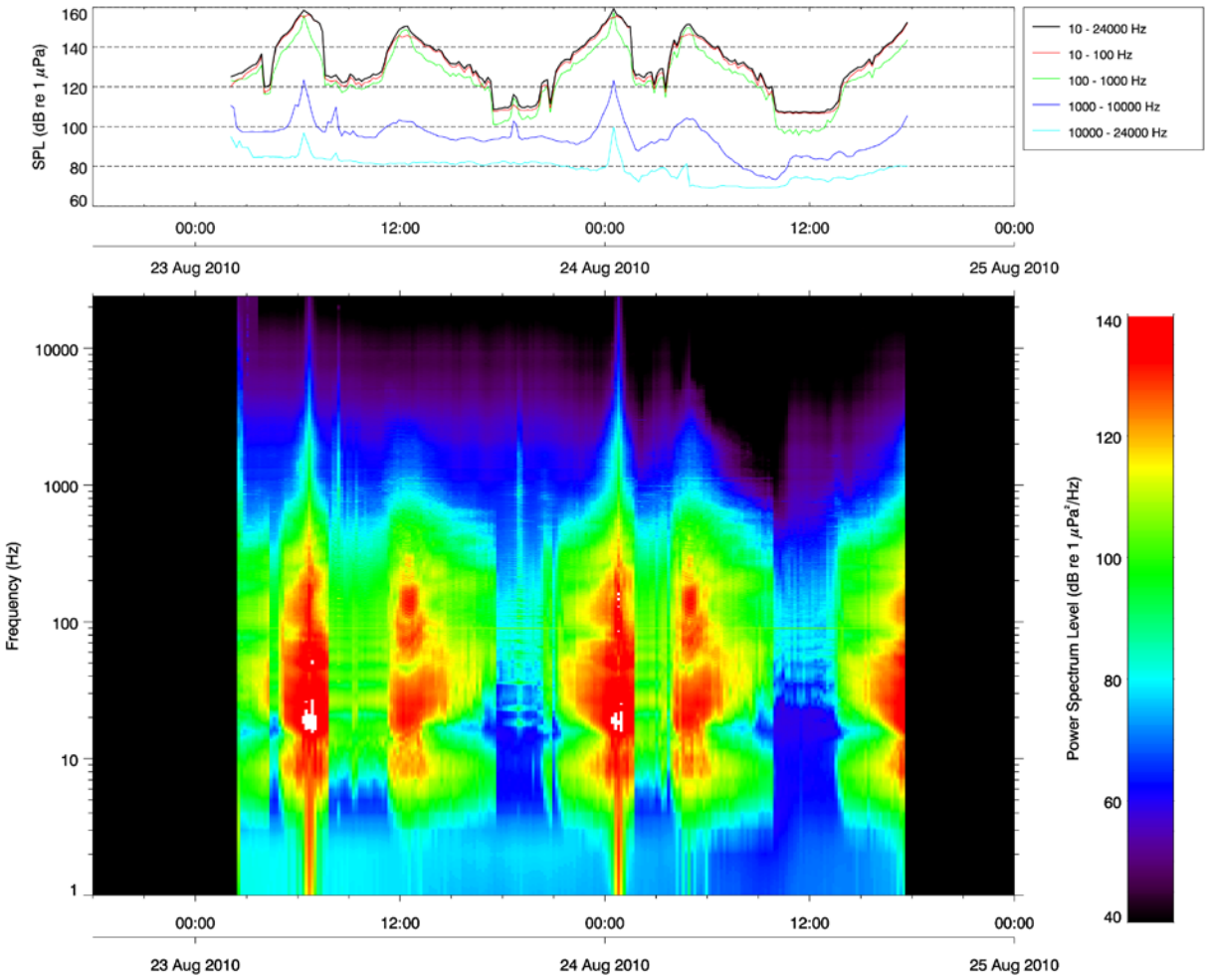


FIGURE 3.20. Decade band and broadband SPLs (top) and ambient noise spectral levels (bottom) measured at OBH B. White areas, the highest received levels, represent the closest points of approach for survey lines 1169 (left) and 1145 (right).

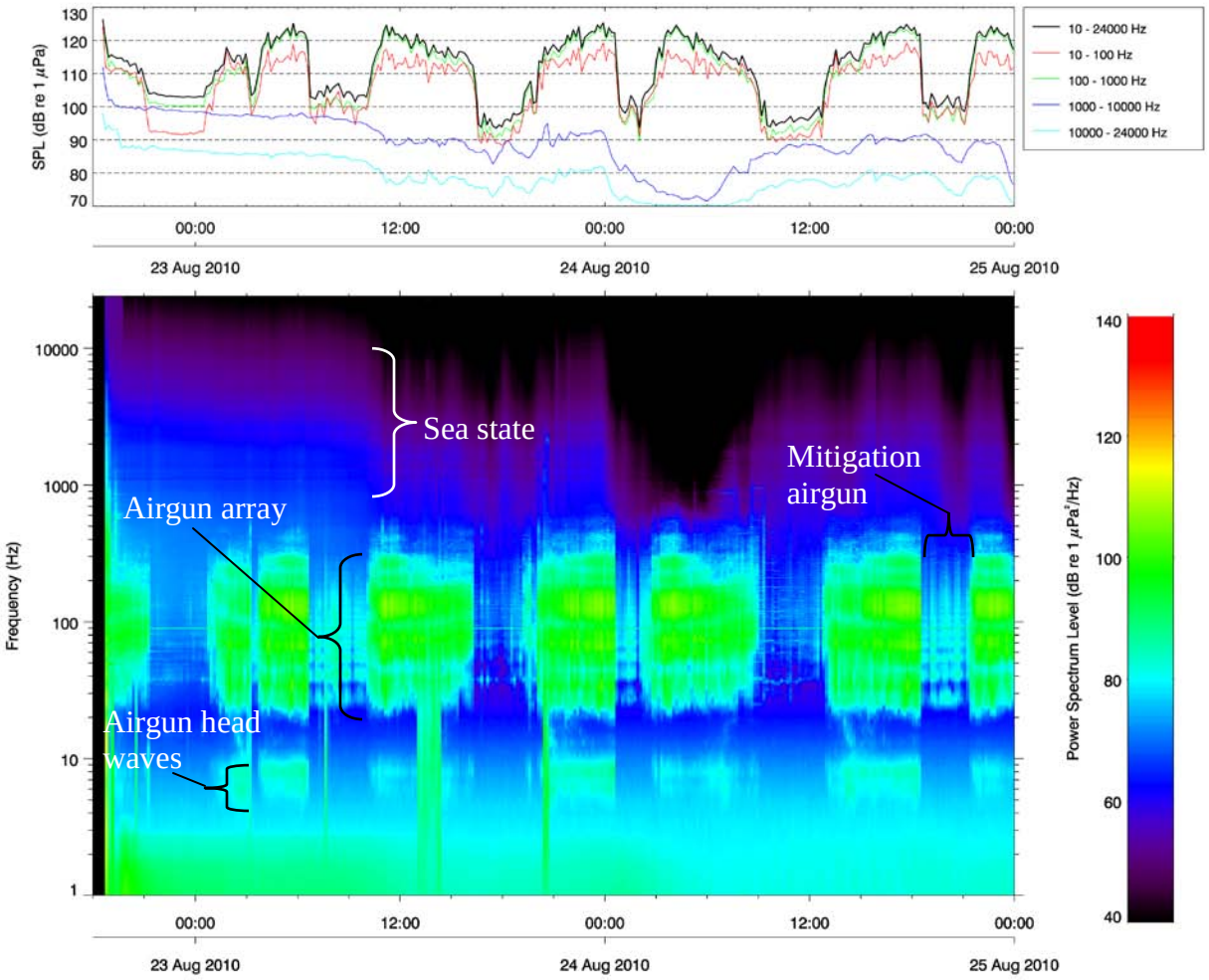


FIGURE 3.21. Decade band and broadband sound pressure levels (top) and ambient noise spectral levels (bottom) measured at OBH C.

Marine Mammal Vocalizations

During data analysis, marine mammal vocalizations were found among the airgun shots. JASCO bioacousticians, with extensive experience classifying marine mammal vocalizations, identified the vocalizations as primarily walrus grunts. Using a combination of an automated detector and limited manual searching, walrus grunts were found in recordings on OBH A1 and OBH B, the majority occurring between 08:55 and 12:20, 24/Aug/10 (UTC). No grunts were found in recordings on OBH A2 and OBH C. Grunts were loudest on the OBH A1 recordings, indicating that the walrus were closer to this location. It is estimated walrus would have to be closer than approximately 5 km (3 mi) to be audible on any OBH recording.

Fig. 3.22 to Fig. 3.25 show several examples of walrus grunts found on the OBH recordings. Grunts occurred in sequences of single grunts, pairs of grunts, and groups of three grunts. Vocalizations occurred both during and between seismic survey lines, with several sequences of grunts and airgun shots overlapping (see Fig. 3.24 and Fig. 3.25).

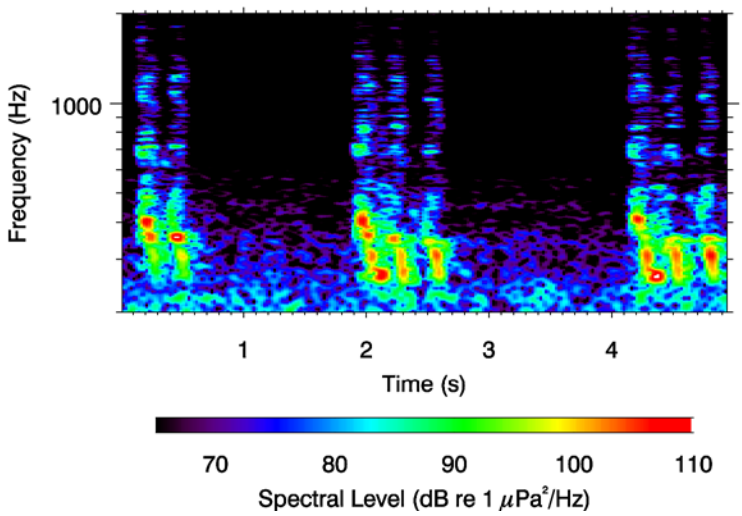


FIGURE 3.22. Sequence of walrus grunts recorded on OBH A1 at 09:56, 24/Aug/10 (UTC). Survey line 1601 was underway at this time, with the airgun array approximately 47.6 km away from OBH A1.

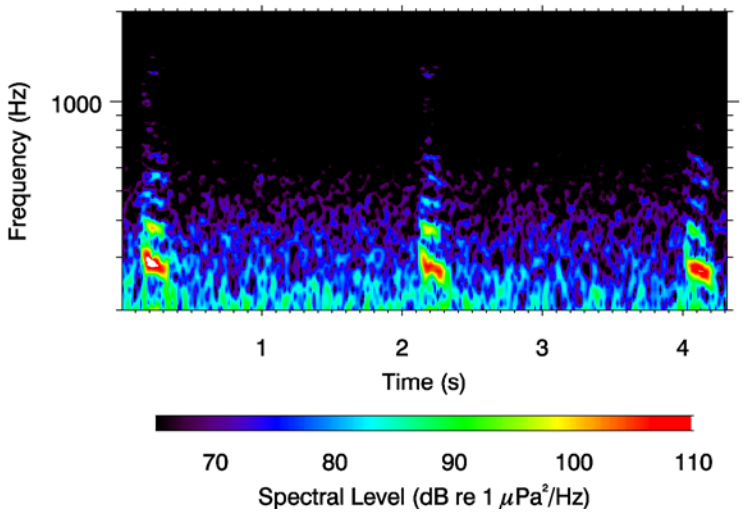


FIGURE 3.23. Three single walrus grunts recorded on OBH A1 at 09:57, 24/Aug/10 (UTC). Survey line 1601 was underway at this time, with the airgun array approximately 47.7 km away from OBH A1.

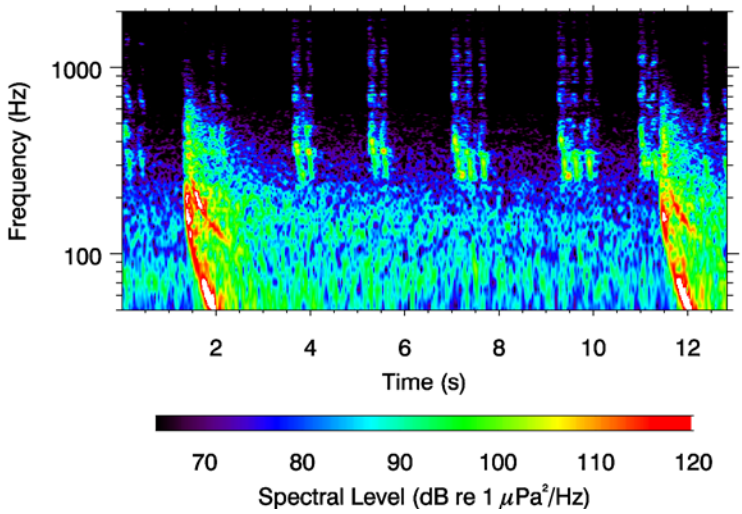


FIGURE 3.24. Sequence of walrus grunts recorded on OBH A1 at 09:56, 24/Aug/10 (UTC). Airgun array pulses occur at 1.5 and 11.5 s, with many walrus grunts between 200 and 500 Hz. Survey line 1601 was underway at this time, with the airgun array approximately 47.6 km away from OBH A1.

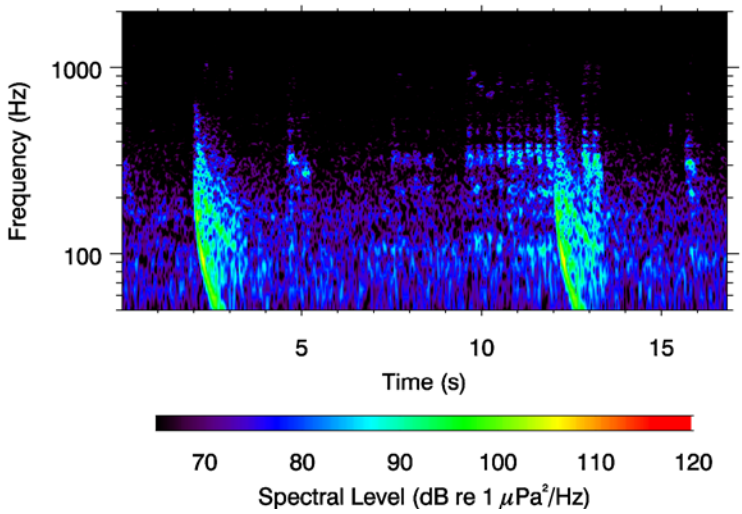


FIGURE 3.25. Sequence of walrus grunts recorded by OBH A1 at 10:12, 24/Aug/10 (UTC). Mitigation airgun pulses occur at 2 and 12 s, with many walrus grunts between 200 and 500 Hz. The mitigation airgun was operated during a line change, at least 48 km from OBH A1.

Discussion

Comparison of Measured and Pre-Season Radii

Pre-season radii were estimated for an airgun array that differed slightly from the production system (24 airguns and 3147 in^3 preseason, versus 24 airguns and 3000 in^3 production). The pre-season expected tow depth of 6 m (6.5 yd) was used by the production system. Pre-season estimated sound

threshold radii were based on measurements made for other operators in the Chukchi Sea during SSVs in 2006, 2007, and 2008. Comparison of the marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays (Table 3.8) showed that the measured 190 dB and 180 dB re 1 µPa radii were less than the pre-season estimates and that the measured 160 dB and 120 dB re 1 µPa safety radii were greater than the pre-season estimates. Comparisons for *Geo Celtic*'s 60 in^3 mitigation airgun (Table 3.9) showed that the measurements did not exceed the estimated pre-season 190 dB, 180 dB, 160 dB, and 120 dB re 1 µPa safety radii.

TABLE 3.8. Comparison of measurements with pre-season estimated marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays.

	Safety Radii		
SPL_{rms90} Threshold (dB re 1 µPa)	Pre-season Estimated	Measured	Ratio (%)
190	700 m	430 m	61
180	2,500 m	1,600 m	64
160	13,000 m	16,000 m	123
120	70,000 - 120,000 m	130,000 m	<108

TABLE 3.9. Comparison of measurements with pre-season estimated marine mammal safety radii for *Geo Celtic*'s 60 in^3 mitigation airgun.

	Safety Radii		
SPL_{rms90} Threshold (dB re 1 µPa)	Pre-season Estimated	Measured	Ratio (%)
190	75 m	13 m	17
180	220 m	68 m	31
160	1,800 m	1,500 m	83
120	50,000 m	26,000 m	52

Ambient Sound Levels

The ambient noise levels for a given location will depend on the typical weather conditions of the region as wind, waves, and precipitation all influence underwater ambient noise levels. The main source of anthropogenic noise in the oceans is vessel traffic. The contributions to the ambient noise field from various sources have been well summarized through what are known in the literature as the Wenz curves (Wenz, 1962). These curves indicate typical ranges of ambient noise levels that can be expected in shallow water environments (see Fig. 3.26).

The 50th percentile levels plotted in Fig. 3.17 and Fig. 3.18 fall within the ranges anticipated from the Wenz curves. The 5th and 25th percentiles are from airguns and shipping/vessel noise. Aside from the *Geo Celtic*, there were three other vessels in the project area during the SSV measurements: R/V *Norseman I,* M/V *Tanux I,* and R/V *Westward Wind.*

The largest contribution to ambient noise during SSV measurements was sounds from the seismic survey. The four SSV track lines are clearly visible in the spectrum plots for OBH A1 and OBH B (see Fig. 3.19, Fig. 3.20), and the mitigation turn recorded at OBH A2 (see Fig. 3.19). Fig. 3.21 shows the impact of the seismic survey on ambient noise 80 km (50 mi) away from the SSV site. The airgun arrays generate spectral levels of approximately 100 dB re 1 µPa/Hz between 20 and 300 Hz, which is greater

than the range of heavy shipping noise on the Wentz curves. The mitigation airgun, between 20 and 200 Hz, generates 80 dB re 1 μPa/Hz, which is in the range of usual traffic noise in shallow water. The head waves from the airgun arrays are 80 dB re 1 μPa/Hz between 5 and 10 Hz, which is within the range of prevailing ambient noise. The noise due to sea state can be seen between the 1 to 10 kHz, at a level of 60 dB re 1 μPa/Hz, from the beginning of the recording until noon on August 23rd. According to the Wenz curves this indicates sea state 4. The sea state then calms to spectral levels of 50 dB re 1 μPa/Hz at these frequencies, representative of normal sea state 2 levels, and then further decreases to 40 dB on August 24th, indicating sea state 0.5. Although we don't have weather records for the entire recording time at OBH C, our notes during deployment and retrieval are consistent with the sea states indicated by the Wenz curves during the same time periods. There was minimal precipitation during the SSV study, which agrees with the absence of levels around 80 dB re 1 μPa/Hz between 1 and 10 kHz. Tidal data was found for Barrow, AK during the time of the SSV (NOAA Tides and Currents, 2010), which showed a maximum variation on water level of 0.3 ft. As a result, current noise due to tidal effects (primarily due to wind forcing) does not contribute significantly to ambient sound levels at the SSV site.

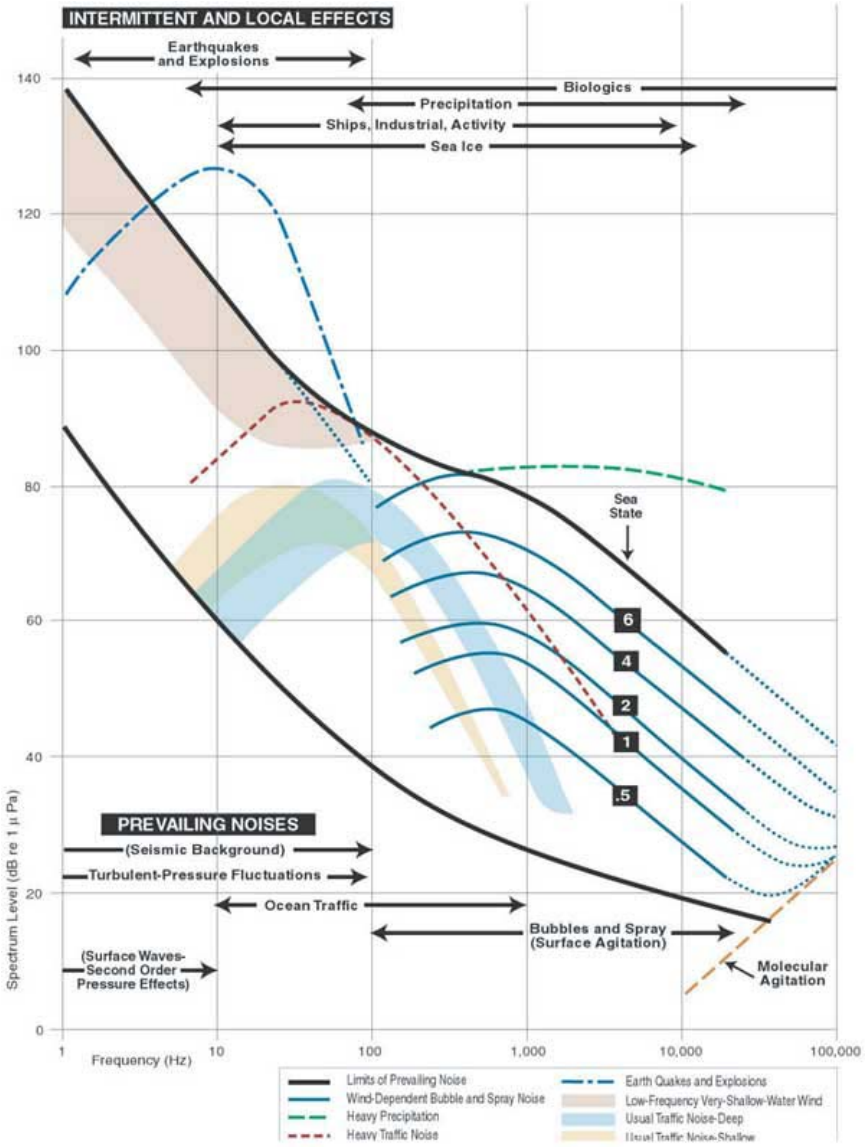


FIGURE 3.26. Wenz Curves, which describe the contributions to ambient noise from various sources in shallow water (http://www.dosits.org/science/ssea/2b.htm).

Summary and Conclusions

A sound source verification (SSV) study was carried out for Statoil's 2010 3-D marine seismic survey program in the Chukchi Sea. Measurements from this study were used to verify marine mammal safety radii around the survey vessel's 3000 in^3 airgun arrays and 60 in^3 mitigation airgun (see Table 3.10). The *Geo Celtic's* 3000 in^3 airgun arrays did not exceed the estimated pre-season 190 dB and 180 dB re 1 µPa safety radii. However, the measured 160 dB and 120 dB re 1 µPa safety radii for the airgun arrays were greater than the pre-season estimated values. The SSV measurements for the *Geo Celtic's* 60 in^3 mitigation airgun did not exceed the estimated pre-season 190 dB, 180 dB, 160 dB, and 120 dB re 1 µPa safety radii.

TABLE 3.10. Measured marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays and 60 in^3 mitigation airgun.

SPL_{rms90} Threshold (dB re 1 µPa)	Airgun Arrays (3000 in^3)	Mitigation Airgun (60 in^3)
190	520 m	13 m
180	1,600 m	68 m
170	4,900 m	340 m
160	13,000 m	1,500 m
150	30,000 m	4,700 m
140	57,000 m	10,000 m
130	91,000 m	18,000 m
120	130,000 m	26,000 m

Marine mammal safety radii were also computed based on the proposed Southall *et al.* (2007) species specific auditory injury criteria. Unlike the NMFS criteria which were based on SPL levels, the Southall auditory injury criteria consider exposure to high peak levels (peak SPL) as well as cumulative exposure due to multiple pulses (cumulative SEL). The Southall criteria also apply M-frequency weighting to account for differences in frequency-dependence of hearing sensitivity between four different marine mammal functional hearing groups. The Southall criteria were not applied for determining operational safety radii for the Statoil seismic survey. The Southall radii were calculated here only for comparison with the SPL threshold radii. Distances from the airgun array at which the Southall auditory injury criteria would be reached were computed from cumulative M-weighted SEL and peak SPL measurements. The auditory injury distances according to these criteria were less than the distances based on the 190 and 180 dB re 1 µPa *rms* SPL criteria.

Spectrograms of selected airgun pulses, detected at various distances and directions from the arrays, showed the presence of head waves, normal mode striations, and seismic vessel noise. At long ranges from the arrays, prominent, low-frequency (< 30 Hz) head waves arrived several seconds in advance of the water borne airgun pulses. The head waves were due to low frequency sound energy refracted along layer boundaries and through higher sound speed seabed layers.

Ambient noise was measured up to 80 km (50 mi)from the prospect area during the SSV. Contributions to the ambient noise included: airgun arrays, mitigation airgun, vessels, marine mammal vocalizations, and sea state. At this range the airgun arrays were above ambient noise levels associated with heavy shipping traffic. The mitigation airgun contributed sound levels equivalent to usual traffic noise. Walrus grunts were recorded on OBH A1 and OBH B during the seismic survey. Plots of percentile levels showed that the 50th percentile corresponded with ambient noise levels at the SSV site.

Acknowledgements

Many individuals contributed to the success of the 2010 Statoil SSV field study. Captain Paul Tate and the crew of the R/V *Norseman I* provided outstanding shipboard support and conducted all activities in a professional and safe manner. Party Manager Bud Hodgson and the survey crew aboard the M/V *Geo Celtic* assisted with the planning and execution of the SSV tests. Jon Kåre Hovde of Statoil provided many helpful comments and suggestions regarding the 120-hour field report. David Hannay of JASCO performed a scientific review of the 120-hour field and 90-day report and also provided several helpful comments.

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4. MONITORING, MITIGATION, AND DATA ANALYSIS METHODS[1]

This chapter describes the marine mammal monitoring and mitigation measures implemented for Statoil's seismic survey in the Chukchi Sea during the 2010 open-water season. The required measures were detailed in the IHA and LOA (Appendices A and B) issued to Statoil by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS), respectively. It also describes the methods used to categorize and analyze the monitoring data collected by observers and reported in the following chapter.

Monitoring Tasks

The main purposes of the marine mammal monitoring program were to ensure that the provisions of the IHA and LOA issued to Statoil were satisfied, effects on marine mammals were minimized, and residual effects on animals were documented. Tasks specific to monitoring are listed below (also see Appendices A and B):

- use of dedicated Marine Mammal Observers (MMOs) aboard the seismic source vessel, to visually monitor the occurrence and behavior of marine mammals near the airguns when the airguns were operating and during a sample of the times when they were not;
- use of MMOs aboard support vessels to visually monitor the occurrence and behavior of marine mammals and to conduct visual surveys of areas where airgun sounds could reach received sound levels ≥160 dB re 1 μPa (rms);
- use the visual monitoring data as a basis for implementing the required mitigation measures;
- record (insofar as possible) the effects of the airgun operations and the resulting sounds on marine mammals;
- estimate the number of marine mammals potentially exposed to airgun sounds at specified levels.

Safety and Potential Disturbance 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 levels of pulsed sounds are ≥180 dB re 1 μPa (rms) for cetaceans and ≥190 dB re 1 μPa (rms) for pinnipeds. The ≥180 and ≥190 dB (rms) guidelines were also employed by USFWS for the species under its jurisdiction (≥180 dB [rms] for walrus and ≥190 dB [rms] for polar bear, respectively) in the LOA issued to Statoil. These safety criteria are based on a cautionary assumption that seismic pulses at lower received levels will not harm these animals or impair their hearing abilities, but that higher received levels *might* have some such effects. Marine mammals exposed to ≥160 dB (rms) are assumed by NMFS to be potentially subject to behavioral disturbance.

Statoil's 2010 permits also required implementation of mitigation measures for large groups (≥12 individuals) of bowhead or gray whales (IHA) and Pacific walruses (LOA) that occurred within an area where sound levels were ≥160 dB (rms; Appendices A and B). Monitoring of the ≥160 dB (rms) zone at specified times and locations is discussed below in the section on *Special Mitigation Measures*.

Statoil's IHA and LOA applications described the anticipated underwater sound field around the planned 3000 in^3 airgun array with airguns at a depth of 6 m (20 ft) based on the 2006, 2007 and 2008

[1] By Megan Blees, Kris Hartin and Darren Ireland (LGL).

sound source verification (SSV) measurements in the Chukchi Sea of a similar array, towed at a similar depth (Hannay and Warner 2009). Field measurements of the received airgun sounds as a function of distance and aspect were acquired during the beginning of seismic data acquisition (O'Neill and MacGillivray 2010) and are reported in Chapter 3 of this report. During the 2010 field measurements and until those results were available, the modeled safety radii distances were used for mitigation purposes. The 2010 measured radii were similar to, but in most cases less than the modeled safety radii (Table 4.1). The preliminary empirical measurements of the ≥180 and ≥190 dB (rms) radii, as presented by O'Neill and MacGillivray (2010), were adopted as safety radii for Statoil's seismic survey (Table 4.1).

More extensive analysis of the field measurements was completed after the field season as described in Chapter 3 of this report. Those analyses resulted in some refinements of the various radii (Table 4.1). The refined values were not available for use by the MMOs in the field. However, the refined estimates were used during processing of the monitoring data presented in Chapter 5 and to estimate the numbers of marine mammals exposed to various sound levels.

TABLE 4.1. Comparison of measurements of the ≥190, 180, 160 and 120 dB (rms) distances (in km) for sound pulses from the 26-airgun, 3000 in^3 array and 60 in^3 mitigation airgun deployed from *Geo Celtic* in the Chukchi Sea, Alaska, 2010.

	Full Airgun Array			Mitigation Airgun		
Received Level dB (rms)	**Modeled Radii**	**Preliminary Radii**	**Final Radii**	**Modeled Radii**	**Preliminary Radii**	**Final Radii**
≥190	0.700	0.430	0.520	0.075	0.013	0.013
≥180	2.500	1.600	1.600	0.220	0.068	0.068
≥160	13.000	16.000	13.000	1.800	1.500	1.500
≥120	70.000-120.000	130.000	130.000	50.000	26.000	26.000

Mitigation Measures as Implemented

Through pre-season meetings with coastal communities and stakeholders, the location and timing of survey activities, especially in relation to subsistence uses of marine mammals, were considered when developing the mitigation plan for Statoil's seismic operations. During survey operations, the primary mitigation measures that were implemented included ramp up, power down, and shut down of the airguns. These measures are standard procedures during seismic surveys and are described in detail in Appendix E. Mitigation also included those measures specifically identified in the IHA and LOA (Appendices A and B) as described below.

Standard Mitigation Measures

Standard mitigation measures implemented during the study included the following:

1. Modeled safety radii (distances used in the IHA application) were initially implemented during the seismic activities, and were revised to the preliminary results of the 2010 field measurements once they became available (O'Neill and MacGillivray 2010; Chapter 3; Table 4.1).
2. Power down or shut down procedures were implemented when a marine mammal was sighted within or approaching the applicable safety radius while the airguns were operating.

3. A change in vessel course and/or speed alteration was identified as a potential mitigation measure if a marine mammal was detected outside the safety radius and, based on its position and motion relative to the ship track, was judged likely to enter the safety radius. In practice, this measure was not implemented because the *Geo Celtic* was unable to maneuver quickly while towing the airguns and streamers. Monitoring vessels did use course alterations to avoid disturbing marine mammals whenever possible.
4. A ramp up procedure was implemented whenever operation of the airguns was initiated if >10 min had elapsed since shut down or power down of the full array airguns.
5. In order for seismic operations to begin, the entirety of the ≥180 dB (rms) safety radius, the largest safety radii to be monitored by MMOs on the vessel, must have been visible for at least 30 min.

The specific procedures applied during power downs, shut downs, and ramp ups are described in Appendix E. Briefly, a power down involved reducing the number of operating airguns from the full array (3000 in^3) to a single "mitigation" airgun (60 in^3) when a marine mammal was observed approaching or was first detected already within the full array safety radius. Power downs also occurred when the survey vessel was between seismic survey lines to reduce the amount of sound energy introduced into the water. A shut down involved suspending operation of all airguns. A shut down was implemented if a marine mammal was sighted within or approaching the safety radius of the mitigation airgun either after the full array had been powered down or upon initial observation. A ramp up involved a gradual increase in the number of airguns operating (from no airguns firing) usually accomplished by an addition of airguns such that the number of airguns operating is doubled approximately every 5 min. For the *Geo Celtic*, the ramp up duration was between 25 and 40 min. In this report, when a ramp up was initiated while the mitigation airgun had been firing it is referred to as a power up. A ramp up could not be initiated during times when the ≥180 dB (rms) safety radii was not visible to MMOs for 30 min because the mitigation airgun had not been firing. A power up could be initiated during times when the full safety radius was not visible because the mitigation airgun had been firing.

Special Mitigation Measures as Required by NMFS and USFWS

In addition to the standard safety radii based on the ≥190 and ≥180 dB (rms) distances for pinnipeds and cetaceans, NMFS and USFWS required Statoil to monitor the ≥160 dB (rms) radius for aggregations of 12 or more non-migratory bowhead or gray whales and Pacific walruses during all seismic activities (Appendices A and B). To survey the ≥160 dB (rms) zone for aggregations of whales and walruses, monitoring vessels followed a "zig-zag" pattern through the area of seismic lines expected to be surveyed in the next 24–48 h. MMOs onboard the monitoring vessel searched the area and reported all cetacean sightings to MMOs on the *Geo Celtic*. Power down or shut down procedures were to be implemented if groups of 12 or more bowhead whales, gray whales, or Pacific walruses were observed within the ≥160 dB (rms) radius while the airguns were in operation. During this project, survey activities in some areas were postponed when Pacific walrus concentrations were determined to be high based on observations from a monitoring vessel searching the 160 dB zone ahead of the seismic vessel.

Marine Mammal Monitoring Methods

Marine mammal monitoring methods were designed to meet the requirements specified in the IHA and LOA as listed above (Appendices A and B). The main purposes of MMOs aboard the seismic source vessel and monitoring vessels were as follows: ***(1)*** Conduct monitoring and implement mitigation measures to avoid or minimize exposure of cetaceans and walruses to airgun sounds with received levels ≥180 dB (rms), or of other pinnipeds and polar bears to ≥190 dB (rms). ***(2)*** Conduct monitoring and

implement mitigation measures to avoid or minimize exposure of groups of 12 or more bowhead or gray whales and/or Pacific walruses to airgun sounds with received levels ≥160 dB (rms). ***(3)*** Document numbers of marine mammals present, any reactions of marine mammals to seismic activities, and whether there was any possible effect on accessibility of marine mammals to subsistence hunters in Alaska. Results of marine mammal monitoring effort are presented in Chapter 5.

The visual monitoring methods that were implemented during Statoil's seismic survey were similar to those used during various previous seismic cruises conducted under IHAs since 2003. The standard visual observation methods are described below and in Appendix E.

During the seismic survey, at least one MMO onboard the seismic source vessel, *Geo Celtic*, maintained a visual watch for marine mammals 24 h per day while airguns were in use. Observers focused their search effort forward and to the sides of the vessel but also searched aft of the vessel occasionally. Watches were conducted with the unaided eye, Fujinon 7×50 reticle binoculars, Zeiss 20×60 image stabilized binoculars, or Fujinon 25×150 "Big-Eye" binoculars. MMOs instructed seismic operators to power down or shut down the airguns if marine mammals were sighted within or about to enter applicable safety radii.

MMOs onboard the two support vessels, *Tanux I* and *Norseman I*, conducted watches similar to those of MMOs onboard the source vessel. However, observers limited watches to only daylight hours as darkness periods increased later in the season. The *Norseman I* was used primarily to monitor the ≥160 dB (rms) radius and the *Tanux I* usually remained near the *Geo Celtic* to support operations and assist in monitoring the ≥180 dB (rms) radius. MMOs onboard the monitoring vessel notified MMOs onboard the *Geo Celtic* if groups of bowheads or gray whales (or bowhead cow/calf pairs), or groups of walrus, were sighted within the ≥160 dB (rms) radius, allowing the *Geo Celtic* to implement the appropriate mitigation. During most seismic operations, at least one monitoring vessel traveled approximately 3–5 km (1.9–3.1 mi) ahead of and 1 km (0.6 mi) to either side of the *Geo Celtic's* trackline. MMOs on watch aboard the monitoring vessels called the *Geo Celtic* MMOs if they observed marine mammals within the *Geo Celtic's* applicable safety radii. MMOs aboard the *Geo Celtic* then initiated any necessary mitigation measures.

Data Analysis Methods

Categorization of Data

Observer effort and marine mammal sightings were divided into several analysis categories related to environmental conditions and vessel activity. The categories were similar to those used during various other recent seismic studies conducted under IHAs in this region (e.g., Funk et al. 2008, Ireland et al. 2007a, b, Patterson et al. 2007). These categories are defined briefly below, with a more detailed description provided in Appendix E.

Species Groups

Results are presented separately by species groups including cetaceans, pinnipeds (excluding walrus), Pacific walrus and polar bear. Cetaceans and pinnipeds are treated separately due to expected differences in potential reactions to industry activities. Pacific walrus are presented separately due to their management by USFWS. No polar bears were observed during this project.

Geographic Boundaries and Vessel Role

Data were categorized by the duties of the vessel on which the data were collected. All data collected by MMOs aboard the seismic source vessel, *Geo Celtic*, were categorized as "source vessel" data. All data collected by MMOs aboard the *Tanux I* and *Norseman I* were categorized as "monitoring

vessel" data. Only sightings and effort from vessel activities north of Point Hope (68.34 °N) were included in the analysis. Monitoring vessel data were compared to source vessel data in Chapter 5 to consider the potential impact of seismic vessel activities at greater distances than could be directly observed from the source vessel.

Seismic Periods

Sighting and observer effort data from the *Geo Celtic* were categorized into three groups depending on airgun status. Periods of seismic testing, ramp up, and full array activity were grouped as "full array". Periods of only mitigation gun activity were categorized as "mitigation airgun" while periods with no airgun activity were categorized as "non-seismic".

Monitoring vessels were in constant motion relative to the sound source. Therefore, sighting and effort data were categorized by received sound level (RSL) based on their distance to the active sound source and the results of the sound source measurements (see Chapter 3). Monitoring vessel data were categorized into 10 dB (rms) sound level bins from >190 through <120 dB (rms). In order to keep sample sizes large enough for comparisons among RSL bins, data were grouped into three broader bins: (1)≥160 dB (rms), (2) 159–120 dB (rms), and (3) <120 dB (rms). The ≥160 dB (rms) bin is roughly equivalent to the "full array" category in the source vessel data and the "seismic" category used in some previous seismic survey reports. The <120 dB (rms) bin is roughly equivalent to the "non-seismic" category in the source vessel data and the "non-seismic" category used in previous seismic survey reports. The 159–120 dB (rms) bin represents data collected where received sound levels were at intermediate levels. In this report, the term "seismic" refers to "full array" data from the source vessel and monitoring vessel data in the ≥160 (rms) bin while the term "non-seismic" refers to "non-seismic" data from the source vessel and the <120 dB (rms) bin from monitoring vessel data. Statistical analyses were generally limited to comparisons of the "seismic" and "non-seismic" bins where adequate effort allowed for meaningful interpretation.

Sighting Rate Calculation and Comparisons

Sighting rates (sightings/1000 km of observer effort) are presented for the *Geo Celtic* and monitoring vessels within the analysis categories of Beaufort wind force, number of MMOs on watch, and by seismic status (for the *Geo Celtic*) or RSL (for the monitoring vessels). Sighting rates presented independently by species groups including cetaceans, pinnipeds (excluding walrus), and Pacific walrus. Where appropriate and sample sizes permitted, comparisons of sightings rates between categories were made using a chi-square (X^2) test.

Sighting rates have the potential to be biased by a number of different factors. In order to present meaningful and comparable sighting rates, especially for purposes of considering the potential effects of seismic activity on the distribution and behavior of marine mammals, effort and sightings data were categorized by sighting conditions (e.g. environmental conditions), operational conditions, and other vessel proximity. The criteria were intended to exclude data from periods of observation effort when conditions would have made it unlikely to detect marine mammals that were at the surface. If those data were to be included in analyses, important metrics like sightings rates and densities would be biased downward.

Criteria for Sighting Rate Data

Different definitions were used for pinnipeds and cetaceans in order to account for assumed differences in their reactions to seismic survey and vessel activities. Therefore, effort and sightings occurring under the following conditions were excluded when calculating sighting rates and densities.

- periods 3 min to 1 h for pinnipeds and polar bears, or 2 h for cetaceans, after the airguns were turned off (post-seismic period);

- periods when ship speed was <3.7 km/h (2 kt);
- periods aboard a vessel when one or more vessels were operating within 5 km (3.1 mi) for cetaceans and 1 km (0.6 mi) for pinnipeds in the forward 180° of that vessel;
- periods with seriously impaired visibility including:
  - all nighttime observations;
  - visibility distance <3.5 km (2.2 mi);
  - Beaufort wind force (Bf) >5 (Bf >2 for Minke whales, belugas, and porpoises; See Appendix F for Beaufort wind force definitions);
  - >60º of severe glare in the forward 180° of the vessel.

This categorization system was designed primarily to identify potential differences in behavior and distribution of marine mammals during periods with airgun activity versus periods without airgun activity. The rate of recovery toward "normal" behavior and distributions during the post-seismic period is uncertain. Marine mammal responses to seismic sound likely diminish with time after the cessation of seismic activity. The end of the post-seismic period was defined as a time long enough after cessation of airgun activity to ensure that any carry-over effects of exposure to sounds from the airguns would have waned to zero or near-zero. The reasoning behind these categories was explained in MacLean and Koski (2005) and Smultea et al. (2005) and is discussed in Appendix E. Data that met these criteria are presented in Parts 2 and 3 of Appendix H.

Distribution and Behavior

Marine mammal behavior is difficult to observe because individuals and/or groups are often at the surface only briefly, and may avoid the vessel. This causes difficulties in re-sighting those animals, and in determining whether two sightings some minutes apart are repeat sightings of the same individual(s). Limited behavioral data were collected during this project because marine mammals were often observed at distances too far from the vessel to determine behavior, and they were typically not tracked for long distances or durations while the vessel was underway.

Data collected during visual observations provided some information about behavioral responses of marine mammals to the seismic survey:

- bearings and distances of initial sightings to marine mammals from the MMO observation station;
- observed behavior of animals at the time of the initial sighting;
- animal movements relative to vessel movements; and
- reaction of animals in response to the vessel or seismic sounds.

Closest Point of Approach

The closest point of approach (CPA) of each sighting to the observer position and airgun array was calculated in a GIS using the closest sighting record to the MMO position on the vessel and then triangulating to the airgun array. The mean CPA to the observer or airgun array was calculated separately for sightings from source and monitoring vessels and within the three seismic activity or RSL bins. Standard deviation and range of distances (m) to the observer were also calculated.

Similar to sighting rate calculations, the calculation of mean CPA distances and subsequent comparisons during different seismic states could be biased by including data from observation periods of poor visibility or when animals may have been affected by something other than seismic sounds.

Therefore, only sightings that met the criteria for inclusion in the sighting rate calculations were used in the calculation of mean CPA distances.

Movement

Animal movements relative to the vessel were grouped into five categories: swim (move) away, swim (move) towards, neutral (e.g. parallel), none, or unknown. The observed movements of animals that fell into these categories were compared between source and monitoring vessels and across the three seismic activity or RSL bins.

Initial Behavior

For each sighting an initial behavior was recorded by the MMO. Animal behavior codes included: blow, dive, logging, looking, milling, resting, surface active, surface active travel, sink, swim, thrash, and unknown. The initial behaviors of animals that fell into these categories were compared between source and monitoring vessels and across the three seismic activity or RSL.

Reaction Behavior

Animal reactions in response to the vessel or the seismic source were recorded during each sighting. Reaction behavior codes included: change in direction, increase in speed, look, splash, interactions with seismic gear, unknown, and no reaction. The reaction behaviors of animals that fell into these categories were compared between source and monitoring vessels and across the three seismic activity or RSL bins.

Line Transect Estimation of Densities

Marine mammal sightings recorded during seismic and non-seismic periods were used to calculate densities (#/km^2) of marine mammals near source and monitoring vessels during those periods. Density calculations were based on line-transect principles (Buckland et al. 2001). Whenever sample size allowed, correction factors for animals not detected at greater distances from the vessels, $f(0)$, were calculated from data collected from these project vessels during the 2010 season. When sufficient data collected during this survey were not available, $f(0)$ correction factors from other similar studies were substituted. Correction factors for animals near the vessel, but underwater and therefore unavailable for detection by observers [$g(0)$], were taken from related studies, as summarized by Koski et al. (1998) and Barlow (1999). This was necessary because of the inability to assess trackline sighting probability, $g(0)$, during a project of this type. Further details on the line transect methodology used during the survey are provided in Appendix E.

Estimating Numbers Potentially Affected

NMFS and USFWS practice in situations with intermittent impulsive sounds like seismic pulses has been to assume that "take by harassment" (Level B harassment) may occur if marine mammals are exposed to received levels of sounds exceeding 160 dB re 1 μPa rms (NMFS 2005, 2006; USFWS 2008). When calculating the number of mammals potentially affected as described below, we used the measured ≥160 dB (rms) distances shown in Table 4.1.

Two methods were used to estimate the number of pinnipeds and cetaceans exposed to airgun sound levels that may have caused disturbance or other effects. The methods were:

(A) minimum estimates based on direct observations during seismic activities; and

(B) estimates based on pinniped and cetacean densities calculated from data collected during this study multiplied by the area of water exposed to seismic sounds ≥160 dB (rms).

As noted in the previous section, separate density estimates were calculated from data collected during seismic and non-seismic periods or locations. The use of non-seismic densities in method ***(B)*** provides an estimate of the number of animals that presumably would have been present in the absence of seismic activities. The use of seismic densities in method ***(B)*** provides an estimate of the number of animals that were likely present in the area of seismic activity during this project. In cases where seismic densities are lower than non-seismic densities, the difference between the two estimates could be taken as an estimate of the number of animals that moved in response to the operating seismic vessel, or that changed their behavior sufficiently to affect their detectability by visual observers. In cases where seismic densities are greater than non-seismic densities, it suggests that individuals of that species did not move in response to the operating seismic vessel, or that they altered their behavior in such a way that made them more detectable by visual observers. The actual number of individuals exposed to, and potentially affected by, seismic survey sounds was likely between the minimum and maximum estimates resulting from methods ***(A)*** and ***(B)***.

Method ***(B)*** above provided an estimate of the number of animals that would have been exposed to airgun sounds at various levels if the seismic activities did not influence the distribution of animals near the activities. However, it is known that some animals are likely to have avoided the area near the seismic vessel while the airguns were firing (see Richardson et al. 1995, 1999; Stone 2003; Gordon et al. 2004; Smultea et al. 2004, Funk et al. 2008). Within the ≥160 dB (rms) radii around the seismic source (i.e., 2.5 km [1.6 mi]), the distribution and behavior of cetaceans may have been altered as a result of the seismic survey. The distribution and behavior of pinnipeds may have been altered within some lesser distance. These effects could occur because of reactions to the active airgun array, or to other sound sources or other vessels working in the area.

Density estimates for each species group were used to estimate the number of animals potentially affected by seismic operations (method ***(B)***). This involved using two approaches to estimate the extent to which marine mammals may have been exposed to given sound levels ≥160, ≥170, ≥180, and ≥190 dB (rms):

1. Estimates of the number of different *individual* marine mammals exposed; and
2. Estimates of the average number of *exposures* each individual may have received.

The ≥160, ≥170, ≥180, and ≥190 dB (rms) distances are summarized in Table 4.1. The following description of the two different methods refers only to the ≥160 dB (rms) sound level, but the same method of calculation was used for ≥170, ≥180 and ≥190 dB (rms) sound levels.

The first method ("individuals") involved multiplying the following three values:

- km of seismic survey;
- width of area assumed to be ensonified to ≥160 dB rms (2 × 160 dB radius), counting the areas ensonified on more than one occasion *only once*; and
- densities of marine mammals estimated from data collected during this survey as described above.

The second approach ("exposures") represents the average number of times a given area of water within the seismic survey area was ensonified to the specified level. The value was calculated as the ratio of the area of water ensonified *including* multiple counts of areas exposed more than once to the area of water ensonified *excluding* multiple counts of areas exposed more than once. If an animal remained in approximately the same location through the duration of the survey activities it would have been exposed an equivalent number of times.

This approach was originally developed to estimate numbers of seals potentially affected by seismic surveys in the Alaskan Beaufort Sea conducted under IHAs (Harris et al. 2001). The method has

recently been used in estimating numbers of seals and cetaceans potentially affected by other seismic surveys conducted under IHAs (e.g., Funk et al. 2008; Ireland et al. 2007a,b; Patterson et al. 2007).

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5. MARINE MAMMAL MONITORING[1]

Monitoring Effort and Marine Mammal Encounter Results

This section summarizes the visual observer effort from the *Geo Celtic* and its two monitoring vessels (*Tanux I* and *Norseman I*) during Statoil's 2010 seismic operations in the Chukchi Sea, and does not include effort conducted during transit from Dutch Harbor to and from the survey area (north of Point Hope, Alaska). The survey period began when the *Geo Celtic* and its monitoring vessels entered the Chukchi Sea survey area on 11 Aug 2010 (AKDT) and ended when the *Geo Celtic* departed the area on 4 October 2010.

The *Geo Celtic* traveled along a total of 10,717 km (6659 mi) of trackline in the Chukchi Sea survey area. Airgun operations occurred along 8069 km (5014 mi) of that trackline. The full airgun array was ramping up or active along 5387 km (3347 mi) of trackline. The single mitigation airgun operated along 2681 km (1666 mi), including turns and power downs. The airguns did not operate along the remaining 2648 km (1645 mi) of trackline in the Chukchi Sea.

Other Vessels

The *Geo Celtic* and at least one of its monitoring vessels typically worked within 5 km (3 mi) of each other and often as close as a few hundred meters. Vessels' proximity to each other was variable over time and may have influenced the number and behavior of marine mammals sighted from different vessels. Vessels other than those involved in the survey seldom passed through the project area. Each ship that was not participating in the project transited well away from survey activities (>15 km) and MMOs observed no instances of harassment or disturbance to marine mammals due to their presence.

Observer Effort

MMOs aboard the three vessels were on watch for a total of 28080 km (17,448 mi; 2741 h). Of this total, 10,477 km (6510 mi; 1223 h) of observation effort was from the *Geo Celtic*, 9250 km (5748 mi; 784 h) from the *Norseman I*, and 8353 km (5190 mi; 734 h) from the *Tanux I* (Fig. 5.1).

The IHA required MMOs on the *Geo Celtic* to watch at night during night time power ups or if daytime monitoring had resulted in a power down due to the presence of a marine mammal within the applicable safety radius. Of the total observation effort on all three vessels, 3564 km (2215 mi; 399 h) occurred during darkness (Fig. 5.1). Observers on the *Geo Celtic* conducted 3187 km (1980 mi; 365 h) of watch effort in darkness while observers on the two monitoring vessels conducted 377 km (234 mi; 34 h; Fig. 5.1). Hereafter, effort analyses will compare the seismic source vessel, *Geo Celtic*, to the combined data of the two monitoring vessels.

Observer Effort by Beaufort Wind Force

Observer effort from the *Geo Celtic* occurred between Beaufort wind force (Bf) zero and Bf eight (Fig. 5.2). The monitoring vessels did not have any observation effort in Bf seven and eight because it was not safe to observe from the smaller vessels during high sea states (>Bf 6). The greatest amount of observer effort on the *Geo Celtic* occurred during Bf three, which accounted for 29% of *Geo Celtic* MMO effort. Observer effort from the monitoring vessels was greatest during Bf two, which accounted for 31% of the monitoring vessel MMO effort.

[1] By Megan Blees, Kris Hartin, Danielle Dickson, and Darren Ireland

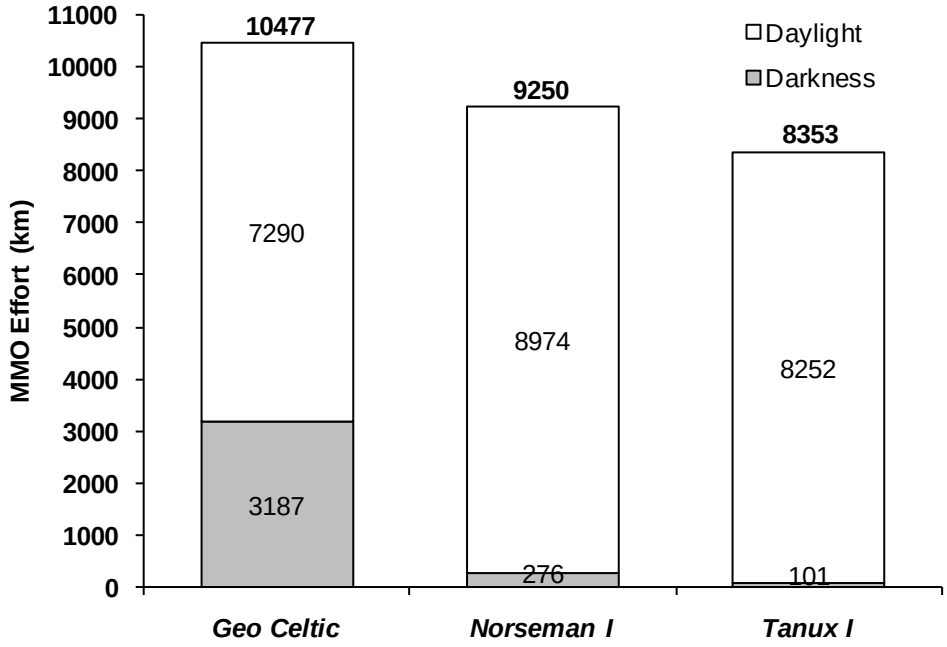

FIGURE 5.1. MMO observation effort (km) by daylight and darkness periods, during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010. Total MMO observation effort is displayed in bold above each bar.

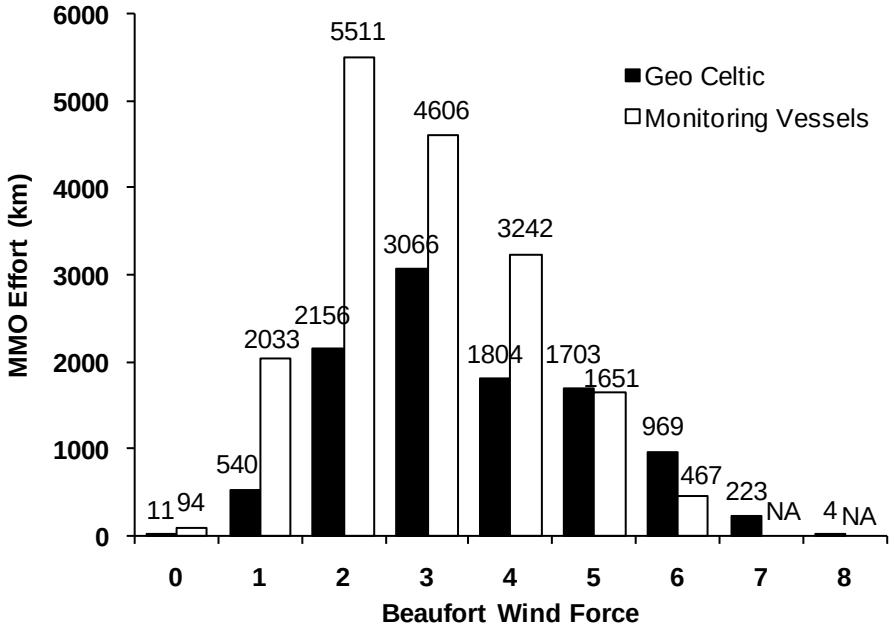

FIGURE 5.2. MMO observation effort (km) by Beaufort wind force from the *Geo Celtic* and its monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Observer Effort by Number of MMOs

On the *Geo Celtic*, two MMOs were on watch during 58% of observation effort while on the monitoring vessels, one MMO was on watch during 60% of effort (Fig. 5.3). The lesser amount of two-person watch on the monitoring vessels was a result of the fewer number of MMOs on those vessels due to bunk and bridge space restrictions.

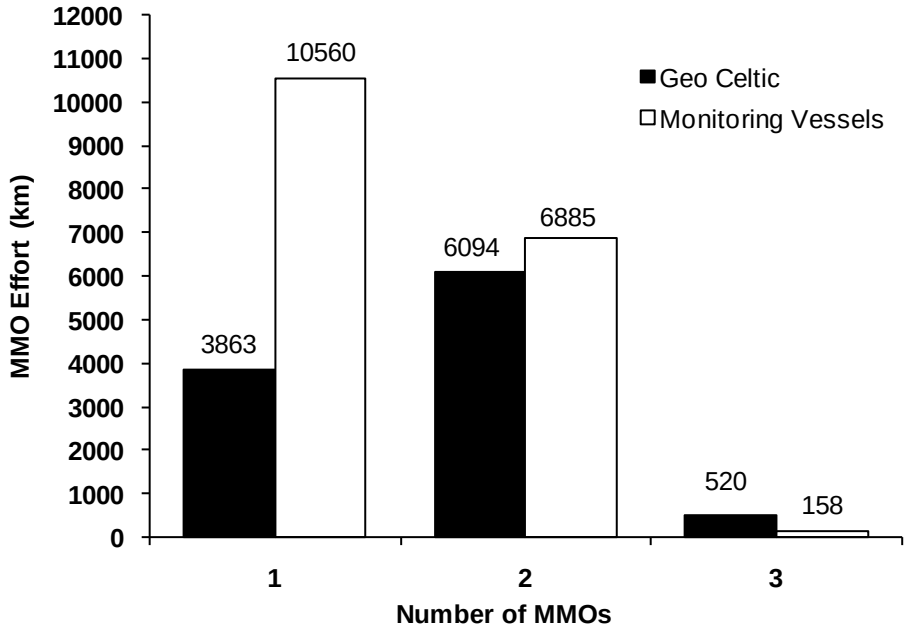

FIGURE 5.3. MMO observation effort (km) by number of MMOs, during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010.

Observer Effort by Seismic Status and Received Sound Level

Most observer effort from the *Geo Celtic* occurred while the airguns were active: 51% while the full array was active and 26% while the mitigation airgun was active (Fig. 5.4). Observer effort during non-seismic periods accounted for the remaining 23% of total effort.

Most observer effort from the monitoring vessels occurred where RSLs were 159-120 dB or <120 dB (rms; 84%; Fig. 5.5). This was expected because monitoring vessels typically operate in areas away from the seismic source where RSLs are lower during airgun activity. The amount of effort that occurred where RSLs were ≥160 dB (rms) was much lower (16% of total observer effort).

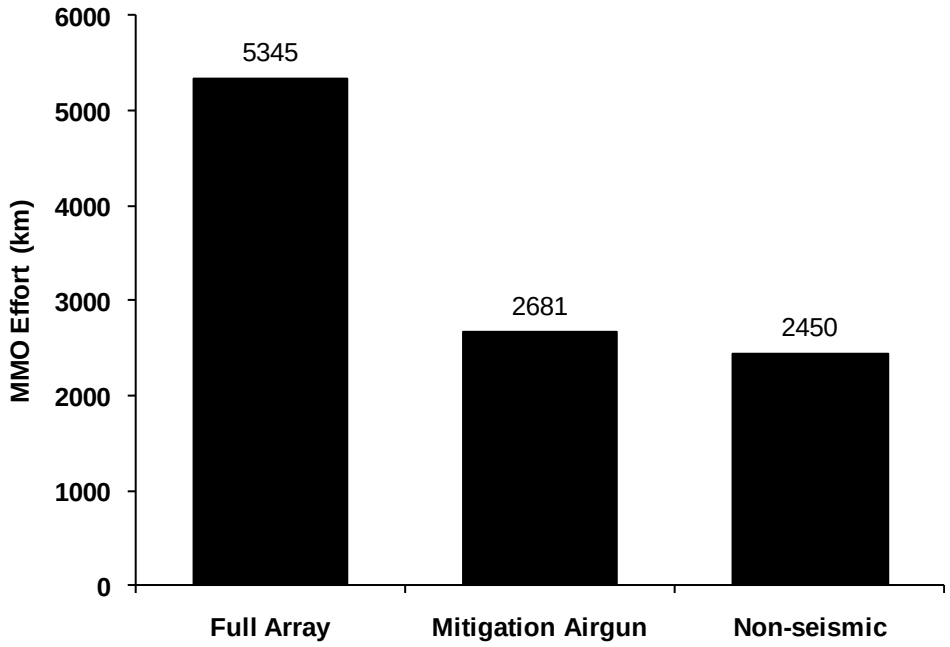

FIGURE 5.4. MMO observation effort (km) for the *Geo Celtic* by seismic status during Statoil's seismic survey, 11 Aug – 4 October 2010. The full airgun array operated at 3000 in^3 and the mitigation airgun operated at 60 in^3.

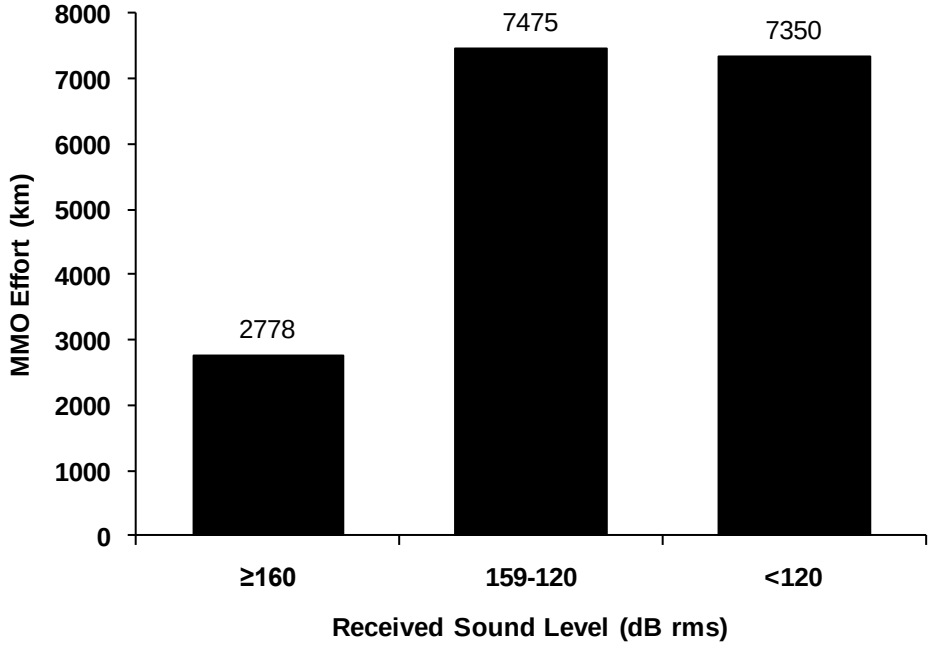

FIGURE 5.5. MMO observation effort (km) from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010.

Marine Mammal Sightings

During the Statoil seismic survey, MMOs observed a total of 310 sightings of 534 marine mammals from the *Geo Celtic* and 428 groups of 939 marine mammals from the monitoring vessels. Details of each marine mammal sighting observed north of Point Hope are available in Appendix I. The sighting data below is presented in three species groups: cetaceans, seals, and Pacific walruses.

Cetacean Sightings

MMOs observed 32 sightings of 45 cetaceans from the *Geo Celtic* and its monitoring vessels (Table 5.1). More than half of the cetaceans sightings were unable to be identified to species (Table 5.1).

TABLE 5.1. Number of cetacean sightings (number of individuals) from the *Geo Celtic* and its monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Species	*Geo Celtic*	Monitoring Vessels	*Total*
Cetaceans			
Bowhead Whale	0	5 (6)	**5 (6)**
Gray Whale	1 (1)	4 (9)	**5 (10)**
Minke Whale	4 (5)	0	**4 (5)**
Unidentified Mysticete Whale	7 (10)	9 (10)	**16 (20)**
Unidentified Toothed Whale	1 (3)	0	**1 (3)**
Unidentified Whale	0 (0)	1 (1)	**1 (1)**
Total Cetaceans	**13 (19)**	**19 (26)**	**32 (45)**

Cetacean Sighting Rates

Cetacean sighting rates were calculated using only the periods of effort that met the criteria for being able to reliably detect cetaceans (See Chapter 4 and Appendix E) and the sightings that occurred during those periods. Data that met these criteria are presented in Parts 2 and 3 of Appendix H.

Cetacean Sighting Rates by Beaufort Wind Force – Cetacean sighting rates from the *Geo Celtic* were greatest during periods of Beaufort wind force (Bf) two through four (Fig. 5.6). Sighting rates from the monitoring vessels were greatest during Bf conditions one and two.

Cetacean Sighting Rates by Number of MMOs – There were relatively few periods on the *Geo Celtic* during which either one or three MMOs were on watch. Aboard the monitoring vessels, it was rare to have three MMOs on duty. Therefore, effort and sightings from all three vessels were combined in order to compare sighting rates between periods with different numbers of MMOs on watch (Fig. 5.7). Cetacean sighting rates were greatest with two MMOs on watch. This sighting rate was 8% greater than periods when three MMOs were on watch, and over three times greater than periods when only one MMO was on watch. Sighting rates were significantly greater with two MMOs on watch, than with one MMO on watch ($X^2 = 6.56$, $df = 1$, $p = 0.01$).

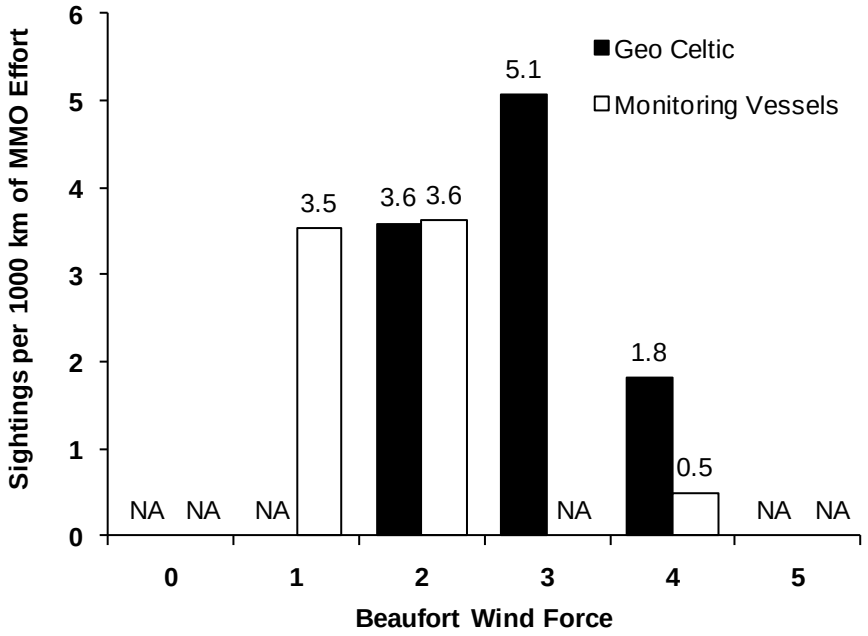

FIGURE 5.6. Cetacean sighting rates during Beaufort wind force conditions 0 through 5 during Statoil's seismic survey, 11 Aug – 4 October 2010.

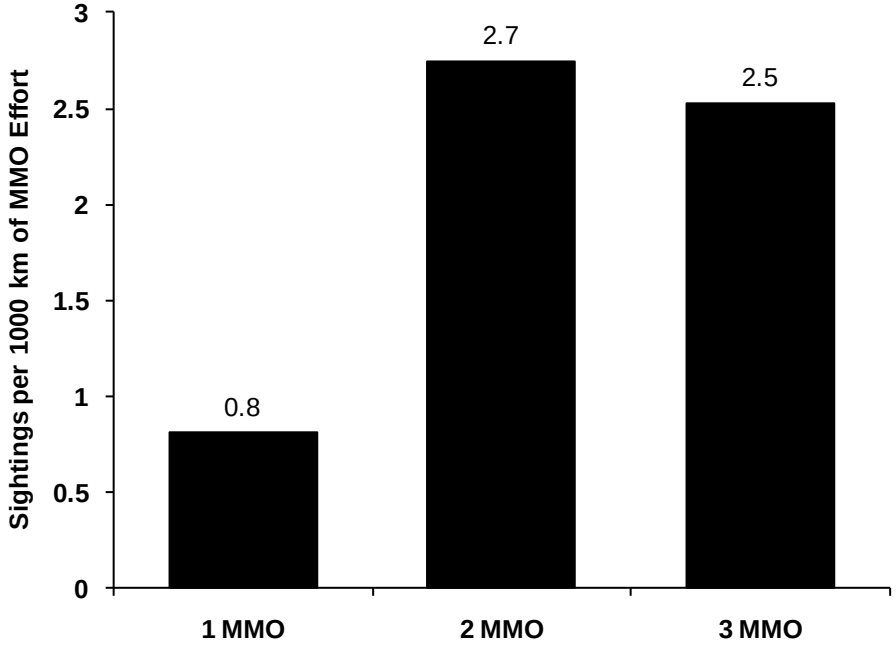

FIGURE 5.7. Cetacean sighting rates by number of MMOs on watch from all vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Cetacean Sighting Rates by Received Sound Level – Cetacean sighting rates from the *Geo Celtic* and the monitoring vessels generally increased with decreasing seismic source levels or RSLs (Fig. 5.8). Sighting rates from the *Geo Celtic* when the full array was active and during non-seismic periods were over three times higher than those from the monitoring vessels in areas where RSLs were ≥160 and <120 dB (rms). Sighting rates were higher from the monitoring vessels where RSLs were 159–120 dB (rms) than during periods when the *Geo Celtic* was operating only the mitigation airgun. When effort and sightings from the *Geo Celtic* and its monitoring vessels were pooled (full array activity pooled with ≥160 dB; mitigation airgun activity pooled with 159–120 dB; and non-seismic periods pooled with <120 dB) there was no significant difference between sighting rates during seismic periods and non-seismic periods ($X^2 = 0.02$, $df = 1$, $p = 0.89$).

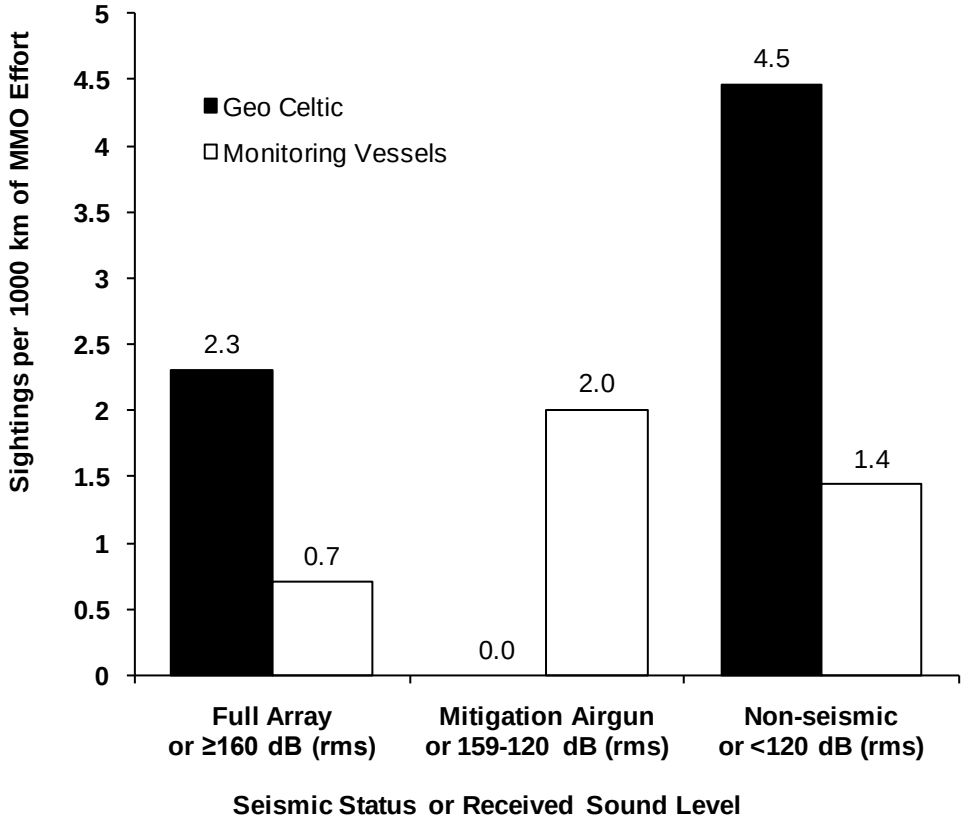

FIGURE 5.8. Cetacean sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159-120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

Seal Sightings

There were 362 seals sightings of 388 individuals by MMOs on the *Geo Celtic* and its monitoring vessels (Table 5.2). Bearded seal was the most frequently identified seal species, although nearly half of the seals sighted could not be identified to species.

TABLE 5.2. Number of sightings (number of individuals) of seals during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010.

Species	*Geo Celtic*	Monitoring Vessels	*Total*
Seals			
Bearded Seal	53 (56)	69 (72)	**122 (128**
Ribbon Seal	0	1 (1)	**1 (1)**
Ringed Seal	17 (18)	16 (17)	**33 (35)**
Spotted Seal	1 (1)	4 (4)	**5 (5)**
Unidentified Pinniped	19 (25)	26 (31)	**45 (56)**
Unidentified Seal	57 (63)	97 (98)	**154 (161)**
Total Seals	**147 (163)**	**213 (223**	**360 (386)**

Seal Sighting Rates

Seal sighting rates were calculated using only the periods of effort that met the criteria for being able to reliably detect seals (See Chapter 4 and Appendix E) and the sightings that occurred during those periods.

Seal Sighting Rates by Beaufort Wind Force – As would be expected, seal sighting rates from the *Geo Celtic* and its monitoring vessels decreased with increasing Beaufort wind force (Fig. 5.9). Sighting rates for the *Geo Celtic* during periods of Bf 1 were approximately three times greater than those during Bf 2, but should be viewed with caution as the MMO effort was limited during this period for both the *Geo Celtic* (7.4 km; 4.6 mi) and its monitoring vessels (54.2 km; 33.7 mi).

Seal Sighting Rates by Number of MMOs – There were relatively few periods on the *Geo Celtic* during which either one or three MMOs were on watch. Aboard the monitoring vessels, it was rare to have three MMOs on duty at one time. Therefore, effort and sightings from all three vessels were combined in order to compare sighting rates between periods with different numbers of MMOs on watch (Fig . 5.10). Seal sighting rates with three MMOs on watch were 1.5 times greater than with two MMO on watch, and three times greater than with one MMO on watch. However, limited effort (464 km; 288 mi) occurred when there were three MMOs on watch, so that sighting rate should be viewed with some caution. Seal sighting rates were significantly greater with two MMOs on watch than with one MMO on watch ($X^2 = 28.4$, $df = 1$, $p < 0.0001$).

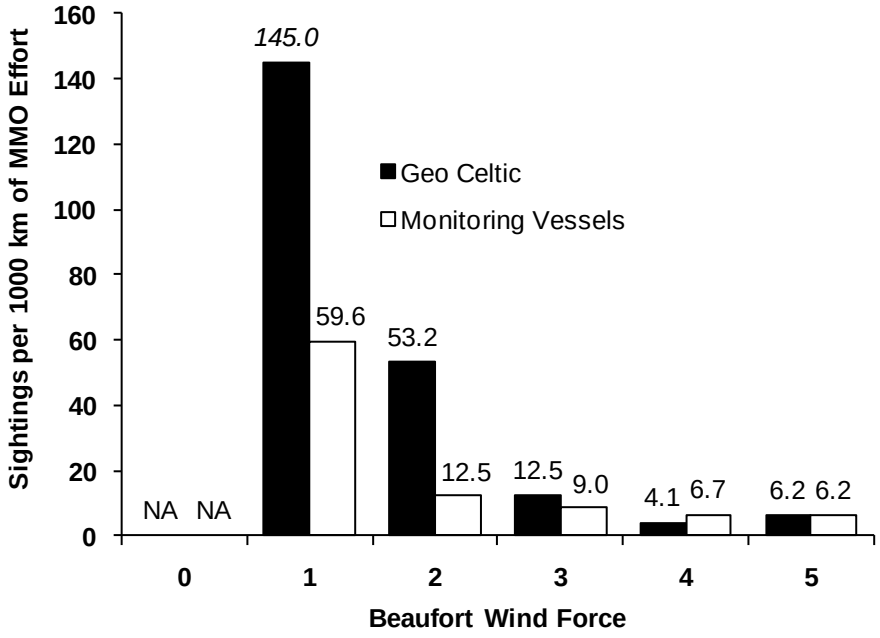

FIGURE 5.9. Seal sightings by Beaufort wind force during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010. Italics indicate a marginal level of effort was available for calculating the sighting rate.

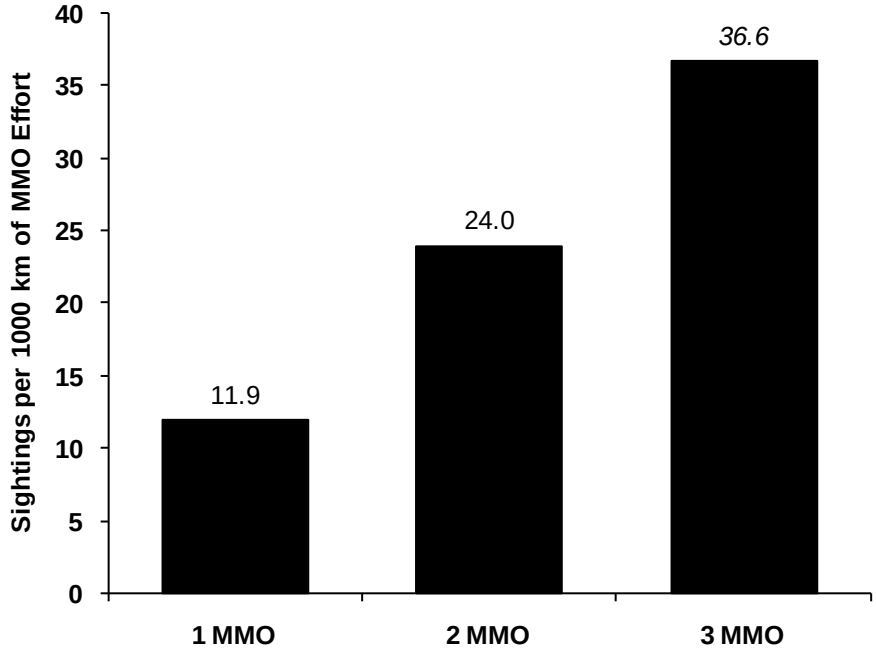

FIGURE 5.10. Seal sighting rates by number of MMOs from three vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Seal Sighting Rates by Received Sound Level – The seal sighting rate from the *Geo Celtic* was highest during full array activity; Fig. 5.11). The sighting rate during full array activity was 2.5 times greater than during only mitigation airgun activity and non-seismic periods. The difference between sighting rates during full array activity and non-seismic periods was statistically significant ($X^2 = 10.57$, $df = 1$, $p = 0.001$). The sighting rates from the monitoring vessels were highest where RSLs were 159–120 dB (rms), which was ~17% higher than the sighting rate where RSLs were≥160 dB (rms) and ~37% higher than the sighting rate where RSLs were <120 dB (rms; Fig. 5.11). However, there was not a significant difference between sighting rates where RSLs were ≥160 dB and <120 dB (rms; $X^2 = 1.22$, $df = 1$, $p = 0.27$).

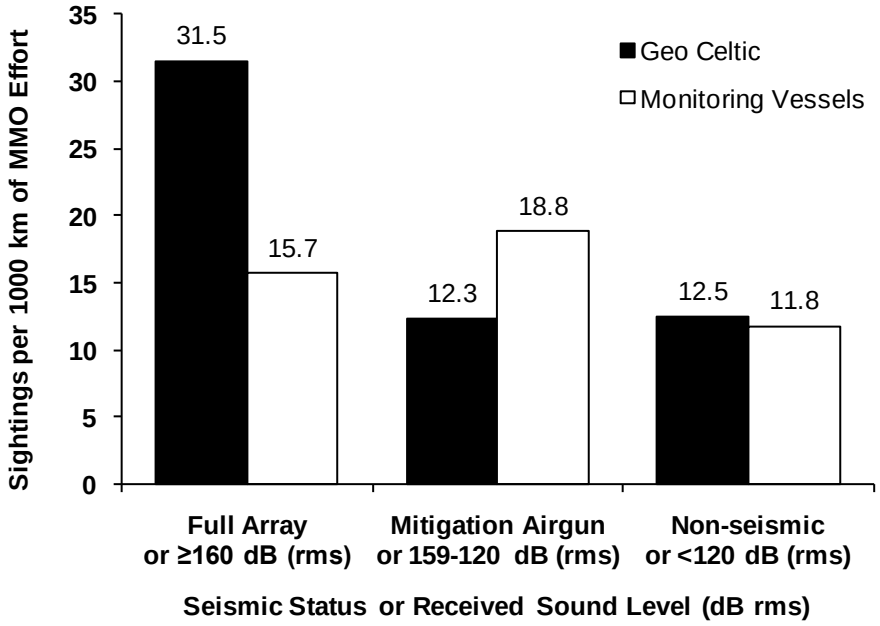

FIGURE 5.11. Seal sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159 -120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

Polar Bear Sightings

No polar bears were observed during Statoil's seismic survey.

Pacific Walrus Sightings

There were 346 Pacific walrus sightings of 1042 individuals by MMOs on the *Geo Celtic* and its monitoring vessels (Table 5.3). The majority (72%) of these sightings were observed between 28 and 31 August 2010 (250 sightings of 823 individuals) as a large number of Pacific walrus moved from the receding ice edge towards land (Fig. 5.12).

TABLE 5.3. Number of sightings (number of individuals) of Pacific walruses during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010.

Species	*Geo Celtic*	Monitoring Vessels	*Total*
Pacific Walruses	150 (352)	196 (690)	346 (1042)

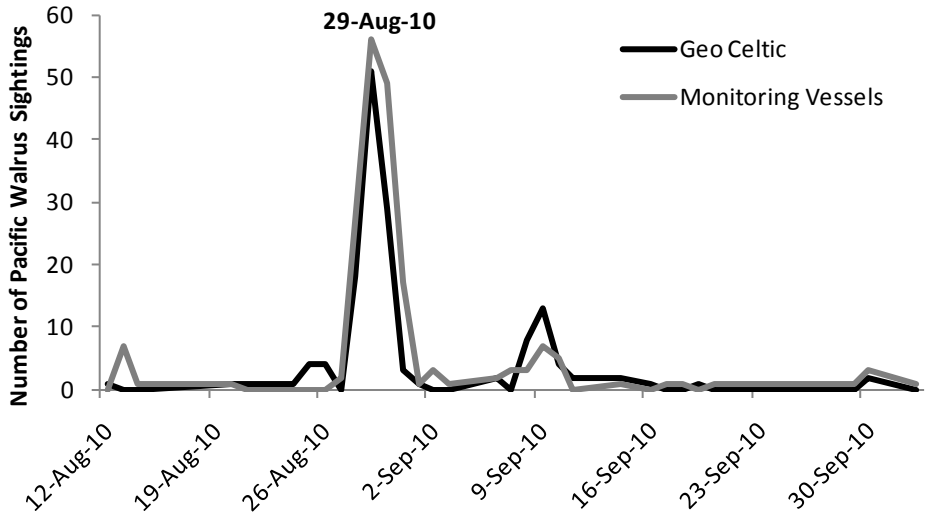

Figure 5.12. Number of Pacific Walrus sightings per day as observed by MMOs during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010.

Pacific Walrus Sighting Rates

Pacific walrus sighting rates were calculated using only the periods of effort that met the criteria for being able to reliably detect walruses (See Chapter 4 and Appendix E) and the sightings that occurred during those periods.

Pacific Walrus Sightings Rates by Beaufort Wind Force – Pacific walrus sighting rates from the *Geo Celtic* and its monitoring vessels generally decreased with increasing Beaufort wind force (Bf; Fig. 5.13). Sighting rates from the *Geo Celtic* during periods of Bf two were over three times greater than during periods of Bf three. Conditions of Bf zero were very uncommon during the survey resulting in very little effort being recorded in that category. Additionally, observations during Bf one from the *Geo Celtic* were limited (121 km; 75 mi) so the resulting sighting rate should be viewed with caution.

Pacific Walrus Sighting Rates by Number of MMOs – There were relatively few periods on the *Geo Celtic* during which either one or three MMOs were on watch. Aboard the monitoring vessels, it was rare to have three MMOs on duty at one time. Pinniped effort and sightings from all three vessels were therefore combined in order to compare sighting rates between periods with different numbers of MMOs on watch (Fig. 5.14). Pacific walrus sighting rates with three MMOs on watch were 1.2 times greater than with two MMOs on watch, and over 3.5 times greater than with one MMO on watch. However, as with seals, limited effort (464 km; 288 mi) was available when three MMOs were on watch so that sighting rate should be viewed with some caution. Pacific walrus sighting rates increased as the number

of MMOs increased and were significantly greater with two MMOs on watch than with one MMO on watch ($X^2 = 56.48$, $df = 1$, $p < 0.0001$).

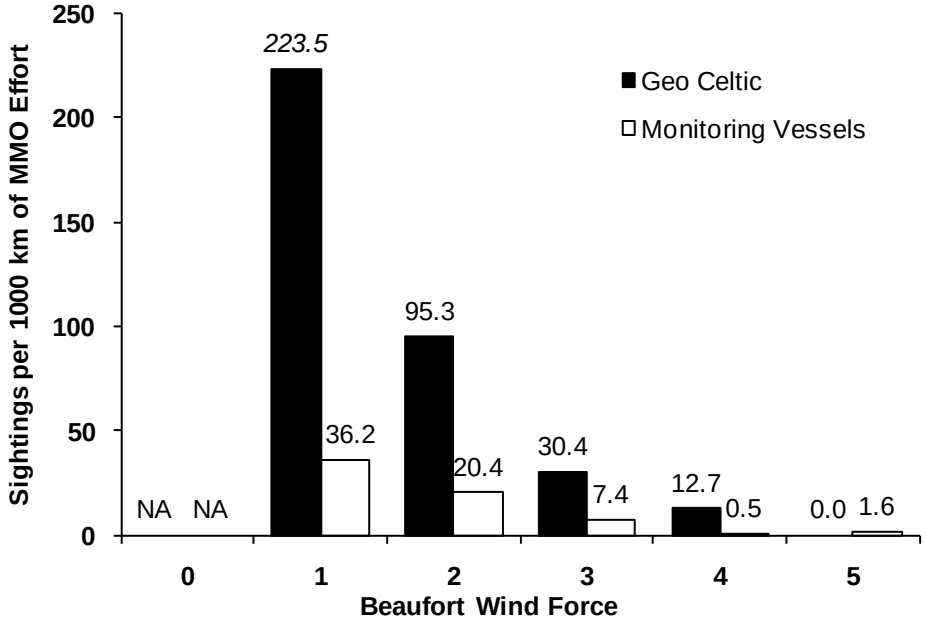

FIGURE 5.13. Pacific walrus sighting rates by Beaufort wind force from the *Geo Celtic* and its monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Pacific Walrus Sighting Rates by Received Sound Level – Pacific walrus sighting rates from both the *Geo Celtic* and its monitoring vessels were greatest during mitigation airgun activity and where RSLs were 159–120 dB (rms), respectively. From the *Geo Celtic*, sighting rates during mitigation airgun were 32% greater than during full array activity and over 5.5 times greater than during non-seismic periods. *Geo Celtic* sighting rates were significantly greater during full array activity periods than during non-seismic periods ($X^2 = 15.04$, $df = 1$, $p = 0.0001$). These results likely reflect the brief period over which most of the walrus sightings occurred, and the seismic activity that was ongoing at that time (mitigation airgun activity), rather than a typical distribution of walruses relative to received sound levels from airguns. For the monitoring vessels, sighting rates where RSLs were 159–120 dB (rms) were over two times greater than where RSLs were ≥160 dB (rms) and almost 2.5 times greater than where RSLs were <120 dB (rms; Fig. 5.15). There was no significant difference between sighting rates from monitoring vessels in locations near to the active seismic source (RSLs ≥160 dB rms) and very distant from the active airguns or when they were not operating (RSLs ≤120 dB rms; $X^2 = 0.05$, $df = 1$, $p = 0.82$).

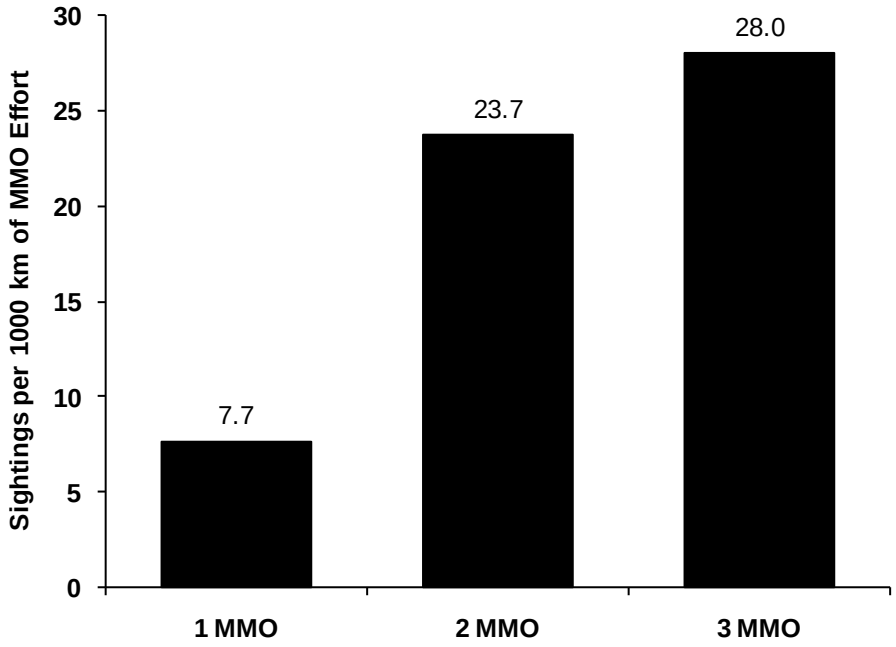

FIGURE 5.14. Pacific walrus sighting rates by number of MMOs from all three vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

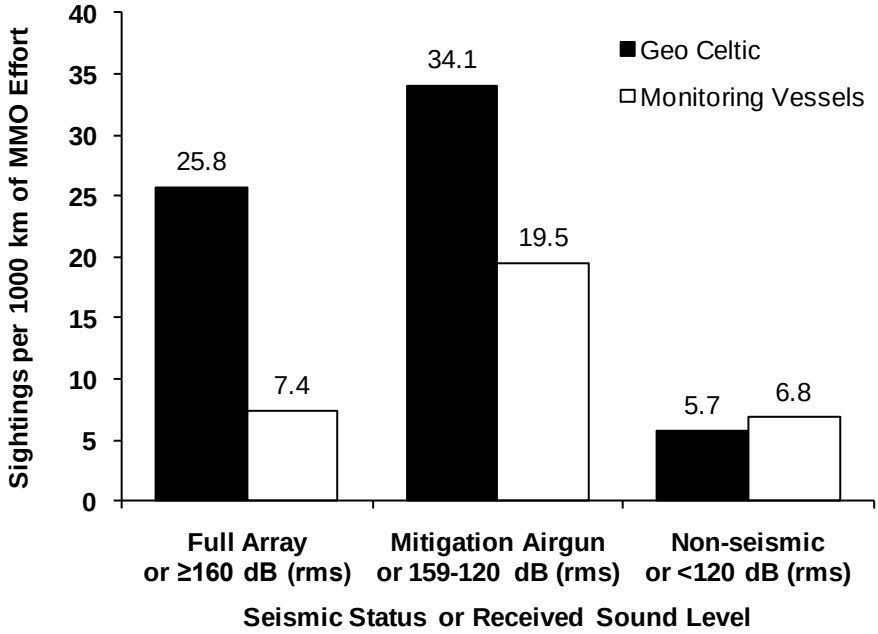

Figure 5.15. Pacific walrus sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159 - 120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

Distribution and Behavior of Marine Mammals

Marine mammal behaviors and reactions were difficult to observe because individuals and/or groups typically spent most of their time below the water surface and could not be observed for extended periods. Additionally, the MMOs primary duty is mitigation rather than collecting behavioral data. The data collected during visual observations therefore provided limited information about reactions of marine mammals to Statoil's seismic survey. The relevant data collected from the *Geo Celtic* and its monitoring vessels included estimated distance to the vessel, movement relative to the vessel, and behavior and reaction of animals at the time of the initial detections.

Cetaceans

Cetacean Closest Point of Approach

The mean closest points of approach (CPAs) of cetaceans were calculated using only sightings that occurred during periods of effort that met the criteria for being able to reliably detect cetaceans (See Chapter 4 and Appendix E). The mean closest point of approach (CPA) of cetaceans from the *Geo Celtic* during full array activity was 3741 m (2.3 mi), while it was 983 m (0.6 mi) during non-seismic periods (Table 5.4). From the monitoring vessels, the mean CPA where RSLs were ≥160 and <120 dB (rms) were 1298 m (0.8 mi) and 684 m (0.4 mi), respectively (Table 5.4). Cetaceans were observed from the *Geo Celtic* as close as 587 m (0.4 mi) and as far as 4974 m (3.1 mi). From the monitoring vessels, the CPA of cetaceans ranged from 10 m (11 yd) up to 2010 m (1.3 mi). Only one cetacean sighting from the monitoring vessels occurred where RSLs were ≥160 dB (rms) and the CPA to the vessel was 298 m (326 yd).

TABLE 5.4. Comparison of mean cetacean CPA distances by seismic status from the *Geo Celtic* and received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances from all three seismic activity or RSL bins.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (m)	s.d.	Range (m)	*n*
***Geo Celtic* Full Array**	3741	1438	1853-4971	5
***Geo Celtic* Mitigation Airgun**	--	--	--	0
***Geo Celtic* Non-Seismic**	983	359	587-1287	3
Geo Celtic Overall	***2707***	***1804***	***587-4971***	***8***
Monitoring Vessels ≥160	298	--	--	1
Monitoring Vessels 159-120	874	619	100-2010	8
Monitoring Vessels <120	684	631	10-1785	7
Monitoring Vessel Overall	***755***	***602***	***10-2010***	***16***

[a] CPA=*Closest Point of Approach.* For *Geo Celtic* this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel.

Cetacean Movement

The movement relative to the vessel of most cetaceans (84%) observed from the *Geo Celtic* and its monitoring vessels was either unknown or neutral across all received sound level bins (Table 5.5). Neutral movement indicated the animal(s) were swimming neither towards nor away from the vessel (i.e. parallel to vessel). Two cetaceans were observed swimming away from the monitoring vessels and two were observed with no overall movement. Due to the low number of cetacean sightings from all vessels, meaningful comparisons of cetacean movements during Statoil's seismic survey were not possible.

TABLE 5.5. Number of cetacean sightings by movement relative to vessels by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Movement Relative to Vessel					
	Neutral	None	Swim Away	Swim Towards	Unknown	Totals
***Geo Celtic* Full Array**	2	0	0	0	3	***5***
***Geo Celtic* Mitigation Airgun**	0	0	0	0	2	***2***
***Geo Celtic* Non-Seismic**	4	0	0	1	1	***6***
Geo Celtic Total	***6***	***0***	***0***	***1***	***6***	***13***
Monitoring Vessels ≥160	0	0	0	0	1	***1***
Monitoring Vessels 159-120	2	2	1	0	4	***9***
Monitoring Vessels <120	3	0	1	0	5	***9***
Monitoring Vessel Total	***5***	***2***	***2***	***0***	***10***	***19***

Cetacean Initial Behavior

The number of cetacean sightings was insufficient to make meaningful comparisons of differences in observed behaviors across received sound level bins. Most initial cetacean behaviors recorded from the *Geo Celtic* and its monitoring vessels (53%) were blow (Table 5.6). This is typical because a blow is a highly visible sighting cue. The other recorded initial behaviors were swim (34%), dive (6%), feeding (3%) and logging (3%; Table 5.6). The logging category indicates a cetacean drifting motionless at the surface.

Cetacean Reaction Behavior

One of the 24 cetacean sightings observed during Statoil's seismic survey displayed activity that may have been a reaction to the vessel (Table 5.7). This individual, observed from a monitoring vessel, demonstrated an increase in speed in reaction to the vessel. All other cetacean sightings from the *Geo Celtic* and its monitoring vessels exhibited no overt (or discernable) reaction to the vessel (Table 5.7).

TABLE 5.6. Comparison of cetacean behaviors by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during the Statoil's seismic survey period, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Initial Behavior					
	Blow	Dive	Feeding	Swim	Logging	Totals
***Geo Celtic* Full Array**	4	0	0	1	0	***5***
***Geo Celtic* Mitigation Airgun**	2	0	0	0	0	***2***
***Geo Celtic* Non-Seismic**	1	0	0	5	0	***6***
Geo Celtic Total	***7***	***0***	***0***	***6***	***0***	***13***
Monitoring Vessels ≥160	1	0	0	0	0	***1***
Monitoring Vessels 159-120	7	0	0	2	0	***9***
Monitoring Vessels <120	2	2	1	3	1	***9***
Monitoring Vessel Total	***10***	***2***	***1***	***5***	***1***	***19***

TABLE 5.7. Comparison of reaction of cetaceans by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Reaction		
	Increase in Speed	None	Totals
***Geo Celtic* Full Array**	0	5	***5***
***Geo Celtic* Mitigation Airgun**	0	2	***2***
***Geo Celtic* Non-Seismic**	0	6	***6***
Geo Celtic Total	***0***	***13***	***13***
Monitoring Vessels ≥160	0	1	***1***
Monitoring Vessels 159-120	0	9	***9***
Monitoring Vessels <120	1	8	***9***
Monitoring Vessel Total	***1***	***18***	***19***

Seals

Seal Closest Point of Approach

The mean closest points of approach of seals were calculated using only the sightings that occurred during periods of effort that met the criteria for being able to detect seals (See Chapter 4 and Appendix E). The mean closest point of approach (CPA) for seals observed from the *Geo Celtic* was greatest during mitigation airgun activity. From the monitoring vessels, the mean CPA of seals was greatest where RSLs were <120 dB (rms; Table 5.8). Seals were observed as close as 430 m (0.26 mi) and as far as 3677 m (2.3 mi) from the *Geo Celtic* and from 10 m (11 yd) to 1072 m (0.7 mi) from the monitoring vessels (Table 5.8).

Seal Movement

Most of the seal movements recorded during Statoil's seismic survey were either neutral or unknown relative to the vessels (67%;Table 5.9). Excluding unknown movements, most seals observed from the *Geo Celtic* (88%) appeared to be neutral or swimming away from the vessel, whereas seals observed from the monitoring vessels were most often either neutral or swimming towards the vessels (79%).

Seal Initial Behavior

Most of the initial seal behaviors (89%) observed from the *Geo Celtic* and its monitoring vessels were of seals looking or swimming (Table 5.10). Most of the recorded initial behaviors of seals sighted from the *Geo Celtic* were swimming (69%) while most seals observed from the monitoring vessels were recorded as looking (52%) at the vessel.

Seal Reaction Behavior

Seals observed from the *Geo Celtic* were most often recorded as having no reaction (63%), while the second-most observed reaction was of seals looking at the vessel (30%; Table 5.11). From the monitoring vessels, seals reacted primarily by looking at the vessel (51%). Most of the remaining sightings (39% of the total) were recorded as no reaction.

TABLE 5.8. Comparison of seal CPA distances from MMO sightings by seismic status from the *Geo Celtic* and received sound levels from monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances for all three seismic activity or RSL bins in the calculation.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (m)	s.d.	Range (m)	*n*
***Geo Celtic* Full Array**	978	558	430-3677	***93***
***Geo Celtic* Mitigation Airgun**	2177	621	1508-3352	***13***
***Geo Celtic* Non-Seismic**	1019	308	634-1614	***13***
Geo Celtic Overall	***1113***	***657***	***430-3677***	***119***
Monitoring Vessels ≥160	194	195	20-685	***19***
Monitoring Vessels 159-120	185	158	10-700	***85***
Monitoring Vessels <120	225	220	10-1072	***62***
Monitoring Vessel Overall	***201***	***187***	***10-1072***	***166***

[a] CPA=Closest Point of Approach. For Geo Celtic this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel.

TABLE 5.9. Comparison of seal movement relative to vessels by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Movement Relative to Vessel					
	Swim Towards	Swim Away	Neutral	None	Unknown	Totals
***Geo Celtic* Full Array**	9	44	48	0	17	***118***
***Geo Celtic* Mitigation Airgun**	1	1	7	0	4	***13***
***Geo Celtic* Non-Seismic**	4	1	4	0	7	***16***
Geo Celtic Total	***14***	***46***	***59***	***0***	***28***	***147***
Monitoring Vessels ≥160	10	4	10	0	11	***35***
Monitoring Vessels 159-120	16	6	42	3	44	***111***
Monitoring Vessels <120	6	8	14	5	34	***67***
Monitoring Vessel Total	***32***	***18***	***66***	***8***	***89***	***213***

TABLE 5.10. Comparison of seal initial behavior by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Initial Behavior										
	Dive	Logging	Looking	Milling	Resting	Surface Active	Sink	Swim	Thrash	Unknown	Totals
***Geo Celtic* Full Array**	4	0	27	1	0	0	0	86	0	0	***118***
***Geo Celtic* Mitigation Airgun**	0	0	5	0	0	0	0	8	0	0	***13***
***Geo Celtic* Non-Seismic**	0	0	6	0	0	0	2	8	0	0	***16***
Geo Celtic Total	***4***	***0***	***38***	***1***	***0***	***0***	***2***	***102***	***0***	***0***	***147***
Monitoring Vessels ≥160	1	2	15	0	1	1	0	14	0	1	***35***
Monitoring Vessels 159-120	7	3	60	0	1	1	0	35	0	4	***111***
Monitoring Vessels <120	3	0	36	0	1	1	0	21	1	4	***67***
Monitoring Vessel Total	***11***	***5***	***111***	***0***	***3***	***3***	***0***	***70***	***1***	***9***	***213***

TABLE 5.11. Comparison of reaction of seals by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Reaction						
	Splash	Increase in Speed	Change in Direction	Look at Vessel	None	Unknown	Totals
***Geo Celtic* Full Array**	2	6	3	35	72	0	***118***
***Geo Celtic* Mitigation Airgun**	0	0	0	3	10	0	***13***
***Geo Celtic* Non-Seismic**	0	0	0	6	10	0	***16***
Geo Celtic Total	***2***	***6***	***3***	***44***	***92***	***0***	***147***
Monitoring Vessels ≥160	1	0	0	20	14	0	***35***
Monitoring Vessels 159-120	8	4	2	50	47	0	***111***
Monitoring Vessels <120	2	3	0	38	22	2	***67***
Monitoring Vessel Total	***11***	***7***	***2***	***108***	***83***	***2***	***213***

Pacific Walruses

Pacific Walrus Closest Point of Approach

The mean closest points of approach of Pacific walruses were calculated using only sightings that occurred during periods of effort that met the criteria for being able to detect Pacific walruses (See Chapter 4 and Appendix E). The mean CPA of Pacific walruses observed from the *Geo Celtic* was greatest during mitigation airgun activity. The overall mean CPA to the *Geo Celtic* was 1427 m (0.89 mi; Table 5.12). Mean CPA distances from the monitoring vessels were similar across all RSL bins with an overall mean CPA of 361 m (0.22 mi). Pacific walruses were observed as close as 230 m (0.14 mi) and as far as 3313 m (2.06 mi) from the *Geo Celtic* and from 10 m (11 yd) to 1217 m (0.76 mi) from the monitoring vessels (Table 5.12).

TABLE 5.12. Comparison of Pacific walrus CPA distances from MMO sightings by seismic status from the *Geo Celtic* and received sound levels from monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances from all three seismic activity or RSL bins.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (m)	s.d.	Range (m)	*n*
***Geo Celtic* Full Array**	1115	572	230-3313	***76***
***Geo Celtic* Mitigation Airgun**	2092	474	1508-3313	***36***
***Geo Celtic* Non-Seismic**	1377	464	648-1906	***6***
Geo Celtic Overall	***1427***	***697***	***230-3313***	***118***
Monitoring Vessels ≥160	361	157	50-500	***9***
Monitoring Vessels 159-120	357	277	10-1217	***88***
Monitoring Vessels <120	368	197	100-1000	***36***
Monitoring Vessel Overall	***361***	***250***	***10-1217***	***133***

[a] CPA=Closest Point of Approach. For Geo Celtic this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel

Pacific Walrus Movement

Movements neutral relative to the vessels were the most commonly recorded movements from both the *Geo Celtic* and the monitoring vessels during Statoil's seismic survey (Table 5.13). From the *Geo Celtic*, the second most observed Pacific walrus movement was swim away (27%) and from the monitoring vessels it was unknown (21%).

TABLE 5.13. Comparison of Pacific walrus movement relative to vessels by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Movement Relative to Vessel					
	Swim Towards	Swim Away	Neutral	None	Unknown	Totals
***Geo Celtic* Full Array**	10	30	47	0	8	***95***
***Geo Celtic* Mitigation Airgun**	10	7	15	0	7	***39***
***Geo Celtic* Non-Seismic**	0	4	9	0	3	***16***
Geo Celtic Total	***20***	***41***	***71***	***0***	***18***	***150***
Monitoring Vessels ≥160	2	1	7	1	3	***14***
Monitoring Vessels 159-120	15	25	49	14	23	***126***
Monitoring Vessels <120	3	6	25	7	15	***56***
Monitoring Vessel Total	***20***	***32***	***81***	***22***	***41***	***196***

Pacific Walrus Initial Behavior

Most of the initial walrus behaviors (64%) observed from the *Geo Celtic* and its monitoring vessels were of animals swimming (Table 5.14). From the *Geo Celtic*, 84% of walruses were initially observed swimming, while 15% were initially observed looking at the vessel. Besides swimming and looking, the monitoring vessels also recorded initial behaviors of traveling (9%), diving (2%), logging (2%), sinking (2%), and surface active (2%).

Pacific Walrus Reaction Behavior

Walruses observed from the *Geo Celtic* and its monitoring vessels were most often recorded has having no reaction (59%). The second-most observed reaction (27%) was of walruses looking at the vessel (Table 5.15).

TABLE 5.14. Comparison of Pacific walrus initial behavior by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Initial Behavior								
	Dive	Logging	Looking	Sink	Surface Active	Surface Active Travel	Swim	Unknown	Totals
***Geo Celtic* Full Array**	1	0	10	0	0	0	84	0	***95***
***Geo Celtic* Mitigation Airgun**	0	0	10	0	0	0	29	0	***39***
***Geo Celtic* Non-Seismic**	0	0	3	0	0	0	13	0	***16***
Geo Celtic Total	***1***	***0***	***23***	***0***	***0***	***0***	***126***	***0***	***150***
Monitoring Vessels ≥160	0	0	4	0	0	3	7	0	***14***
Monitoring Vessels 159-120	2	3	45	2	2	9	59	4	***126***
Monitoring Vessels <120	2	0	16	2	1	6	29	1	***56***
Monitoring Vessel Total	***4***	***3***	***65***	***4***	***3***	***18***	***94***	***5***	***196***

TABLE 5.15. Comparison of reaction of Pacific walrus by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Reaction						
	Splash	Increase in Speed	Interaction with Gear	Change in Direction	Look at Vessel	None	Totals
***Geo Celtic* Full Array**	1	2	3	7	26	56	***95***
***Geo Celtic* Mitigation Airgun**	0	0	0	4	4	31	***39***
***Geo Celtic* Non-Seismic**	0	2	0	0	3	11	***16***
Geo Celtic Total	***1***	***4***	***3***	***11***	***33***	***98***	***150***
Monitoring Vessels ≥160	0	0	0	0	6	8	***14***
Monitoring Vessels 159-120	3	7	0	11	39	66	***126***
Monitoring Vessels <120	2	3	0	5	14	32	***56***
Monitoring Vessel Total	***5***	***10***	***0***	***16***	***59***	***106***	***196***

Mitigation Measures Implemented

Safety and Disturbance Radii

Prior to completion of the sound source verification measurements, MMOs on the Statoil vessels used the modeled safety radii presented in Statoil's 2010 IHA application and outline in the IHA issued by NMFS (Appendix A) for mitigation purposes. Once Statoil's site specific sound source verification (SSV) was completed on 24Aug 2010), the results were reported (O'Neill and MacGillivray 2010) on 30 Aug 2010, the distances shown in Table 4.1 were implemented for mitigation purposes throughout the duration of the survey.

The pre-SSV ≥190 dB (rms) safety radii for seals were 700 m (766 yd) from the full airgun array and 75 m (82 yd) from the mitigation airgun. Safety radii for cetaceans (≥180 dB rms) were 2.5 km (1.6 mi) from the full airgun array and 220 m (241 yd) for the single mitigation airgun. The pre-SSV ≥160 dB (rms) disturbance for the full array was 13 km (8.1 mi) and from the mitigation airgun was 1.8 km (1.1 mi). The SSV results decreased the ≥190 dB safety radius around the full array to 430 m (470 yd) while the ≥190 dB safety radius around the mitigation airgun decreased to 13 m (14 yd). The ≥180 dB safety radius decreased to 1.6 km (0.99 mi) and 68 m (74 yd) around the full airgun array and mitigation airgun, respectively. The ≥160 dB (rms) disturbance radius increased to 16 km from the full airgun array but decreased to 1.5 km (0.9 mi) from the mitigation airgun as a result of the SSV measurements.

Mitigation Actions

A total of 39 power downs and 3 shut downs were requested during the Statoil seismic survey as a result of marine mammal sightings within or approaching the applicable safety radius. This included 1 power down for a cetacean sighting, 9 power downs for seals, and 29 power downs and 3 shut downs for walruses, of which one was a carcass.

The single power down for a cetacean was requested by the *Geo Celtic* on 25 Aug for a gray whale that was observed approaching the 180 dB (rms) safety radius (Table 5.16). The gray whale was initially detected by the monitoring vessel, *Tanux I*, who alerted the MMOs aboard the *Geo Celtic*. The whale was observed approaching the *Geo Celtic* at a distance of 2913 m (1.8 mi) and subsequently 2165 m (1.5 mi) from the MMOs. The CPA to the active airgun array was 2567 m (1.6 mi), so a power down to the mitigation airgun was requested prior to the whale entering the safety radius. The whale was not observed again, so confirmation that it had left the safety radius could not be made, and therefore a 30-min watch occurred prior to a power up of the full airgun array.

TABLE 5.16. The single power down for a cetacean during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (m)	CPA[c] to Airguns (m)
GEO201072	Gray whale	1	25-Aug	BL	NO	3352	2567

[a] Initial Behavior Code: BL = Blow

[b] Reaction Codes: No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

Nine power downs of the airgun array were requested by *Geo Celtic* MMOs due to seals sighted within or approaching the ≥190 dB (rms) safety radius of the active array during Statoil's seismic survey (Table 5.17). The first power down was implemented 23 Aug 2010 when a ringed seal was first observed within the 700 m (766 yd) pre-SSV safety radius. This seal was estimated to have a CPA of 611 m (668 yd) from the active array. When applying the updated safety radius based on the SSV measurements, it was unlikely that the animal was exposed to a sound level ≥190 dB (rms). This was also the case for three additional seal sightings that occurred within the pre-SSV safety radius. The power downs that were implemented after 30 Aug 2010 were due to sightings of seals approaching or already within the measured ≥190 dB (rms) safety radius of 430 m (170 yd. Each of the power downs occurred when the array was operating at full volume (3000 in^3). None of the seals that caused the power downs were seen within the 13 m (14 yd) safety radius of the mitigation airgun, so no shut downs were requested.

TABLE 5.17. The nine power down events for seals observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (m)	CPA[c] to Airguns (m)
GEO201066	Ringed seal	1	23-Aug	SW	LO	611	611
GEO201069	Ringed seal	1	25-Aug	SW	IS	926	926
GEO201078	Ringed seal	1	25-Aug	SW	IS	501	501
GEO201082	Unidentified seal	1	25-Aug	SW	LO	501	501
GEO201089	Unidentified seal	1	28-Aug	SW	NO	784	784
GEO2010176	Ringed seal	1	29-Aug	SW	IS	648	648
GEO2010237	Bearded seal	1	31-Aug	SW	NO	510	510
GEO2010308	Bearded seal	1	12-Sep	DI	NO	488	454
GEO2010319	Bearded seal	1	17-Sep	SW	LO	430	430

[a] Initial Behavior Code: BL = Blow ; DI = Dive; LO = Look; SW = Swim

[b] Reaction Codes: CD = Change in Direction; IS = Increase in Speed; LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

Twenty-nine power downs were requested and implemented for Pacific walruses observed within or about to enter the ≥180 dB (rms) safety radius around the full 3000 in^3 airgun array (Table 5.18). Ten power downs occurred during the 4-day period, 28–31 Aug, when walrus sightings were most numerous. Similar to seals, the power downs requested after release of the SSV results on 30 Aug were due to sightings of Pacific walruses approaching or within the revised and reduced ≥180 dB (rms) safety radius of 1.6 km (0.99 mi).

In addition to the power downs, three complete shut downs were implemented during the seismic survey (Table 5.19). All three shut downs occurred before the SSV measurement results were available. The first shut down occurred on 21 Aug for a Pacific walrus carcass. Once it was determined by MMOs aboard the *Geo Celtic* that the death had not occurred as a result of the seismic activities (i.e. the carcass appeared >3 days old which was the length of time that seismic activity had thus far been occurring), permission was granted to resume the seismic survey. The second shut down was for a small group of Pacific walruses, including a calf, which progressed in a straight line parallel to the vessel towards the airgun array, which was already powered down to the mitigation gun as a result of a previous sighting.

The mitigation airgun was shut down prior to the animals entering the safety radius of 220 m (241 yd). The final shut down event occurred on 28 Aug, the first day of noticeably increased walrus sightings. The walrus was observed approaching the ≥180 dB (rms) radius of the mitigation airgun, so a shut down of the airgun was implemented.

TABLE 5.18. The 29 power downs for Pacific walruses observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (m)	CPA[c] to Airguns (m)
GEO201065	Pacific walrus	4	22-Aug	SW	LO	2342	2342
GEO201079	Pacific walrus	1	25-Aug	SW	LO	891	891
GEO201085	Pacific walrus	1	26-Aug	SW	NO	825	825
GEO201087	Pacific walrus	1	26-Aug	SW	LO	542	542
GEO201092	Pacific walrus	1	28-Aug	SW	NO	2129	2129
GEO201099	Pacific walrus	2	28-Aug	SW	NO	1842	1842
GEO2010119	Pacific walrus	3	29-Aug	SW	NO	543	543
GEO2010121	Pacific walrus	1	29-Aug	SW	CD	926	926
GEO2010123	Pacific walrus	2	29-Aug	SW	NO	904	904
GEO2010175	Pacific walrus	2	29-Aug	SW	NO	1708	1708
GEO2010179	Pacific walrus	5	30-Aug	SW	NO	2178	2178
GEO2010194	Pacific walrus	1	30-Aug	SW	LO	747	747
GEO2010223	Pacific walrus	3	30-Aug	SW	LO	2567	2567
GEO2010243	Pacific walrus	1	31-Aug	SW	NO	681	681
GEO2010246	Pacific walrus	2	1-Sep	LO	NO	3400	1410
GEO2010251	Pacific walrus	2	6-Sep	LO	LO	1117	1117
GEO2010252	Pacific walrus	1	6-Sep	SW	LO	603	603
GEO2010267	Pacific walrus	1	8-Sep	SW	LO	1889	1889
GEO2010270	Pacific walrus	2	9-Sep	SW	LO	497	497
GEO2010278	Pacific walrus	5	9-Sep	SW	LO	880	880
GEO2010285	Pacific walrus	2	9-Sep	SW	CD	698	698
GEO2010298	Pacific walrus	1	10-Sep	LO	LO	825	825
GEO2010299	Pacific walrus	1	10-Sep	SW	CD	1410	1410
GEO2010301	Pacific walrus	5	10-Sep	SW	NO	1213	1213
GEO2010305	Pacific walrus	2	11-Sep	SW	NO	542	542
GEO2010307	Pacific walrus	1	11-Sep	SW	LO	579	579
GEO2010311	Pacific walrus	2	14-Sep	LO	LO	1115	747
GEO2010315	Pacific walrus	3	16-Sep	DI	LO	656	656
GEO2010339	Pacific walrus	1	30-Sep	LO	NO	1708	1708

[a]Initial Behavior Code: BL = Blow ; DI = Dive; LO = Look; SW = Sw im

[b] Reaction Codes: CD = Change in Direction; IS = Increase in Speed; LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

TABLE 5.19. The three shut down events for Pacific walruses observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Individuals	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (m)	CPA[c] to Airguns (m)
*GEO2010999	Pacific walrus	1	21-Aug	DE	--	--	--
GEO201080	Pacific walrus	3	25-Aug	SW	LO	2567	230
GEO2010101	Pacific walrus	1	28-Aug	SW	NO	739	739

[a]Initial Behavior Code: DE = Dead; SW = Swim

[b] Reaction Codes: LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

*Sighting was a carcass.

MMOs aboard the two monitoring vessels, *Noreseman I* and *Tanux I*, actively assisted with monitoring the ≥180 dB (rms) safety radius and the larger≥160 dB (rms) safety radius. The IHA issued by NMFS to Statoil required that the full array be powered down if a group of 12 or more non-migratory mysticete whales were observed within the ≥160 dB radius. No aggregations of 12 or more non-migratory mysticete whales were observed by the MMOs during Statoil's seismic survey.

Estimated Number of Marine Mammals Present and Potentially Affected

It was difficult to obtain meaningful estimates of "take by harassment" for several reasons: ***(1)*** the relationship between numbers of marine mammals that are observed and the number actually present is uncertain. ***(2)*** the most appropriate criteria for take by harassment are uncertain and presumed to vary among different species, individuals within species, and situations. ***(3)*** the distance to which a received sound level (RSL) reaches a specific criterion such as 190 dB, 180 dB, or 160 dB re 1 µPa (rms) is variable. The RSL depends on water depth, sound source depth, water-mass and bottom conditions, and - for directional sources - aspect (Chapter 3; see also Greene 1997, Greene et al. 1998; Burgess and Greene 1999; Caldwell and Dragoset 2000; Tolstoy et al. 2004a,b). ***(4)*** 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 even further reduced for animals that are on ice.

Two methods were used 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. The procedures included ***(A)*** minimum estimates based on the direct observations of marine mammals by MMOs, and ***(B)*** estimates based on pinniped (seal and Pacific walrus) and cetacean densities obtained during this study. 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. Further details about the methods and limitations of these estimates are provided below.

Disturbance and Safety Criteria

Table 4.1 summarizes estimated RSLs at various distances from the *Geo Celtic's* 26-airgun array. The NMFS required that distances to RSLs of 180 dB and 190 dB (rms) be used to implement mitigation measures for cetaceans and seals respectively. The USFWS required that distances to RSLs of 180 dB and

190 dB (rms) be used to implement mitigation measures for Pacific walruses and polar bears, respectively. Both agencies assume that disturbance to marine mammals may occur at RSLs ≥160 dB (rms).

Estimates from Direct Observations

All sightings data were included in the following exposure estimates based on direct observations, regardless of whether they met the data-analysis criteria described in Chapter 4. The number of animals actually sighted by observers within the various sound level distances during seismic activity provides a minimum estimate of the number potentially affected by seismic sounds. Some animals probably moved away before coming within visual range of MMOs, and it was unlikely that MMOs were able to detect all of the marine mammals near the vessel trackline. During daylight, animals are missed if they are below the surface when the ship is nearby. Other animals, even if they surface near the vessel, are missed because of limited visibility (e.g. fog), glare, or other factors limiting sightability. Also, RSLs of ≥160 dB (rms) were estimated to occur out to 16 km (9.9 mi) by the SSV measurements of the full airgun array. This distance was well beyond that at which MMOs aboard the source vessel could detect even the more conspicuous animals under favorable sighting conditions, and this was the rationale for using monitoring vessels to survey the ≥160 dB (rms) safety radius. Furthermore, marine mammals could not be seen effectively during periods of darkness, which increased as the survey progressed. Nighttime observations were not required except prior to and during nighttime power ups and if a power down had been implemented during daytime, however MMOs aboard the *Geo Celtic* stayed on watch throughout the night to monitor survey operations.

Animals may also have avoided the area near the *Geo Celtic* while the airguns were firing (see Richardson et al. 1995, 1999; Stone 2003; Gordon et al. 2004; Smultea et al. 2004). Within the assumed ≥160–170 dB (rms) radii around the source, and perhaps farther away in the case of the more sensitive species and individuals, the distribution and behavior of pinnipeds and cetaceans may have been altered as a result of the seismic survey. Changes in distribution and behavior could result from reactions to the airguns, or to the *Geo Celtic* and monitoring vessels themselves. The extent to which the distribution and behavior of pinnipeds might be affected by the airguns is uncertain, given variable previous results (Harris et al. 2001; Moulton and Lawson 2002; Miller et al. 2005). It was not possible to determine if cetaceans exhibited avoidance behavior beyond the distance at which they were detectable by MMOs.

Cetaceans Potentially Exposed to Received Sound Level ≥180 dB re 1 µPa (rms)

Eight cetacean sightings were recorded from the *Geo Celtic* while airguns were operating. None of these sightings occurred within the ≥180 dB (rms) safety radius (Table 5.20). However, one cetacean was observed approaching the ≥180 dB (rms) radius of the full airgun array and therefore a power down was implemented (Table 5.16; see previous section *Mitigation Measures Implemented*). MMOs aboard the monitoring vessels did not record any cetaceans while airguns were operating that were within the ≥180 dB radius of the airguns.

Seals Potentially Exposed to Received Sound Level ≥190 dB re 1 µPa (rms)

From the *Geo Celtic*, 146 seals were observed while airguns were operating. There were ten seals observed in areas where RSLs were likely ≥190 dB (rms; Table 5.20). A power down of the airguns was initiated for nine of these ten sightings (Table 5.17). A power down was not requested in one case because the sighting occurred outside of the safety radius in effect at that time (pre-SSV radius). However, based on the final analysis of the SSV measurements it was subsequently calculated to have been within the ≥190 dB (rms) radius (Table 4.1). MMOs aboard the monitoring vessels observed 154 seals while airguns were active (or while the vessel was beyond the 120 dB radius), none of which were within the ≥190 dB (rms) radius.

Pacific Walruses Potentially Exposed to Received Sound Level ≥180 dB re 1 µPa (rms)

From the *Geo Celtic*, 307 Pacific walruses were observed while airguns were operating. Based on the final SSV measurement results, 40 walruses (in 21 separate sightings) were likely exposed to RSLs ≥180 dB (rms; Table 5.20). Twenty-nine power downs and three shut downs resulted from these sightings. Because of the reduction in the size of the ≥180 dB (rms) safety radius based on the SSV results, the number of power downs and shut downs for walruses exceeded the number of animals that were observed in locations where RSLs were likely ≥180 dB (rms). MMOs aboard the monitoring vessels observed 408 Pacific walruses while airguns were active (or while the vessel was beyond the 120 dB radius), none of which were within the ≥180 dB (rms) safety radius.

TABLE 5.20. Number of individual marine mammals observed within specific safety radii and potentially exposed to the respective sound levels during Statoil's seismic survey, 11 Aug – 4 October 2010.

Number of Individuals and Exposure Level in dB re 1 µPa (rms)		
Cetaceans ≥ 180	**Seals ≥ 190**	**Pacific Walruses ≥ 180**
0	10	40

Estimates Extrapolated from Density

The number of marine mammals visually detected by MMOs likely underestimated the actual numbers that were present for reasons described above. To correct for animals that may have been present but not detected by observers, the sightings recorded during seismic and non-seismic periods along with detectability corrections $f(0)$ and $g(0)$ were used to calculate separate densities of marine mammals present in the project area. The estimated densities of marine mammals were then multiplied by the area of water ensonified (exposed to seismic sounds) to estimate the number of individual marine mammals exposed to received sound levels (RSL) ≥160, 170, 180, and 190 dB (rms). The average number of exposures per individual marine mammal was calculated using the overlap in ensonified areas around nearby seismic lines based on the fact that an animal remaining in the area would have been exposed repeatedly to the passing seismic source.

Marine mammal densities were based on data collected from the *Geo Celtic* and its monitoring vessels (*Tanux I, Norseman I*) during Statoil's seismic operations in the Chukchi Sea. The density estimates for the Statoil survey, including corrections for sightability biases, are summarized in Table 5.21. The ensonified areas are shown in Table 5.22. The methodology used to estimate the areas exposed to RSLs ≥160, 170, 180 and 190 dB (rms) was described in Chapter 4 and in more detail in Appendix E.

The following estimates based on density calculations assume that all mammals present were well below the surface where they were exposed to RSLs at various distances as predicted in Chapter 3 and summarized in Table 4.1. Some pinnipeds and cetaceans in the water might remain close to the surface, where sound levels would be reduced by pressure-release effects (Greene and Richardson 1988). Also, some pinnipeds and cetaceans may have moved away from the path of the *Geo Celtic* before it arrived, either because the monitoring vessels frequently traveled in front of the *Geo Celtic*, or because of an avoidance response to the approaching source vessel and its airguns. In the case of cetaceans, the

estimated number of exposures based on non-seismic densities (Table 5.23) represents the number of animals that would have been exposed had they not shown any localized avoidance of the airguns or the ships themselves. The lower densities of cetaceans observed during seismic periods suggests that some such avoidance did occur. Therefore, the estimate based on non-seismic densities likely overestimates the actual number of animals exposed. The estimates based on densities observed during seismic periods are likely closer to the true numbers of animals exposed. In the cases of seals and walruses, the seismic period densities were higher than the non-seismic densities, which suggests that these species did not show localized avoidance of the seismic survey. For these species, the exposure estimates based on the higher seismic survey densities are considered the maximum number of individuals likely exposed.

TABLE 5.21. Densities of marine mammals in the Alaskan Chukchi Sea observed during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010. Densities are corrected for *f*(0) and *g*(0) biases (see Appendix E).

	No. individuals / 1000 km^2			
	Seismic (≥160 dB rms)		**Non-seismic (<120 dB rms)**	
Species	**Density**	**CIs**	**Density**	**CIs**
Cetaceans				
Bowhead whale	0.000	(0.055-3.055)	0.409	-
Gray whale	0.316	(0.108-3.468)	0.613	(0.058-1.735)
Minke whale	0.000	(0.065-0.947)	0.247	-
Unidentified mysticete whale	1.322	(0.328-3.871)	1.126	(0.427-4.093)
Unidentified whale	0.000	(0.024-1.589)	0.195	-
Total Cetacean Density	**1.638**	**(0.601-4.463)**	**2.591**	**(1.076-6.237)**
Seals				
Ringed Seal	22.740	(10.587-48.841)	7.754	(1.958-30.711)
Spotted seal	0.000	-	3.322	(0.692-15.939)
Bearded Seal	79.164	(42.891-146.114)	40.980	(16.888-99.438)
Unidentified Seal	94.278	(41.868-212.295)	56.487	(16.412-194.418)
Unidentified Pinniped	5.918	(2.538-13.796)	3.265	(1.259-8.467)
Total Seal Density	**202.099**	**(126.535-322.79)**	**111.806**	**(52.634-237.501)**
Pacific walrus	**73.553**	**(28.702-188.486)**	**55.270**	**(17.593-173.637)**

TABLE 5.22. Estimated areas (km^2) ensonified to various sound levels during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010.

	Level of ensonification in dB re1µPa (rms)				
Area (km^2)	**120**	**160**	**170**	**180**	**190**
Including Overlap Area	8,992,477	221,137	64,761	18,642	5771
Excluding Overlap Area	108,491	10,786	6136	4038	3227

Cetaceans

Table 5.23 summarizes the estimated numbers of cetaceans that may have been exposed to seismic sounds at various received levels based on the density estimates in Table 5.21, and the ensonified areas in Table 5.22. Higher sighting rates during non-seismic periods from both the *Geo Celtic* and its monitoring vessels (Fig. 5.7) suggest that some cetaceans may have moved away from the seismic source before being exposed to strong sounds.

(A) ≥160 dB (rms): We estimate that 28 individual cetaceans would each have been exposed ~21 times to airgun pulses with RSLs ≥160 dB (rms) during the survey if all cetaceans showed no avoidance of active airguns or vessels (Table 5.23). Based on the proportion of identified cetacean species, approximately 14 of the cetaceans exposed to RSLs ≥160 dB (rms) would have been bowhead whales, eight would have been gray whales, and six would have been minke whales.

(B) ≥180 dB (rms): If there was no avoidance of airgun sounds by cetaceans, we estimate that there may have been ~10 individual cetaceans exposed ~five times each to RSLs ≥180 dB (rms; Table 5.23). However, most of these cetaceans probably moved away before being exposed to RSLs ≥180 dB (rms).

TABLE 5.23. Estimated numbers of individual cetaceans exposed to received sound levels ≥160, 170, 180, and 190 dB (rms) and average number of exposures per individual during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010.

	Seismic Densities (≥160 dB rms)		Non-seismic Densities (<120 dB rms)	
Exposure level in dB re 1µPa (rms)	Individuals	Exposures per Individual	Individuals	Exposures per Individual
≥160	18	21	28	21
≥170	10	11	16	11
≥180	7	5	10	5
≥190	5	2	8	2

Seals

Table 5.24 summarizes the estimated numbers of seals potentially exposed to various RSLs during the survey. Exposure estimates were based on seal densities calculated from data collected in locations where RSLs were ≥160 dB (i.e. seismic densities) presented in Table 5.24 and the ensonified areas presented in Table 5.22. Avoidance of seismic surveys may not always occur or be detected, however, localized avoidance of seismic operations by seals has been observed in some cases (Reiser 2009).

(A) ≥160 dB (rms): We estimated that ~2180 individual seals may have been exposed ~21 times each to airgun pulses with RSLs ≥160 dB (rms) during the survey, assuming no avoidance of the ≥160 dB (rms) radius (Table 5.24). Based on the proportion of identified seal species, approximately 416 of the animals would have been ringed seals, 83 would have been spotted seals, and 1681 would have been bearded seals.

(B) ≥190 dB (rms): Based on densities calculated from data where RSLs were ≥160 dB (rms), we estimated that there may have been 652 individual seals exposed approximately two times each to RSLs ≥190 dB (rms) if there was no avoidance of the sound source (Table 5.24). This estimate is higher than the number of seals exposed to RSLs ≥190 rms based on direct observations (Table 5.20). Some pinnipeds

within the ≥190 dB (rms) radius presumably were missed during times when MMOs were on watch as well as at night or in poor visibility conditions when MMOs ability to detected marine mammals was limited. Because of this, density-based estimates of individuals exposed are higher than those based on direct observation. The monitoring vessels might be expected to displace some pinnipeds from the trackline before the *Geo Celtic* arrived, and some additional pinnipeds likely swam away in response to the approaching source vessel to avoid exposure to seismic sound. Therefore, the actual number exposed to RSL ≥190 dB (rms) was probably lower than the estimate calculated based on density estimates, but greater than that from direct observations.

TABLE 5.24. Estimated numbers of individual seals exposed to received sound level ≥160, 170, 180, and 190 dB (rms) and average number of exposures per individual during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010.

	Seismic Densities (≥160 dB rms)		**Non-seismic Densities (<120 dB rms)**	
Exposure level in dB re 1µPa (rms)	**Individuals**	**Exposures per Individual**	**Individuals**	**Exposures per Individual**
≥160	2180	21	1206	21
≥170	1240	11	686	11
≥180	816	5	451	5
≥190	652	2	361	2

Pacific walruses

Table 5.25 summarizes the estimated number of Pacific walruses potentially exposed to various RSLs during the survey. Exposure estimates were based on Pacific walrus densities calculated from data collected in locations where RSLs were ≥160 dB (rms; i.e. seismic densities) presented in Table 5.21 and the ensonified areas presented in Table 5.22. Pacific walrus densities in locations where RSLs were ≥160 dB (rms) were higher than those observed in locations where RSLs were ≤120 dB (rms). The density estimate for locations where RSLs were ≥160 dB (rms) may have been biased upward because of the pulse of sightings observed between 28–31 Aug while airguns were active (Fig. 5.12). A similar pulse of walrus sightings did not occur during non-seismic activities

(A) ≥160 dB (rms): We estimated that 793 individual walruses may have been exposed ~21 times each to airgun pulses with RSLs ≥160 dB (rms) during the survey, assuming no avoidance of the ≥160 dB (rms) radius (Table 5.25).

(B) ≥190 dB (rms): Based on densities calculated from data collected in locations where RSLs were ≥160 dB (rms), we estimated that there may have been 237 individual walruses exposed approximately two times each to RSLs ≥190 dB (rms) if there were no avoidance of the sound source (Table 5.25).

TABLE 5.25. Estimated numbers of individual Pacific walruses exposed to received sound level ≥160, 170, 180, and 190 dB (rms) and average number of exposures per individual during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010.

	Seismic Densities (≥160 dB rms)		Non-seismic Densities (<120 dB rms)	
Exposure level in dB re 1µPa (rms)	Individuals	Exposures per Individual	Individuals	Exposures per Individual
≥160	793	21	596	21
≥170	451	11	339	11
≥180	297	5	223	5
≥190	237	2	178	2

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APPENDIX A: NATIONAL MARINE FISHERIES SERVICE IHA

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

AUG 0 6 2010

Karin Berentsen
Alaska HSE and Stakeholder Advisor
Global Exploration North America E&P
2700 Gambell Street, Suite 200
Anchorage, Alaska 99503

Dear Ms. Berentsen:

Enclosed is an Incidental Harassment Authorization (IHA) issued to Statoil USA E&P Inc. under the authority of 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, small numbers of beluga whales (*Delphinapterus leucas*); harbor porpoises (*Phocoena phocoena*); killer whales (*Orcinus orca*); bowhead whales (*Balaena mysticetus*); gray whales (*Eschrichtius robustus*); humpback whales (*Megaptera novaeangliae*); fin whales (*Balaenoptera physalus*); minke whales (*B. acuturostrata*); bearded seals (*Erignathus barbatus*); spotted seals (*Phoca largha*); ringed seals (*P. hispida*); and ribbon seals (*P. fasciata*) incidental to Statoil's marine survey program in the Chukchi Sea during the 2010 open water season. The IHA is valid from August 6, 2010 through November 30, 2010.

You are required to comply with the conditions contained in the IHA. In addition, you must cooperate with any Federal, state or local agency authorized to monitor the impacts of your activities. If you have any questions concerning the IHA or its requirements, please contact Shane Guan, Office of Protected Resources, NMFS, at (301) 713-2289.

Sincerely,

James H. Lecky, Director
Office of Protected Resources

Enclosure

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

Incidental Harassment Authorization

Statoil USA E&P Inc. (Statoil), 2700 Gambell Street, Suite 200, Anchorage, Alaska 99503, 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 an open water marine seismic survey program in the Chukchi Seas in Arctic Ocean waters under the jurisdiction of the United States, contingent upon the following conditions:

1. This Authorization is valid from August 6, 2010, through November 30, 2010.

2. This Authorization is valid only for activities associated with marine 3D and 2D seismic surveys in the Chukchi Sea. The specific areas where Statoil's marine seismic surveys will be conducted are within the Statoil lease holdings in the Outer Continental Shelf (OCS) Lease Sale 193 area in the northern Chukchi Sea.

3. (a) The species authorized for incidental harassment takings are: beluga whales (*Delphinapterus leucas*); harbor porpoises (*Phocoena phocoena*); killer whales (*Orcinus orca*); bowhead whales (*Balaena mysticetus*); gray whales (*Eschrichtius robustus*); humpback whales (*Megaptera novaeangliae*); fin whales (*Balaenoptera physalus*); minke whales (*B. acutorostrata*); bearded seals (*Erignathus barbatus*); spotted seals (*Phoca largha*); ringed seals (*P. hispida*); and ribbon seals (*P. fasciata*).

(b) The authorization for taking by harassment is limited to vessel noise and to the following acoustic sources (or sources with comparable frequency and intensity) without an amendment to this Authorization:

(i) Airgun array that is composed of three strings for a total of 26 active G-guns (4×60 in^3, 8×70 in^3, 6×100 in^3, 4×150 in^3, and 4×250 in^3) with a total discharge volume of 3000 in^3; and

(ii) A small 60 in^3 airgun as a mitigation gun;

(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 (301-713-2289 ext. 137).

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).

5. Prohibitions

(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above. The taking by Level A harassment, injury or death of these species or the taking by 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 source vessel marine mammal observers (MMOs), required by condition 7(a)(i), are not onboard in conformance with condition 7(a)(i) of this Authorization or the passive acoustic monitoring program described in condition 8 is not fully implemented.

6. Mitigation

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

(i) Avoid concentrations or groups of whales by all vessels under the direction of Statoil. Operators of support vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

(ii) Reduce vessel speed to below 10 knots when within 300 yards (274 m) of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.

(iii) Avoid multiple changes in direction and speed when within 300 yards (274 m) 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) When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.

(vi) Fully implement the following measures, consistent with the 2010 Plan of Cooperation (POC), in order to avoid having an unmitigable adverse impact on the availability of marine mammal species or stocks for taking for subsistence uses:

(A) For the purposes of reducing or eliminating conflicts between subsistence whaling activities and Statoil's survey program, the holder of this Authorization will participate with other operators in the Communication and Call Centers (Com-Center) Program. The Com-Centers will be operated 24 hours/day during the 2010 fall subsistence bowhead whale hunt.

(B) Statoil shall routinely call the communication center according to the established protocol while in the Chukchi Sea.

(C) Upon notification by a Com-Center operator of an at-sea emergency, the holder of this Authorization shall provide such assistance as necessary to prevent the loss of life, if conditions allow the holder of this Authorization to safely do so.

(D) Upon request for emergency assistance made by a subsistence whale hunting organization, or by a member of such an organization, in order to prevent the loss of a whale, the holder of this Authorization shall assist towing of a whale taken in a traditional subsistence whale hunt, if conditions allow the holder of this Authorization to safely do so.

(E) Post-season Review: Following completion of the 2010 Chukchi Sea open water marine seismic survey program, Statoil shall conduct a co-management meeting with the commissioners and committee heads of the Alaska Eskimo Whaling Commission, Eskimo Walrus Commission, Alaska Beluga Whale Committee, Alaska Ice Seal Committee, and the Alaska Nanuuq Commission to discuss results of mitigation measures and outcomes of the preceding season. The goal of the post-season meeting is to build upon the knowledge base, discuss successful or unsuccessful outcomes of mitigation measures, and possibly refine plans or mitigation measures if necessary.

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

(i) 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 or de-energize the airgun array, as described in condition 6(b)(iii)(A) below.

(ii) Exclusion and Monitoring-Safety Zones:

(A) Establish and monitor with trained MMOs a preliminary exclusion zone for cetaceans surrounding the airgun array on the source vessel 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 2,500 m (1.55 mi) from the seismic source.

(B) Establish and monitor with trained MMOs a preliminary exclusion zone for pinnipeds surrounding the airgun array on the source vessel 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 700 m (0.44 mi) from the seismic source.

(C) A 160-dB vessel monitoring zone for bowhead and gray whales will be established and monitored during all seismic surveys. Whenever an aggregation of 12 or more bowhead whales or gray whales that appear to be engaged in a non-migratory, significant biological behavior (e.g., feeding, socializing) are observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity, the seismic operation will not commence or will shut down. For purposes of the field verification test described in condition 7(b), this radius is estimated to be 13,000 m (8.1 mi) from the seismic source.

(D) Immediately upon completion of data analysis of the field verification measurements required under condition 7(c) below, establish and monitor the new 160-dB, 180-dB, and 190-dB marine mammal exclusion zones.

(iii) Power-down/Shutdown:

(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)(ii) 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 shutdown 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 conditions

6(b)(ii)(A) through (C) 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 MMOs on duty are confident that no marine mammals remain within the appropriate safety zone.

(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 and notify the Marine Mammal Stranding Network within 24 hours of the sighting (telephone: 1-800-853-1964).

(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 source 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)(iv) below) upon completion of a written certification by the MMO. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). 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 is 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)(iv) below) upon completion of a written certification by the MMO. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). 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 is provided to the NMFS staff person.

(III). In the event the animal has not been dead for a period greater than 72 hours or the cause of the injury or death cannot be immediately determined by the lead MMO, the holder of this Authorization shall immediately report the incident to either the NMFS staff person designated by the Director, Office of Protected Resources (Shane Guan, Office of Protected Resources, NMFS, 301-713-2289 ext. 137 or Shane.Guan@noaa.gov) or to the staff person designated by the Alaska Regional Administrator (Brad Smith, Alaska Regional Office, NMFS, 907-271-3023 or Brad.Smith@noaa.gov). The lead MMO must complete written certification and provide it to the NMFS staff person. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). The airgun array may be restarted (by conducting the necessary ramp-up procedures described in condition 6(b)(iv) below) upon completion of the written certification.

(IV). In the event that the marine mammal death or injury was directly caused by the seismic airgun operations (e.g., struck by a vessel, entangled in gear), the holder of this Authorization shall immediately report the incident to the designated NMFS staff person (see III above) by telephone or email and the Marine Mammal Stranding Network of the event and ensure that written certification is provided to the NMFS staff person. The certification must include the following: species or description of the animal(s); the condition of the animal(s) (including carcass condition if the animal is dead); location and time of first discovery; observed behaviors (if alive); and photographs or video (if available). The airguns may not be restarted until NMFS has had an opportunity to review the written certification and any accompanying documentation, make determinations as to whether modifications to the activities are appropriate and necessary, and has notified the holder that activities may be resumed. Approval to resume operations may be provided via letter, email, or telephone.

(iv). Ramp-up:

(A) Conduct a 30-minute period of marine mammal observations by at least two trained MMOs prior to commencing ramp-up described in condition 6(b)(iv)(C): (I) at the commencement of seismic operations and (II) 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 at night unless the seismic source has maintained a sound source pressure level at the source of at least 180 dB re 1 μPa rms during the interruption of seismic survey operations. If a sound source of at least 180 dB re 1 μPa rms has been maintained during the interruption of seismic operations, then the 30 minute pre-ramp-up visual survey is waived; and

(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(iv)(A) and (B): (I) at the commencement of seismic operations and (II) 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 (MMOs) to be onboard the source vessel, who are approved in advance by NMFS, 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.

(A) MMO teams shall consist of Inupiat observers and experienced field biologists. An experienced field crew leader will supervise the MMO team onboard the survey vessel. New observers shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

(B) Crew leaders shall be individuals with experience as observers during one or more of the 1996 - 2009 seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

(C) If there are Alaska Native MMOs, the MMO training that is conducted prior to the start of the survey activities shall be conducted with both Alaska Native MMOs and biologist MMOs being trained at the same time in the same room. There shall not be separate training courses for the different MMOs.

(E) Observers shall understand the importance of classifying marine mammals as "unknown" or "unidentified" if they cannot identify the animals to species with confidence. In those cases, they shall note any information that might aid in the identification of the marine mammal sighted.

(ii) To the extent possible, MMOs should be on duty for four (4) consecutive hours or less, although more than one four-hour shift per day is acceptable. MMOs will not work more than three (3) shifts in a 24-hour period (i.e., 12 hours total per day). During seismic operations when there is 24 hrs of daylight, five MMOs will be based aboard the seismic source vessel and at least three MMOs on the chase/monitoring vessels.

(iii) Monitoring is to be conducted by the MMOs described in condition 7(a)(i) above, onboard the active seismic vessel, to (A) ensure that no marine mammals enter the appropriate safety zone whenever the seismic acoustic sources are 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 acoustic source 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 MMO(s) on-watch. If a marine mammal is within or closely approaching its designated exclusion (safety) zone, the seismic acoustic sources must be immediately powered down or shutdown (in accordance with condition 6(b)(iii)(A) above).

(v) 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.

(vi) Monitoring shall 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); (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 (I) any time a marine mammal is sighted, (II) at the start and end of each watch, and (III) 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) MMOs shall watch for marine mammals from the best available vantage point on the survey vessel, typically the bridge. MMOs shall scan systematically with the unaided eye and 7 x 50 reticle binoculars, supplemented with 20 x 60 image-stabilized Zeiss Binoculars or Fujinon 25 x 150 "Big-eye" binoculars and night-vision equipment ("Generation 3") when needed. With two or three observers on watch, the use of big eyes should be paired with searching by naked eye, the latter allowing visual coverage of nearby areas to detect marine mammals.

(viii) MMOs shall attempt to maximize the time spent looking at the water and guarding the safety radii. They shall avoid the tendency to spend too much time evaluating animal behavior or entering data on forms, both of which detract from their primary purpose of monitoring the safety zone.

(ix) MMOs shall use the best possible positions for observing (e.g., outside and as high on the vessel as possible), taking into account weather and other working conditions. MMOs shall carefully document visibility during observation periods so that total estimates of take can be corrected accordingly.

(b) Field Source Verification: Using a hydrophone system, the holder of this Authorization is required to conduct sound source verification tests for all seismic sources and source vessels not previously measured and, at a minimum, report the following results within 5 days of completing the test:

(i) Statoil shall conduct empirical measurements of the distances in the broadside and endfire directions at which broadband received levels reach

190, 180, 170, 160, and 120 dB re 1 μPa (rms) for the energy source array combinations that may be used during the survey activities. The configurations shall include at least the full array and the operation of a single source that will be used during power downs.

8. Research: The holder of the Authorization, in cooperation with other oil company participants, must conduct all monitoring described in the "*Marine Mammal Monitoring and Mitigation Plan for the Marine Seismic Surveys of Selected Lease Areas in the Alaskan Chukchi Sea in 2010.*" Research will include establishment of: (i) an acoustic program to measure sounds produced by the source vessel (required under condition 7(b) above); and (ii) deployment of arrays of acoustic recorders to localize bowhead whale and other marine mammal vocalization and to further understand, define, and document sound characteristics and propagation resulting from seismic surveys that may have the potential to cause deflections of bowhead whales from their migratory pathway.

9. Reporting:

(a) Sound Source Verification and the distances to the various isopleths and power density spectra of high frequency active acoustic sources are to be reported to NMFS within five (5) days of completing the measurements. In addition to reporting the radii of specific regulatory concern, distances to other sound isopleths down to 120 dB rms (if measurable) will be reported in increments of 10 dB.

(b) Seismic Vessel Monitoring Program: A draft report will be submitted to the Director, Office of Protected Resources, NMFS, within 90 days after the end of Statoil's 2010 open water marine seismic survey program in the Chukchi Seas. 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 2010 shipboard and aerial marine mammal monitoring; (v) a summary of the dates and locations of seismic operations, including summaries of power-downs, shutdowns, 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) an analysis of factors influencing detectability of marine mammals; (x) all spatial data on charts (including vessel location); (xi) summaries on communications with hunters and potential effects on subsistence uses; and (xii) make all data available in the report or electronically for integration with data from other companies.

(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 and vessel-based monitoring programs will be prepared and submitted within 240 days of the date of this Authorization. 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 2010.

(e) The draft comprehensive report will be subject to review and comment by NMFS, the AEWC, and the North Slope Borough Department of Wildlife Management. The draft comprehensive report will be accepted by NMFS as the final comprehensive report upon incorporation of comments and recommendations.

(f) Statoil shall accommodate specific requests for raw data, including tracks of all vessels and aircraft associated with the operation and activity logs documenting when and what types of sounds are introduced into the environment by the operation.

10. 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.

11. The Plan of Cooperation 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.

12. 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.

13. 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.

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

AUG 0 6 2010

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

Date

APPENDIX B: U.S. FISH AND WILDLIFE SERVICE LOA

United States Department of the Interior

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

AFES/MMM

JUL 15 2010

Mr. Martin Cohen
Statoil USA E&P Inc.
2103 CityWest Blvd., Suite 800
Houston, Texas 77042

Mr. Cohen:

This responds to your December 18, 2009, request for a Letter of Authorization (LOA) for the incidental take of polar bears and Pacific walrus in regards to the Statoil USA E&P Inc. (Statoil) 2010 3D Seismic Acquisition project in the Chukchi Sea.

Enclosed is a LOA (10-03-CS) that will allow Statoil to take small numbers of polar bears and Pacific walruses incidental to oil and gas industry activities at the locations identified in your LOA request. The proposed start date for this project is July 15, 2010, with operations completed by November 30, 2010. All provisions contained within Statoil's "Polar Bear and Pacific Walrus Monitoring, Mitigation, and Reporting Plan Statoil 2010 3D Seismic Acquisition Chukchi Sea, Alaska" and "Polar Bear and Pacific Walrus Awareness and Interaction Plan Statoil 2010 3D Seismic Acquisition Chukchi Sea, Alaska" are incorporated by reference into this LOA. If any changes develop during your project, such as activities or location, the Marine Mammals Management Office (MMM) must be notified prior to the planned operation. This will allow us to evaluate the activity and, if appropriate, amend the LOA.

Pacific walrus and polar bear conservation has benefited from monitoring programs associated with the Incidental Take program. The monitoring portions of your interaction plans serve to assess the effect of industrial activities on Pacific walruses and polar bears by evaluating trends and effects of encounter rates, take frequency, as well as the location and timing of encounters. If questions or concerns arise, U.S. Fish & Wildlife Service (Service) biologists are available for consultation during the project period at the phone numbers listed below and noted in your interaction plan.

Furthermore, 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 Chukchi 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 ESA. In order for the Tier 2 BO to be consistent with the "no jeopardy" conclusion of the Tier 1 BO and for an ESA incidental take statement (ITS) to be provided: (1) the proposed activity must provide the required information, as described in §18.118 of the Regulations, (2) the LOA must include any mitigation measures that the MMM believes appropriate for the specific activity and location, as described in §18.118 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 Regulations.

Reasonable and prudent mitigation measures, as well as 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.

An additional requirement of this LOA is for Statoil to provide observational data of polar bears and Pacific walrus throughout the project and a complete report of all observations at the conclusion of the project to document take. The final report will be provided to the MMM no later than 90 days after the completion of the project. The final 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 in 73 FR 33212, dated June 11, 2008. Should you have any further questions contact Craig Perham, (907) 786-3810, or Christopher Putnam, (907) 786-3844, of our Marine Mammals Management Office, (907) 786-3800.

Sincerely,

Rosa Meehan, Ph.D.
Marine Mammals Management

Enclosure

cc: Mr. Pete Sloan, Bureau of Ocean Energy Management, Regulation and Enforcement, (BOE)
Mr. Richard Shideler, Alaska Department of Fish and Game (ADF&G)
Fairbanks Fish and Wildlife Field Office (FWFO)
USFWS Office of Law Enforcement (OLE)
North Slope Borough Department of Law

United States Department of the Interior

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

AFES/MMM

LETTER OF AUTHORIZATION
(10-03-CS)

ISSUED: July 15, 2010
EXPIRES: November 30, 2010

Statoil USA E&P Inc. (Statoil) is hereby authorized to take small numbers of polar bears and Pacific walruses (walruses) incidental to activities occurring during Statoil's 2010 3D Seismic Acquisition project in the Chukchi Sea. Statoil plans to conduct a three-dimensional (3D) marine seismic survey in the Chukchi Sea approximately 100 miles northwest of Wainwright during the 2010 open water season using a towed air gun array. Some two-dimensional (2D) lines designed to tie the 3D data to the surrounding regional geology are a secondary priority for the 2010 seismic acquisition. Geophysical data acquisition activities will be conducted by Fugro-Geoteam, Inc. (Fugro), Statoil's seismic contractor. Three vessels, a seismic vessel and two support vessels, will mobilize out of Dutch Harbor, Alaska, to the project area in mid-July 2010, depending upon ice and weather. It is anticipated that transit time to the project area will be approximately five days. Upon arriving at the project area sound source verification measurements will be collected to determine radii for marine mammal monitoring. Data acquisition is expected to take 60 days. Refueling is anticipated to take place at Nome, though it is possible that fuel re-supply could occur at sea if necessary. Helicopter operations are not planned as a part of the seismic survey, although it is possible that individuals could be transported to and from vessels via helicopter. In general, helicopter operations are expected to occur only in the case of an emergency. Upon completion of data acquisition, all vessels will demobilize to Dutch Harbor.

This LOA is valid from the date of issuance to November 30, 2010. This authorization and the required conditions below apply to all employees, contractors and personnel performing Statoil approved work under the scope of operations to be conducted. This U.S. Fish & Wildlife Service (Service) authorization stipulates the following conditions:

1. Statoil operations managers, or their designates, must be fully aware, understand and be capable of implementing the conditions of this authorization.

2. Intentional take of polar bears and walruses is prohibited under this authorization.

3. The Statoil's "Polar Bear and Pacific Walrus Monitoring, Mitigation, and Reporting Plan Statoil 2010 3D Seismic Acquisition Chukchi Sea, Alaska," dated December 2009 and "Polar Bear and Pacific Walrus Awareness and Interaction Plan Statoil 2010 3D Seismic Acquisition Chukchi Sea, Alaska," dated December 2009 are approved and all provisions must be complied with unless specifically noted otherwise in this Letter of Authorization.

4. A copy of this Letter of Authorization and the approved interaction and avoidance plans listed above must be posted and available for all personnel and in the possession of the operators of all vessels and aircraft engaging in the activities approved under the authority of this Letter of Authorization.

5. This authorization is valid only for those activities and locations identified in the request for a Letter of Authorization dated December 18, 2009, for the Chukchi Sea and described in the Statoil "Plan of Operations 2010 3D Seismic Acquisition Chukchi Sea, Alaska."

6. Polar bear and walrus monitoring, reporting, and survey activities must be conducted in accordance with 50 CFR Section 18.118 and must comply with the following monitoring, mitigation, and reporting requirements:

    a. Statoil must cooperate with the 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 and walruses.

    b. If any changes develop in the project during the period approved under this LOA, such as activities, location or methods, notify the Marine Mammals Management Office prior to the implementation of such changes.

    c. Avoid concentrations or groups of walruses and individuals or groups of polar bears hauled out onto land or ice by all vessels under the management of Statoil. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from known or observed concentrations of walruses or polar bears. 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.

    d. Take every precaution to avoid encroachment upon or harassment of walruses or polar bears in water when a vessel is operated near these animals. Maintain an 800 meter (½ mile) distance, when practicable. Vessels must reduce speed and steer around walruses or polar bears observed in water when able to 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 will avoid multiple changes in direction and speed when walruses or polar bears are present.

e. Power-down procedures will be initiated if any walruses are observed on ice in the walrus disturbance zone of >/= 180 dB to limit impact to walruses in the water associated with the walruses on the ice.

f. Restricting or affecting walrus or polar bear movements, by any means, in sea, on land or on ice, is prohibited. Separation distances will be enforced until animals have left the area of their own volition.

g. Statoil must designate a qualified individual or individuals as Marine Mammal Observers (MMO) to observe, record, and report the effects of project activities on polar bears and walruses to the Service within 24 hours of visual observation.

h. For each walrus or polar bear sighting, an MMO or designated crew member will record at least the following:

i. a unique sighting identification number;
ii. observer name and contact information (phone, email, etc.)
iii. time, location (with latitude, longitude, and datum), heading, speed, activity and identity of the observation vessel;
iv. action taken by vessel operator in response to sighting (describe);
v. for all other vessels visible within 5 km of the observation vessel, when polar bears or walruses are sighted, record the, identification, bearing, distance, heading, speed and activity of the other vessel(s);
vi. Species (polar bear or walrus);
vii. group size (approximate number of individuals);
viii. age/size/sex categories (if determinable);
ix. behavior or activity of animals sighted (describe);
x. reaction of animal(s) to any vessel(s) (describe):
xi. substrate (water, ice and/or land),
xii. heading (if determinable), bearing and distance from vessel of animal(s);
xiii. sighting cue (what caught MMOs attention);
xiv. environmental conditions including:
- weather
- air temperature
- visibility, provide: 1) distance (km, mi or nm), 2) light/dark/twilight and 3) glare (none, little, moderate, severe);
- water depth (meters, feet or fathoms),
- sea state (Beaufort scale),
- ice condition, provide: 1) estimated % ice cover in vicinity of sighting (10% increments), 2) estimated distance to pack ice (km, mi or nm);

xv. estimated range (m, km, mi or nm) at first sighting, estimated range (m, km, mi, or nm) at closest approach;
xvi. MMO comments or notes

7. Any incidental lethal take or injury of a polar bears or walruses must be reported to the Service immediately.

14. This Authorization is valid for the period indicated on this authorization, unless extended or terminated in writing by the U.S. Fish and Wildlife Service, Marine Mammals Management Office.

Chief, Marine Mammals Management

JUL 15 2010
Date

APPENDIX C: DESCRIPTION OF VESSELS AND EQUIPMENT

Vessels

M/V *Geo Celtic*

Vessel	Operator	Length m (ft)	Beam m (ft)	Draft m (ft)
M/V *Geo Celtic*	Fugro-Geoteam AS	100.8 (330.7)	28 (91.8)	7.5 (24.6)

Statoil's seismic source vessel, the M/V *Geo Celtic*, was built specifically for seismic surveys in 2007. The *Geo Celtic* is owned by Fugro, and its current port of registry is Bergen, Norway. The overall length of the *Geo Celtic* is 100.8 m (330.7 ft) and its gross tonnage is 12109 metric tons with a draft of 7.5 m (24.6 ft). The total fuel capacity of the *Geo Celtic* is 1825 m^3 with a fuel consumption rate of approximately 40 tons per day. The *Geo Celtic* has a helicopter deck rated for Sikorsky S61 helicopters. The *Geo Celtic* is equipped with fresh water making capabilities, a sewage treatment plant, and an incinerator.

Airgun Description and Safety Radii

Airgun Description

The seismic source used by Statoil and Fugro consisted of a pair of 3000 in^3 three-string arrays of Sodera G-type airguns towed approximately 394 m (431 yd) behind the *Geo Celtic* for its seismic survey operations. The arrays were fired alternately on consecutive shots. Each array was comprised of three Sodera G-type airgun sub-arrays with a total volume of 3,000 in^3, and were operated at an air pressure of 2000 psi. Individual airguns in the sub-arrays ranged in volume from 60 to 250 in^3 and included four 60-in^3, eight 70-in^3, six 100-in^3, four 150-in^3, and four 250-in^3 airguns in two-gun clusters. A 60-in^3 airgun was used as a mitigation source during power downs when marine mammals were observed within or about to enter the applicable full array safety radius and during turns. Each string was 15 m (16 yd) in

length, and was 10 m (11 yd) from the adjacent string(s). The airgun arrays were towed at a depth of 6 m (19.7 ft) and spacing between arrays was 50 m (55 yd).

The system also included 12 hydrophone streamers with hydrophones distributed over a length of 4,050 m (4,429 yd) and spaced 100 m apart, that recorded reflected sound energy (Fig. C-1). Air compressors aboard the *Geo Celtic* were the source of high pressure air used to operate the airgun arrays. Seismic pulses were emitted at intervals of 25 m (27 yd); average time between shots was 10 sec while the *Geo Celtic* traveled at a speed of 4 to 5 kt (7.4–9.3 km/h, 4.6). In general, the *Geo Celtic* towed this system along a predetermined survey track, although adjustments were occasionally made during the field season to avoid obstacles or during repairs to the equipment.

In general, the signature produced by an array composed of multiple sub-arrays has the same shape as that produced by a single sub-array while the overall acoustic output of the array is determined by the number of sub-arrays employed. When more than one sub-array is used, as here, the arrays are lined up parallel to each other with 10 m (11 yd) cross-line separation between them. This separation was chosen to minimize the dimensions of the array in order to approximate point source radiation characteristics for frequencies in the nominal seismic processing band.

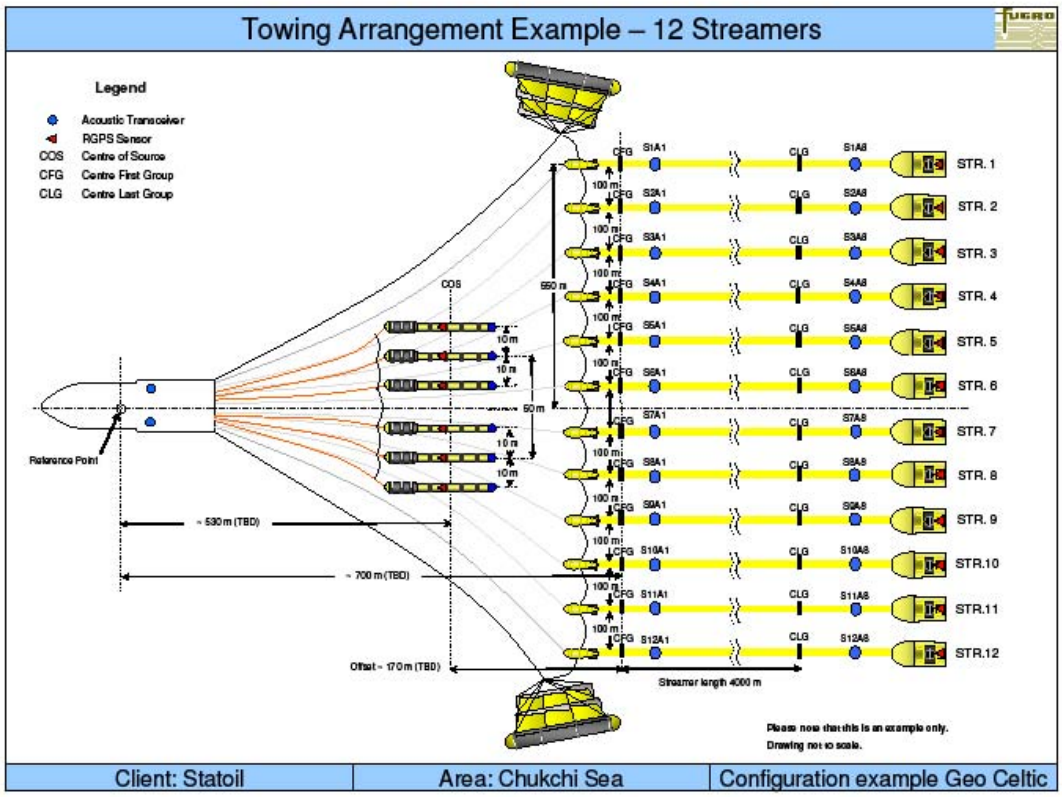

Figure C-1. Towing configuration example for the *Geo Celtic* used during Statoil's seismic survey in the Chukchi Sea, Alaska.

Each sub-array was composed of six tuning elements comprised of 2-gun clusters and 1-2 sets of inactive guns (Figure C-2). The clusters had their component guns arranged in a fixed side-by-side fashion with the distance between the gun ports set to maximize the bubble suppression effects of clustered guns

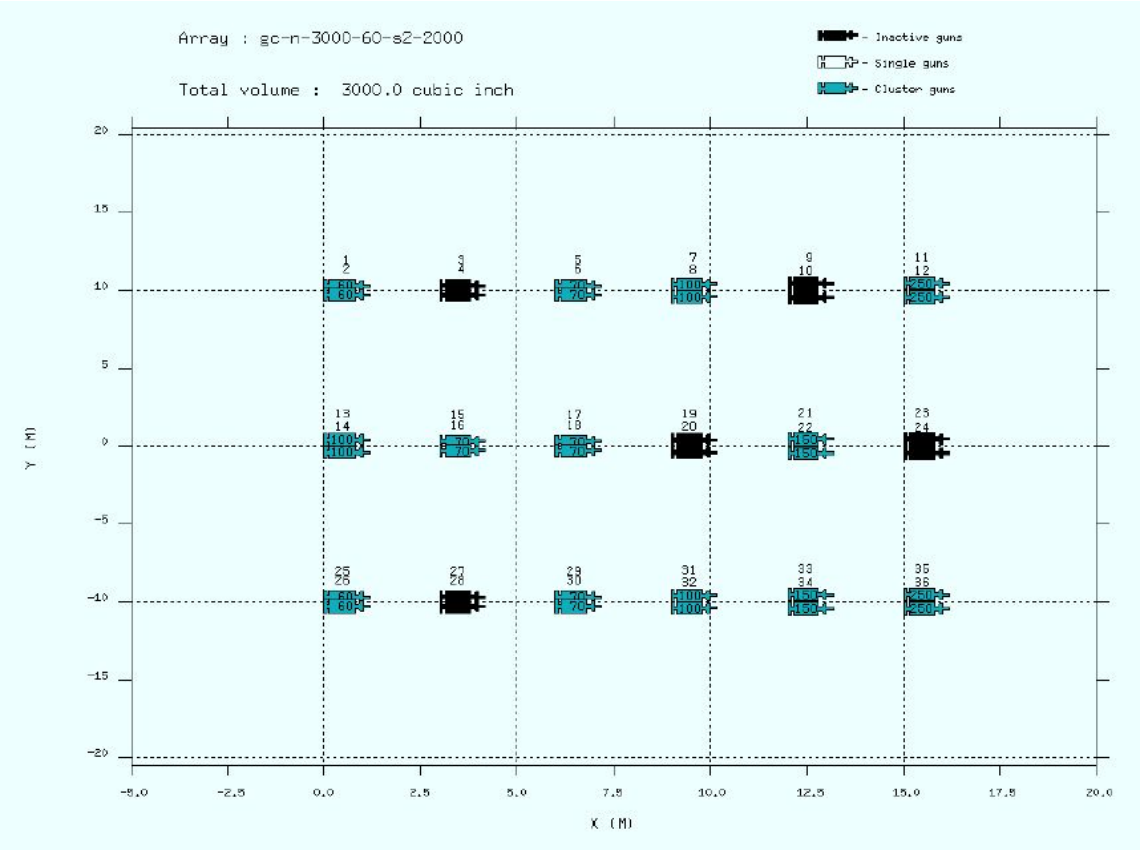

Figure C-2. Layout of the 26-airgun array, comprised of 3 sub-arrays with a total volume of 3000 in^3.

M/V *Tanux I*

Vessel	Operator	Length m (ft)	Beam m (ft)	Draft m (ft)
M/V *Tanux I*	Tanager Offshore AS	53.8 (176.5)	13.8 (45.3)	3.6 (11.8)

The M/V *Tanux I* was the *Geo Celtic's* primary supply vessel and also served as monitoring vessel during the 2010 seismic survey. The *Tanux I* was built in 2006. The current port of registry is Majuro, Marshall Islands. The overall length of the *Tanux I* is 53.8 m (176.5 ft) and the gross tonnage is 1161 metric tons. The *Tanux I* is powered by two Caterpillar D-399 diesel engines and is equipped with a waste oil and sludge incinerator.

MV Norseman I

Vessel	Operator	Length m (ft)	Beam m (ft)	Draft m (ft)
R/V *Norseman I*	Norseman Maritime Charters	32.9 (108)	8.5 (28)	4.0 (13)

The *Norseman I* underwent a redesign in 2005 to research and expedition vessel. The vessel measures 32.9 m (118 ft) in length, 8.5 m (28 ft) wide and a draft of 4.0 m (13 ft). The main engine is a Caterpillar diesel operating at 850 hp. The gross tonnage is 197 tons. Fuel capacity is 40,000 gallons and cruising speed is 10.0 kt. The *Norseman I* operated as the primary ≥160 dB (rms) monitoring vessel for the *Geo Celtic*, and was involved in the deployment and retrieval of acoustic equipment. Detailed specifications can be found at: *http://norsemanmaritme.com/Specs%20NI.pdf.*

APPENDIX D: SOUND SOURCE VERIFICATION CALIBRATION TABLES

Part 1: Tables and Figures Referenced from Chapter 3

Table D.1 to Table D.5 present calibration results with the system gain values used in data analysis for all four OBH locations. There are two tables regarding OBH A2 because the gain value used during analysis was the average of three results: OBH A1's pre-deployment value and OBH A2's pre- and post-deployment calibrations performed in the field. For OBH A1, OBH B, and OBH C only the pre-deployment value is presented because no averaging was done. A post-deployment calibration was not performed on OBH A1, and could not be performed on OBH B and OBH C since they had stopped recording before being recovered.

TABLE D.1. Calibration measurement used in data analysis for OBH A1.

Cor_lev:			0.08 dB
Atmospheric Pressure:			1023.00 mbars (=hPa)
Bandwidth:			50.0 Hz
CHANNEL #1		CHANNEL #2	
Calibrator:	GRAS 42AC	Calibrator:	GRAS 42AC
Frequency:	250.0 Hz	Frequency:	250.0 Hz
Sensor:	RESON 4032	Sensor:	RESON 4043
Cal_lev:	156.0 dB re 1 uPa	Cal_lev:	165.5 dB re 1 uPa
Cal_start:	615.0 s	Cal_start:	715.0 s
Cal_len:	30.0 s	Cal_len:	30.0 s
Sysgain:	-179.7 dB re 1 FS/uPa	Sysgain:	-214.2 dB re 1 FS/uPa

TABLE D.2. Calibration measurement (pre-deployment) used in data analysis for OBH A2.

Cor_lev:			0.09 dB
Atmospheric Pressure:			1024.00 mbars (=hPa)
Bandwidth:			50.0 Hz
CHANNEL #1		CHANNEL #2	
Calibrator:	GRAS 42AC	Calibrator:	GRAS 42AC
Frequency:	250.0 Hz	Frequency:	250.0 Hz
Sensor:	RESON 4032	Sensor:	RESON 4043
Cal_lev:	156.0 dB re 1 uPa	Cal_lev:	165.5 dB re 1 uPa
Cal_start:	150.0 s	Cal_start:	250.0 s
Cal_len:	30.0 s	Cal_len:	30.0 s
Sysgain:	-179.7 dB re 1 FS/uPa	Sysgain:	-214.1 dB re 1 FS/uPa

TABLE D.3. Calibration measurement (post-deployment) used in data analysis for OBH A2.

Cor_lev:			0.09 dB
Atmospheric Pressure:			1024.00 mbars (=hPa)
Bandwidth:			50.0 Hz
CHANNEL #1		CHANNEL #2	
Calibrator:	GRAS 42AC	Calibrator:	GRAS 42AC
Frequency:	250.0 Hz	Frequency:	250.0 Hz
Sensor:	RESON 4032	Sensor:	RESON 4043
Cal_lev:	156.0 dB re 1 uPa	Cal_lev:	165.5 dB re 1 uPa
Cal_start:	3520.0 s	Cal_start:	3600.0 s
Cal_len:	30.0 s	Cal_len:	30.0 s
Sysgain:	-179.5 dB re 1 FS/uPa	Sysgain:	-213.6 dB re 1 FS/uPa

TABLE D.4. Calibration measurement used in data analysis for OBH B.

Cor_lev:	0.07 dB
Atmospheric Pressure:	1022.00 mbars (=hPa)
Bandwidth:	50.0 Hz

CHANNEL #1		CHANNEL #2	
Calibrator:	GRAS 42AC	Calibrator:	GRAS 42AC
Frequency:	250.0 Hz	Frequency:	250.0 Hz
Sensor:	RESON 4032	Sensor:	RESON 4043
Cal_lev:	156.0 dB re 1 uPa	Cal_lev:	165.5 dB re 1 uPa
Cal_start:	520.0 s	Cal_start:	610.0 s
Cal_len:	30.0 s	Cal_len:	30.0 s
Sysgain:	-180.1 dB re 1 FS/uPa	Sysgain:	-213.3 dB re 1 FS/uPa

TABLE D.5. Calibration measurement used in data analysis for OBH C.

Cor_lev:	0.07 dB
Atmospheric Pressure:	1021.00 mbars (=hPa)
Bandwidth:	50.0 Hz

CHANNEL #1		CHANNEL #2	
Calibrator:	GRAS 42AC	Calibrator:	GRAS 42AC
Frequency:	250.0 Hz	Frequency:	250.0 Hz
Sensor:	RESON 4032	Sensor:	RESON 4043
Cal_lev:	156.0 dB re 1 uPa	Cal_lev:	165.5 dB re 1 uPa
Cal_start:	580.0 s	Cal_start:	720.0 s
Cal_len:	30.0 s	Cal_len:	30.0 s
Sysgain:	-183.7 dB re 1 FS/uPa	Sysgain:	-214.2 dB re 1 FS/uPa

Part 2: English Units Tables and Figures from this Appendix and Chapter 3

TABLE D.3.4E. Threshold radii at the SSV site as determined from 90th percentile fit to SPL_{rms90} versus distance data in Fig. 3.5.

SPLrms90 Threshold (dB re 1 µPa)	Endfire		Broadside	
	Best-Fit Line Radius	90th Percentile Radius	Best-Fit Line Radius	90th Percentile Radius
190	980 ft	1,200 ft	1,400 ft	1,700 ft
180	3,300 ft	4,300 ft	4,600 ft	5,200 ft
170	11,000 ft	13,000 ft	13,000 ft	16,000 ft
160	28,000 ft	33,000 ft	36,000 ft	43,000 ft
150	59,000 ft	62,000 ft	89,000 ft	98,000 ft
140	98,000 ft	100,000 ft	170,000 ft	190,000 ft
130	140,000 ft	150,000 ft	280,000 ft	300,000 ft
120	190,000 ft	200,000 ft	400,000 ft	430,000 ft

TABLE D.3.5E. Threshold radii for the mitigation airgun at the SSV site as determined from 90th percentile fit to SPL_{rms90} versus distance data in Fig. 3.12.

SPL_{rms90} Threshold (dB re 1 µPa)	Best-Fit Line Radius	90th Percentile Radius
190	36 ft	43 ft
180	190 ft	220 ft
170	950 ft	1,100 ft
160	4,300 ft	4,900 ft
150	14,000 ft	15,000 ft
140	32,000 ft	33,000 ft
130	56,000 ft	59,000 ft
120	82,000 ft	85,000 ft

TABLE D.3.7E. Perpendicular distances off seismic survey line 1601 to auditory injury criterion thresholds proposed by Southall *et al.* (2007) for cumulative m-weighted sound exposure level (SEL).

Functional Hearing Group	Auditory Injury Criterion (dB_{MW} re 1 μPa^2s)	Distance to Auditory Injury Threshold (ft)
Low-frequency cetaceans	198	950
Mid-frequency cetaceans	198	< 290*
High-frequency cetaceans	198	< 290*
Pinnipeds	186	16,000
* SEL auditory injury criterion not reached at closest recorder (OBH A1).		

TABLE D.3.8E. Comparison of measurements with pre-season estimated marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays.

SPL_{rms90} Threshold (dB re 1 µPa)	Safety Radii		
	Pre-season Estimated	Measured	Ratio (%)
190	2,300 ft	1,400 ft	61
180	8,200 ft	5,200 ft	64
160	43,000 ft	52,000 ft	123
120	230,000 - 390,000 ft	430,000 ft	<108

TABLE D.3.9E. Comparison of measurements with pre-season estimated marine mammal safety radii for *Geo Celtic*'s 60 in^3 mitigation airgun.

SPL_{rms90} Threshold (dB re 1 µPa)	Safety Radii		
	Pre-season Estimated	Measured	Ratio (%)
190	250 ft	43 ft	17
180	720 ft	220 ft	31
160	5,900 ft	4,900 ft	83
120	160,000 ft	85,000 ft	52

TABLE D.3.10E. Measured marine mammal safety radii for *Geo Celtic*'s 3000 in^3 airgun arrays and 60 in^3 mitigation airgun.

SPL_{rms90} Threshold (dB re 1 µPa)	Airgun Arrays (3000 in^3)	Mitigation Airgun (60 in^3)
190	1,700 ft	43 ft
180	5,200 ft	220 ft
170	16,000 ft	1,100 ft
160	43,000 ft	4,900 ft
150	98,000 ft	15,000 ft
140	190,000 ft	33,000 ft
130	300,000 ft	59,000 ft
120	430,000 ft	85,000 ft

APPENDIX E: DETAILS OF MONITORING, MITIGATION, AND ANALYSIS METHODS

This appendix provides details on the standard visual monitoring methods and data analysis techniques implemented for this project. Five marine mammal observers (MMOs) were aboard the seismic source vessel, M/V *Geo Celtic,* throughout the cruise. Three MMOs were biologists experienced in marine mammal identification and observation methods and the other two MMOs were Inupiat with various levels of experience identifying arctic marine mammals. In addition to the MMOs onboard the *Geo Celtic*, Statoil placed 4 MMOs on each of the monitoring vessels (R/V *Norseman I* and M/V *Tanux I*). MMOs generally worked 2–4 hr shifts for up to 12 hrs per day during a 6-week shift before being replaced by other MMOs.

All MMOs participated in extensive safety training and a 5–10 day observer training course (depending on previous MMO experience) designed to familiarize them with the operational and data recording procedures, reporting protocols, and permit stipulations. The permit stipulations and requirements were also explained to the Operations Manager and Head Airgun Operator(s) aboard the *Geo Celtic* during a meeting prior to seismic operations. MMO duties included:

- recording environmental and sighting conditions;
- searching for and identifying marine mammals, and recording their numbers, distances from the vessel, and behavior;
- recording possible reactions of marine mammals to the seismic operations; and
- initiating mitigation measures when appropriate.

Visual Monitoring for Marine Mammals

MMOs monitored marine mammals from the *Geo Celtic* during all daytime seismic operations, and during any nighttime power ups of the airgun(s), as specified in the permits. MMOs onboard the monitoring vessels also monitored marine mammals during much of the time that seismic operations were occurring. Seismic operations were suspended or amended when marine mammals were observed within, or about to enter, designated safety radii described in the permits. In general, observations for marine mammals were conducted using the following guidelines:

- Observations during daylight hours were conducted in good and poor visibility whenever the airgun(s) were operating, and by two observers when possible, unless precluded by safety considerations.
- MMOs observed during transit periods without airgun operations, at the discretion of the lead MMO, to obtain baseline data on marine mammal distribution and (in the case of less experienced observers) to become more familiar with observation protocols.
- Two MMOs observed for 30 min prior to the planned start of seismic operations after an extended shut down and the entirety of the ≥180 re 1 µPa-m dB (rms) radius was required to be visible for those 30 min.
- When the airgun array was powered up at night, at least one MMO watched for marine mammals, using night vision devices, for 30 min prior to start up. (Note that there was 24-hour daylight until late August.)
- MMOs also recorded locations and movements of vessels when on watch; information regarding vessels as well as marine mammals was recorded in a database.

MMO(s) systematically scanned the area around the vessel in a sweeping pattern, usually alternating scan sweeps between reticle binoculars (e.g., Fujinon 7 × 50) and the unaided eye during the

daytime. Observations were focused forward and to the sides of the vessel in an arc of ~210º, but MMOs also regularly checked for the presence of marine mammals astern of the vessel. Night vision devices were used aboard seismic source vessels during non-daylight hours using a similar sweep search pattern.

The duration of a single visual shift was no longer than 4 hr to minimize observer fatigue. Use of two observers simultaneously was desirable and was scheduled when possible to increase detection of marine mammals near the source vessel. In addition to the dedicated MMOs, bridge personnel were responsible for detecting marine mammals and implementing mitigation requirements when MMOs were not present on the bridge.

While on watch, MMOs kept systematic written records of the vessel's position, activity, and environmental conditions using codes that were entered either onto a datasheet and later transcribed onto database, or entered directly into a database using a notebook-style computer. Vessel and environmental data were recorded onto the datasheet every 30 min or whenever conditions changed significantly. Additional data were recorded when marine mammals were observed. For all records, the date and time, vessel position (longitude and latitude), and environmental conditions were recorded. The database was constructed to prevent entry of out-of-range values and codes. Data entries were checked manually by comparing listings of the computerized data with the original handwritten datasheets, both in the field and upon later analyses.

The following information was recorded for each marine mammal sighting: 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 animal was in the 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). On the seismic vessel, distance to marine mammals was measured from the MMO's location on the bridge rather than from the nominal center of the seismic source. The distance of the animal from the airgun array was calculated using a GIS during data error checking and processing at the end of the season. However, for sightings near or within the safety radius in effect at the time, the distance from the marine mammal to the nearest airgun was estimated and recorded for the purposes of implementing power downs or shut downs. The bearing from the vessel to individual or groups of marine mammals was estimated using positions on a clock face, with the bow of the vessel considered to be 12 o'clock and the stern 6 o'clock.

Operational activities that were recorded by MMOs onboard seismic vessels included the number of airguns in use, total volume of the airguns, and the type of vessel/seismic activity. Intra-ship communication between seismic technicians and MMOs was conducted via radio or telephone and used to alert MMOs of any changes in operations, and to request power or shut downs by MMOs. The position of the vessel was logged every 60 sec by GPS and these data were integrated with the marine mammal database to check for data recording errors. Details regarding the seismic activities (start and stop times, number of guns firing, etc.) was collected from the airgun operators log and also used to error check MMO data.

Marine Mammal Mitigation During Operations

The following mitigation measures were adopted for marine mammal sightings during the proposed seismic program: ramp ups, power ups, shut downs, power downs, and course alterations.

Ramp Up

A ramp up is a process commonly used by seismic vessels with large airgun arrays that involves a gradual increase in the number of airguns firing from none or one airgun until the full array is active. In this report, a ramp up from no airguns firing is simply called a ramp up. However, when a ramp up was initiated while the single (mitigation) airgun had been firing it is referred to as a power up. The reason for the different terms, as described further below, is that a ramp up cannot be initiated during times when the full safety radii are not visible to MMOs for 30 minutes while a power up can be initiated during times when the full safety radius is not visible because the mitigation gun has been firing.

Daylight Procedure

During daylight hours, a ramp up or power up was required when the full airgun array had not been operating for a period of >10 min. A 30 min watch period performed by at least two MMOs was required prior to a ramp up. The entire ≥180 dB (rms) safety radius for the full array must be visible for the entire 30-min pre-ramp up observation period before the ramp up could commence. However, if the mitigation airgun had been operating during the break in full array activity, then a power up could be initiated at any time provided two MMOs were on active watch during the power up. If the airguns had been shut down or powered down because of the presence of a marine mammal within or near the applicable safety radius, a ramp up or power up could not begin until that safety radius was clear of marine mammals. Following a marine mammal sighting, the safety radius was considered clear when the marine mammal was observed outside of the safety radius, or if the marine mammal(s) were not seen in the safety radii again for 15 min (for small odontocetes and pinnipeds) or 30 min (for mysticetes, large odontocetes and Pacific walruses). If a marine mammal was observed within the applicable safety radius during the 30-min pre-ramp up observation period, the airgun operator was informed and the ramp up was postponed.

Ramp ups of the airgun array began with firing a single airgun. The number of airguns firing was then increased at a rate no greater than an increase of ~6 dB (rms) per 5-min period. During a power up the same procedure was applied by increasing the number of operating guns from the single mitigation airgun to the full array. During a ramp up or power up, the safety radius for the full airgun array was maintained even though fewer airguns were operating.

MMOs informed the airgun operators when ramp up could proceed. If a marine mammal was observed within its applicable safety radius during the 30-min observation period, or during the ramp up, the bridge and airgun operators were informed, as usual, of any necessary mitigation measures (i.e. power down or shutdown).

Darkness Procedures

During hours of darkness, ramp up could commence only if the entire ≥180 dB (rms) safety radius for the full array was visible to MMOs for 30 min using either the unaided eye or night-vision devices (unlikely with very large safety radii). However, similar to daylight periods with poor visibility conditions, a power up could commence at night even if the full array ≥180 dB (rms) radius was not visible.

Power Down

A power down is a reduction in the number of operating airguns (usually from all airguns firing to a single mitigation airgun firing). If marine mammals were detected outside the applicable safety radius of the full airgun array but were likely to enter the safety radius (i.e., if the mammals were moving towards the vessel or if the vessel was moving in the direction of the mammals), and if the vessel's course or speed could not be changed to avoid having the mammals enter the safety radius, the airgun array was powered down to the single mitigation airgun before the mammals were within the full array safety

radius. Likewise, if a mammal was first observed already within the full array safety radius, the airguns were immediately powered down. The mitigation airgun continued firing at a source level of at least 180 dB (rms) during the interruption of full array seismic operations. A shut down (see below) was implemented only if a marine mammal was detected within or about to enter the smaller safety radius around the mitigation airgun. Full airgun activity did not resume (via a power up) until the marine mammal had cleared the safety radius of the full array.

Shut Down

A shut down is the cessation of all airgun activity, including the single mitigation airgun. If a cetacean or pinniped was detected within or about to enter the applicable safety radius of the mitigation gun, the airgun was shut down. After a shut down, the animal must have cleared the safety radius before start up procedures could begin. If the mitigation airgun was shut down for >10 min, then at least 30 min of observation by two MMOs was necessary prior to ramp up. MMOs informed the bridge when ramp up of the airgun(s) could proceed.

Course Alteration

If a marine mammal was detected outside the applicable safety radius and, based on its position and direction of travel, was likely to enter the safety radius, one possible mitigation measure was to adjust the ship track and/or speed to avoid close approach to the mammal. However, while the streamer(s) and airgun(s) are being towed behind the vessel, the turning rate of the vessel is very limited, and course alteration is generally not a practical mitigation method for a seismic vessel. Instead, the marine mammal's activities and movements relative to the seismic vessel were closely monitored. If the mammal appeared likely to enter the safety radius, further mitigation actions were taken, i.e., power or shut down of the airgun(s). Monitoring vessels reduced speed and altered their course, if practicable, to avoid Pacific walruses in water as per the 2010 LOA. The *Geo Celtic,* however, was already operating at minimum speed and had reduced maneuverability due to the seismic gear it was towing, therefore only seismic mitigation (i.e. power downs, shut downs) was implemented.

Analyses

Marine Mammal Monitoring

This section describes the analyses of the marine mammal sightings and survey effort recorded during this project. It also describes the methods used to calculate densities and estimate the number of marine mammals potentially exposed to airgun sounds associated with Statoil's seismic survey.

The sightings and effort data were grouped into three categories, or bins, to assess potential effects of seismic sounds on marine mammals. These categories were designed to distinguish potential differences in distribution, abundance, and behavior of marine mammals at multiple levels of seismic survey influence. In previous reports, observer data were categorized as "seismic", "non-seismic", or "post-seismic" based on the time and location where data were collected relative to seismic activity. However, the relatively broad criteria used to define these categories did not fully account for difference in the sounds produced by different airgun arrays or the number of guns firing during a given period (i.e. full array activity vs. mitigation airgun activity). Also, the method did not allow data collected from monitoring or support vessels to be considered along the gradient of received sound levels that actually exists around a seismic source while it is operating. For those reasons, the results from sound source measurements were used to categorize sightings and observer effort within 10 dB (rms) sound level bins from >190 through <120 dB (rms).

Data collected aboard the source vessel (*Geo Celtic*) were categorized according to the status of airgun activity at the time. Three categories were defined as follows: *(1)* full array activity (all 26 airguns were active, also includes all ramp up periods), *(2)* mitigation airgun activity (only the single 60 in^3 airgun was active), and (3) non-seismic periods (no airguns were firing). In order to keep sample sizes large enough for comparisons among received sound level bins, data collected on monitoring vessels were also grouped into 3 bins: *(1)* ≥160 dB (rms), *(2)* 159–120 dB (rms), and *(3)* <120 dB (rms). The ≥160 dB (rms) bin was roughly equivalent to the seismic category in previous reports and the full array periods defined for the source vessel data, while the <120 dB (rms) bin was roughly equivalent to the non-seismic category. The <120 dB (rms) bin included data collected while seismic activity was ongoing, but at distances where sounds were estimated to be <120 dB (rms), as well as all data collected when seismic activity was not occurring. The 159–120 dB (rms) bin represented data collected in locations where reactions to seismic (both distributional and behavior) may vary among species.

Data meeting the traditional post-seismic period definition (3 min to 1 h for pinnipeds and polar bears after cessation of seismic activity or 3 min to 2 h for cetaceans) were not included in the <120 dB (rms) bin since the distribution and behavior of animals during this time may still have been altered due to the recent seismic activity. The rate of recovery toward "normal" during the post-seismic period is uncertain. Marine mammal responses to seismic sound likely diminish with time after the cessation of seismic activity. The end of the post-seismic period was defined as a time long enough after cessation of airgun activity to ensure that any carry-over effects of exposure to sounds from the airguns would have waned to zero or near-zero. The reasoning behind these categories was explained in MacLean and Koski (2005) and Smultea et al. (2005).

As summarized in Chapter 4, marine mammal density was one of the variables examined to assess differences in the distribution of marine mammals relative to the seismic vessel between seismic and non-seismic periods. Densities were calculated using line-transect procedures for vessel-based surveys (Buckland et al. 2001). To allow for animals missed during observations, we corrected our visual observations using correction factors calculated with these procedures.

Corrections for Sightability

As is standard for line-transect estimation procedures, corrections for the following two parameters were included in the calculation of densities:

- $g(0)$, a measure of detection bias. This factor allows for the fact that less than 100% of the animals present along a transect line are detected.
- $f(0)$, the reduced probability of detecting an animal with increasing distance from a transect line.

Where species-specific values did not exist, values for similar species were used, and when it was not possible to calculate correction factors using the data collected during this study, values from previous studies were substituted.

The $g(0)$ values for cetaceans and pinnipeds were taken from previous studies. The $g(0)$ value for cetaceans (0.902) was taken from Forney and Barlow (1998). This g(0) value is based on estimates for humpback, fin, and blue whales that were calculated using data collected off the coast of California. In the absence of better data, these estimates were applied to bowhead, gray and unidentified whales in this study. The estimate for minke whales (0.84) comes from Table 4 in Barlow and Gerrodette (1996). The best available $g(0)$ value for pinnipeds (0.6) was taken from Bengtson et al. (2005) based on a study that involved the use of satellite-linked time-depth recorders to study the haulout patterns of ringed seals. In

the absence of better data specific to each species, this correction factor was applied to all pinniped species. In the case of sightings with group size ≥16, $g(0)$ was assumed to be 1.0.

The $f(0)$ factors used in the analysis were calculated from observations made during this study when sample size allowed (Table E.1). Only non-seismic period sightings that met the analysis criteria described in Chapter 4 were used for the calculations. These sightings were imported into Distance 5.0 where the $f(0)$ values were calculated separately for each species or species group. The default analysis method was conventional distance sampling with a half-normal model and cosine expansion with no stratification. For sightings with group size ≥16, a $f(0)$ value of 1.0 was used because probability of detection increases with increasing group size, and there were not enough samples with large group sizes to allow for calculation of a separate detection function.

Table E.1. $f(0)$ values used to correct survey data collected during Statoil's seismic survey.

	Tall vessels[a]				Short vessels[b]			
			95% CI				95% CI	
	n	*f*(0)	Lower	Upper	*n*	*f*(0)	Lower	Upper
Cetaceans	41[d]	1.707	1.163	2.506	52[d]	2.042	1.680	2.481
Cryptic cetaceans[c]	-	0.369	-	-	-	0.369	-	-
Ringed, Spotted and Unidentified Seals	28[d]	8.410	6.424	11.011	54[d]	12.584	8.697	18.207
Bearded Seals	28[d]	8.410	6.424	11.011	54[d]	12.584	8.697	18.207
Unidentified pinniped	190[d]	1.717	1.542	1.912	36[d]	3.550	2.953	4.268
Pacific walrus	190[d]	1.717	1.542	1.912	36[d]	3.550	2.953	4.268

[a] Tall vessel: *Geo Celtic* .

[b] Short vessels: *Tanux I* and *Norseman I* .

[c] Cryptic cetaceans include minke and beluga whales. $f(0)$ value comes from Barlow and Gerrodette (1996).

[d] Value was calculated using samples pooled from multiple categories. Samples from short and tall vessels were never pooled.

Number of Individuals Exposed

Estimates of the number of individual marine mammals potentially exposed to sound levels ≥160 dB (rms; and other received sound levels) were calculated by multiplying the area of water ensonified to that level by the density of marine mammals estimated by line-transect methods. The area of water ensonified was calculated using MapInfo Geographic Information System (GIS) software to create a buffer that extended around the vessel's trackline to the measured received sound level distances. The area of water covered by the buffer was calculated two different ways: 1) "Including Overlap Area" is the area of water ensonified to the given received sound level where areas exposed on more than one occasion (as a result of crossing tracklines or tracklines that were close enough for the received sound level distances to overlap) were counted repeatedly each time they were exposed; and 2) "Excluding Overlap Area" was the area of water that was exposed to a given received sound level where areas exposed on more than one occasion were counted only once.

Number of Exposures per Individual

The estimated number of potential exposures per individual is the ratio of the two area calculations described above and represents the average number of times a given area of water was exposed to a given received sound level.

APPENDIX F: BEAUFORT WIND FORCE DEFINITIONS

Wind Speed		Beaufort Wind Force	World Meteorological Organization Terms	Wave Height (m)	Description
Knots	m/s				
<1	<0.5	0	Calm	0	Glassy like a mirror
1-3	0.5-1.5	1	Light air	<0.1	Ripples with the appearance of scales but no whitecaps or foam crests
4-6	2.1-3.1	2	Light breeze	0-0.1	Small wavelets, crests have a glassy appearance but do not break (no whitecaps)
7-10	3.6-5.1	3	Gentle breeze	0.1-0.5	Smooth large wavelets, crests begin to break, occasional/scattered whitecaps
11-16	5.7-8.2	4	Moderate breeze	0.5-1.2	Slight; small fairly frequent whitecaps
17-21	8.7-10.8	5	Fresh breeze	1.2-2.4	Moderate waves becoming longer, some spray, frequent moderate whitecaps
22-27	11.3-13.9	6	Strong breeze	2.4-4	Rough, larger waves, longer-formed waves, many large whitecaps
28-33	14.4-17.0	7	Near gale	4-6	Very rough, large waves forming, white foam crests everywhere, spray is present
34-40	17.5-20.6	8	Gale		
41-47	21.1-24.2	9	Strong gale		
48-55	24.7-28.3	10	Storm	6-9	High
56-63	28.8-32.4	11	Violent storm	11-14	Very high

APPENDIX G: MARINE MAMMAL STATUS AND ABUNDANCE IN THE CHUKCHI SEA

TABLE G-1. The habitat, abundance and conservation status of marine mammals potentially inhabiting the project areas.

Species	Habitat	Abundance	ESA[1]	IUCN[2]	CITES[3]
Odontocetes					
Beluga whale (*Delphinapterus leucas*)	Offshore, Coastal, Ice edges	50,000[4] 39,257[5]	Not listed	NT	II
Narwhal (*Monodon monoceros*)	Offshore, Ice edge	Rare[6]	Not listed	NT	II
Killer whale (*Orcinus orca*)	Widely distributed		Not listed	DD	II
Harbor Porpoise (*Phocoena phocoena*)	Coastal, inland waters, shallow offshore waters	Common (Chukchi)	Not listed	LC	II
Mysticetes Bowhead whale (*Balaena mysticetus*)	Pack ice & coastal	10,545[7]	Endangered	LC	I
Gray whale (*Eschrichtius robustus*) (eastern Pacific population)	Coastal, lagoons	488[8] 17,500[9]	Not listed	LC	I
Minke whale (*Balaenoptera acutorostrata*)	Shelf, coastal	Small numbers	Not listed	LC	I
Fin whale (*Balaenoptera physalus*)	Slope, mostly pelagic	Rare (Chukchi)	Endangered	EN	I
Humpback whale (*Megaptera novaeangliae*)	Shelf, coastal	Rare	Endangered	LC	I
Pinnipeds Bearded seal (*Erignathus barbatus*)	Pack ice	300,000-450,000[10] 4863[11]	In review for listing	LC	I
Spotted seal (*Phoca largha*)	Pack ice	Unknown[12]	In review for listing	DD	I
Ringed seal (*Pusa hispida*)	Landfast & pack ice	Up to 3.6 million [13] ~208,000-252,000[14]	In review for listing	LC	I
Ribbon seal (*Histriophoca fasciata*)	Offshore, pack ice	90-100,000[15]	In review for listing	DD	I

[1] U.S. Endangered Species Act.
[2] IUCN Red List of Threatened Species (2010; www.iucnredlist.org). Codes for IUCN classifications: EN = Endangered; NT = Near Threatened; DD = Data Deficient; LC = Least Concern
[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora (UNEP-WCMC 2004).
[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 (IWC 2000).
[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).
[8] Southern Chukchi Sea and northern Bering Sea (Clark and Moore 2002).
[9] North Pacific gray whale population (Rugh 2003 *in* Keller and Gerber 2004) ; see also Rugh et al. (2005).
[10] Alaska population (USDI/MMS 1996).
[11] Eastern Chukchi Sea population (NMML, unpublished data).

[12] Alaska Stock unknown (Rugh et al. 1995 *in* Allen and Anglis 2009).
[13] Alaska estimate (Frost et al. 1988 *in* Angliss and Outlaw 2008).
[14] Bering/Chukchi Sea population (Bengston et al. 2005).
[15] Burns, J.J. 1981a.

APPENDIX H: MARINE MAMMAL MONITORING RESULTS

Part 1: English Units Tables and Figures from Chapter 5

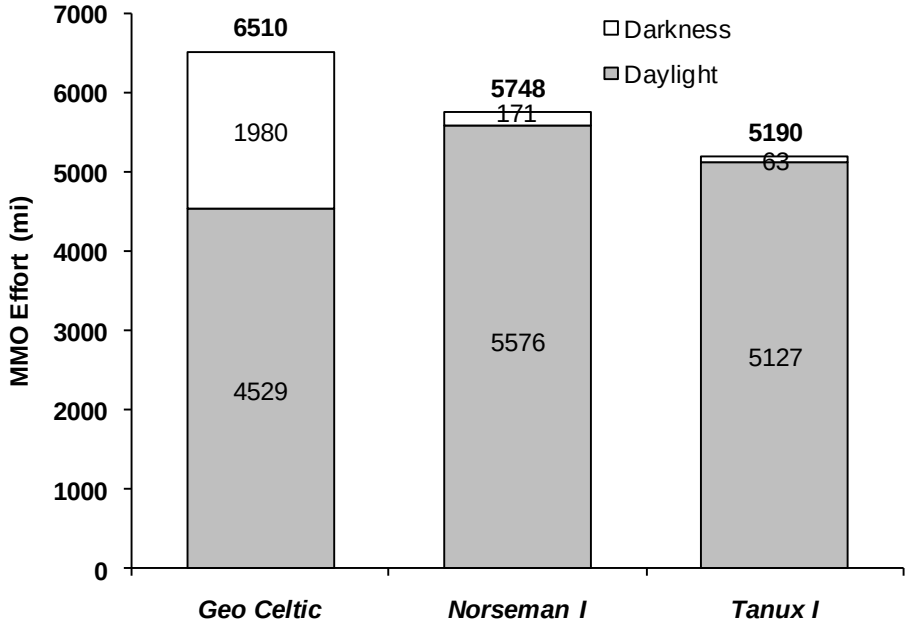

FIGURE H.5.1E. MMO observation effort (mi) by daylight and darkness periods, during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010. Total MMO observation effort is displayed in bold above each bar.

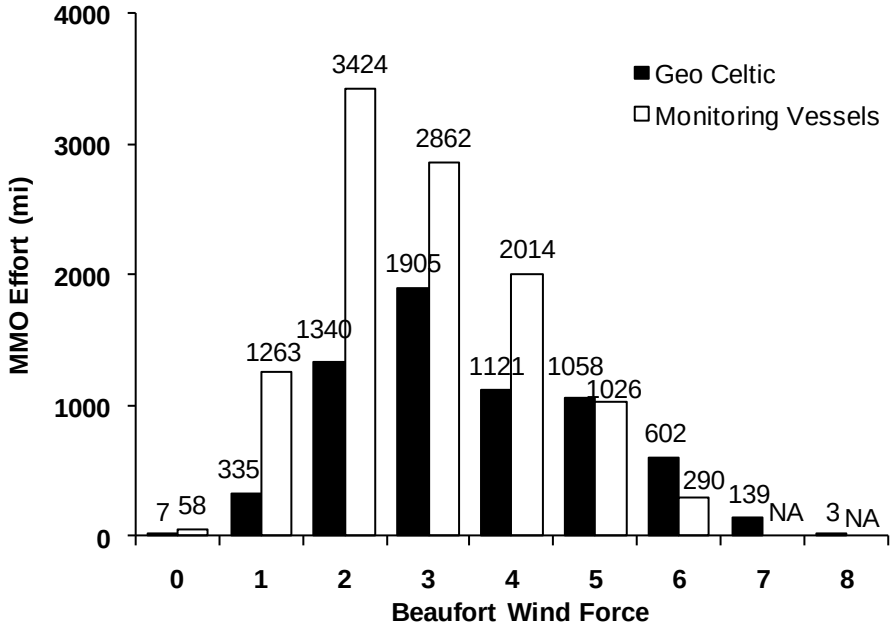

FIGURE H.5.2E. MMO observation effort (mi) by Beaufort wind force from the *Geo Celtic* and its monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

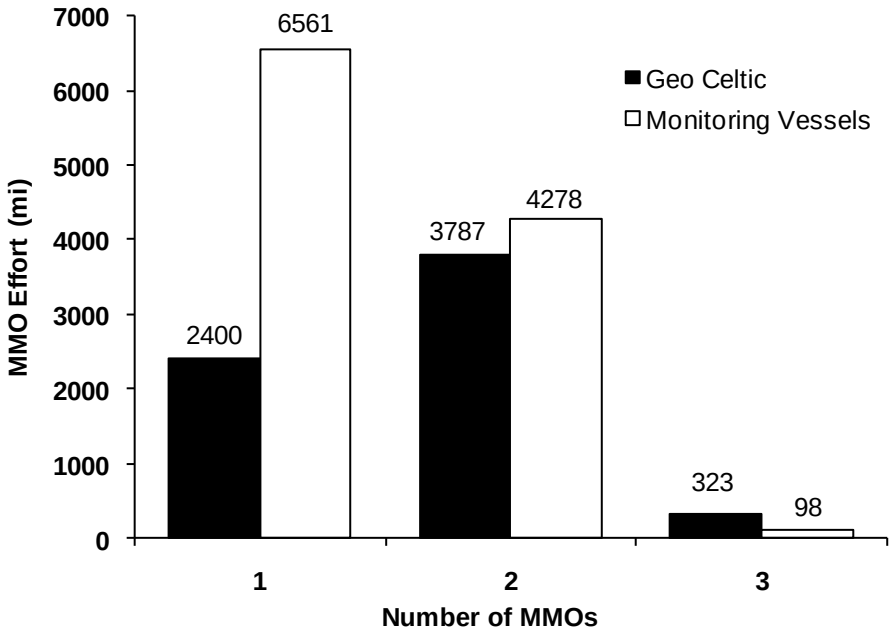

FIGURE H.5.3E. MMO observation effort (mi) by number of MMOs, during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010.

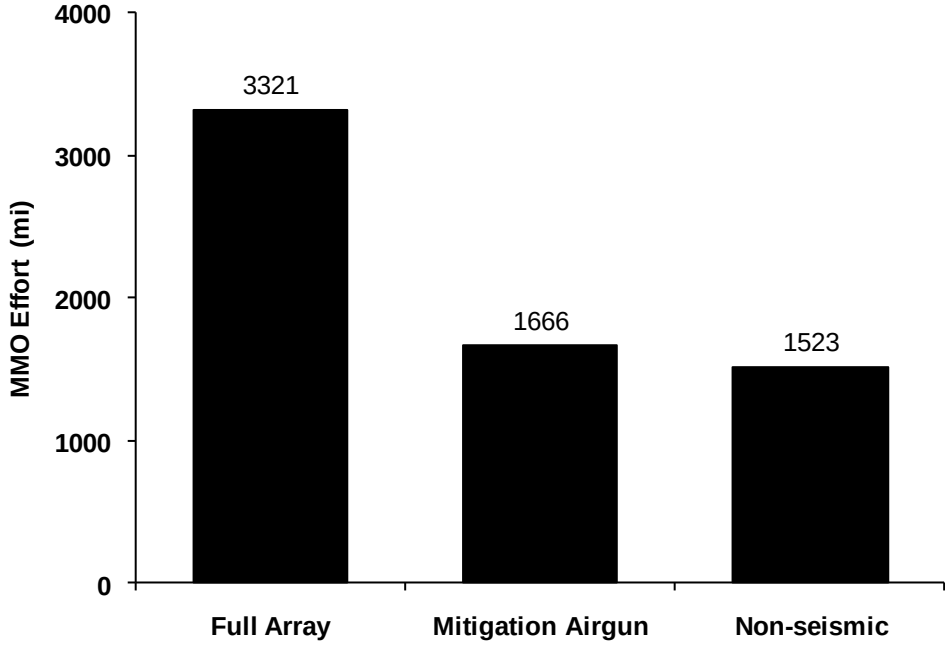

FIGURE H.5.4E. MMO observation effort (mi) for the *Geo Celtic* by seismic status during Statoil's seismic survey, 11 Aug – 4 October 2010. The full airgun array operated at 3000 in^3 and the mitigation airgun operated at 60 in^3.

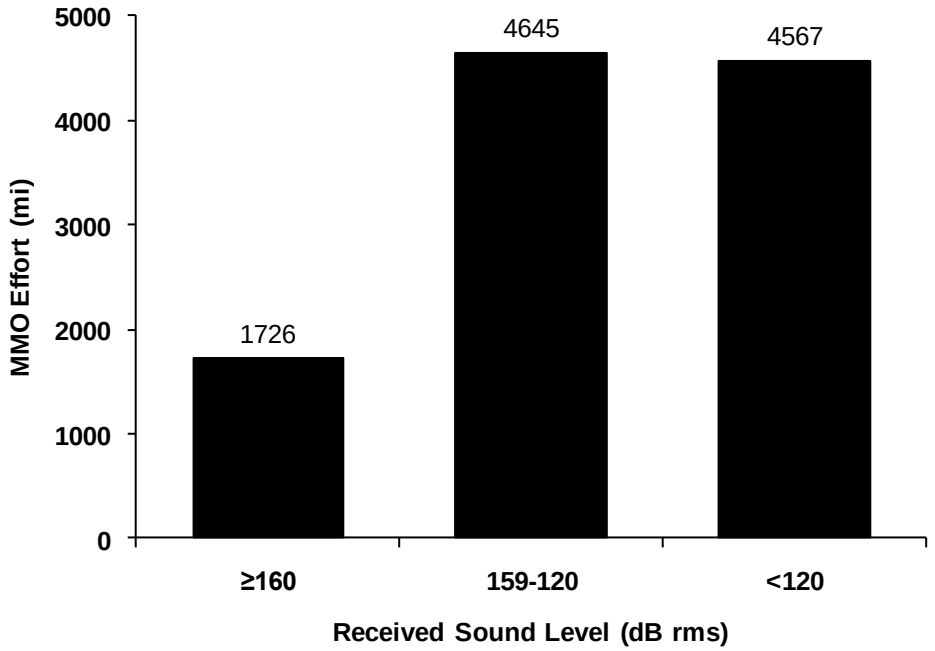

FIGURE H.5.5E. MMO observation effort (mi) from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010.

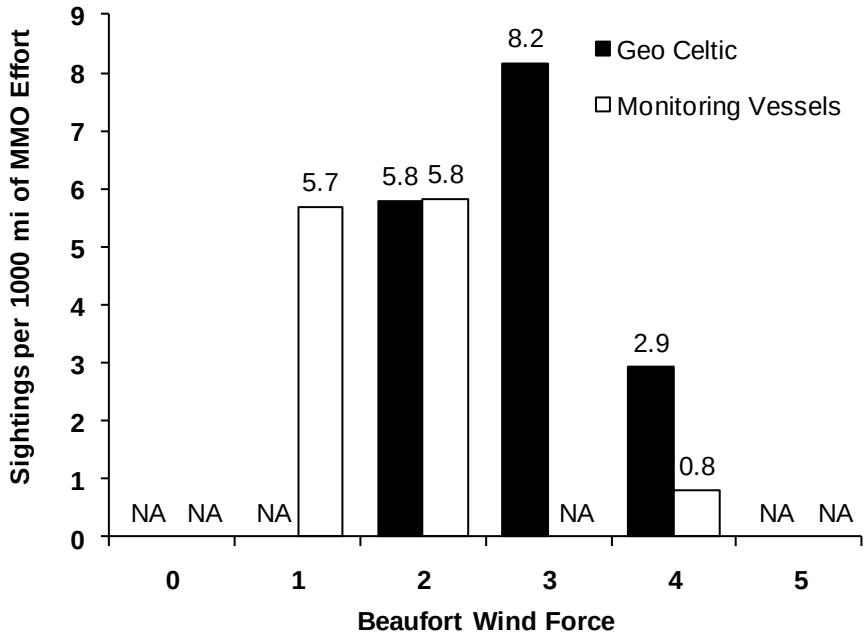

FIGURE H.5.6E. Cetacean sighting rates during Beaufort wind force conditions 0 through 5 during Statoil's seismic survey, 11 Aug – 4 October 2010.

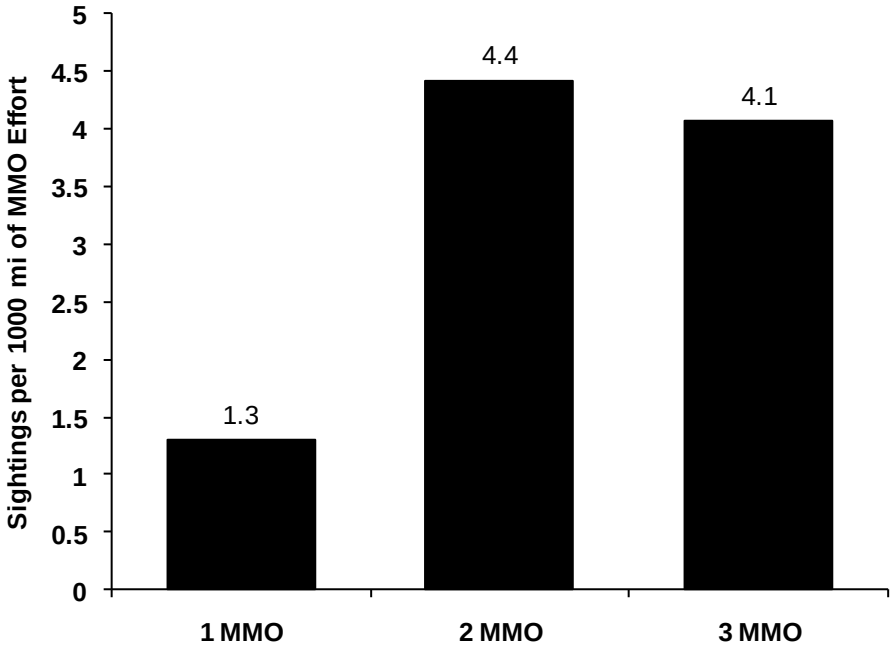

FIGURE H.5.7E. Cetacean sighting rates by number of MMOs on watch from all vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

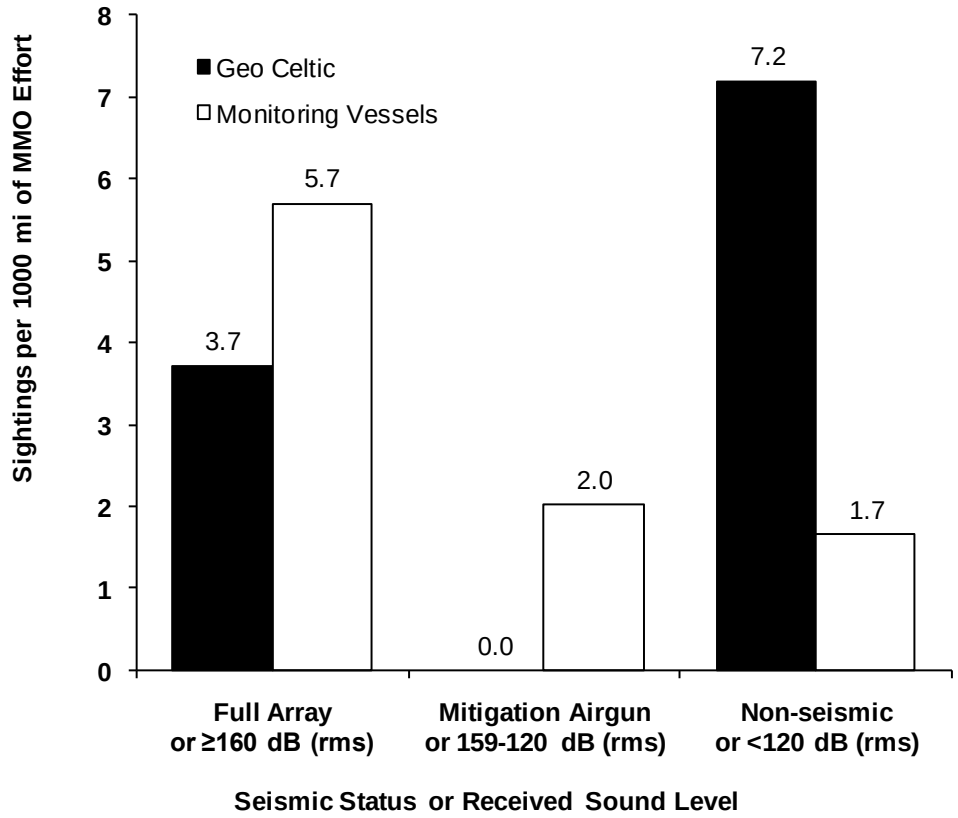

FIGURE H.5.8E. Cetacean sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159-120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

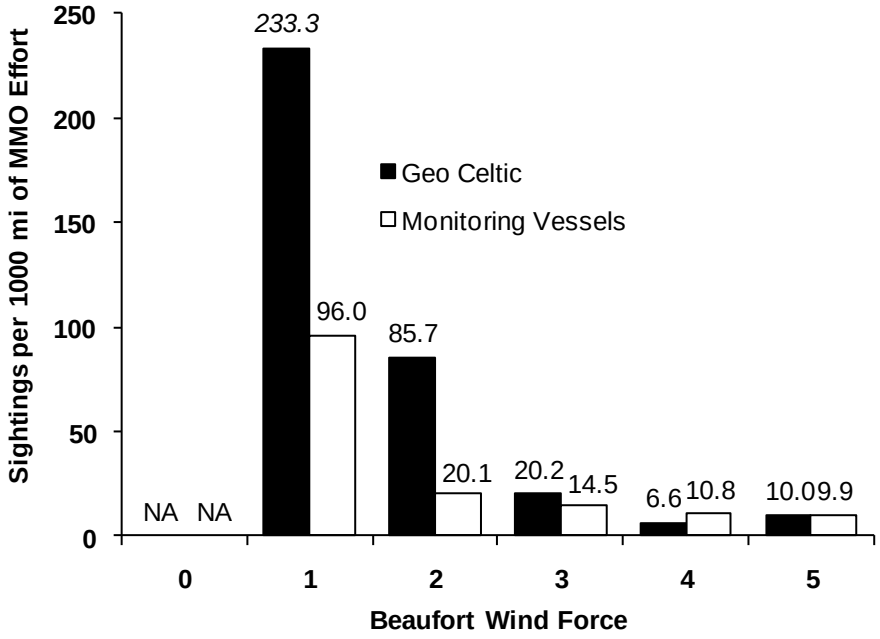

FIGURE H.5.9E. Seal sightings by Beaufort wind force during Statoil's seismic survey from the *Geo Celtic* and its monitoring vessels, 11 Aug – 4 October 2010. Italics indicate a marginal level of effort was available for calculating the sighting rate.

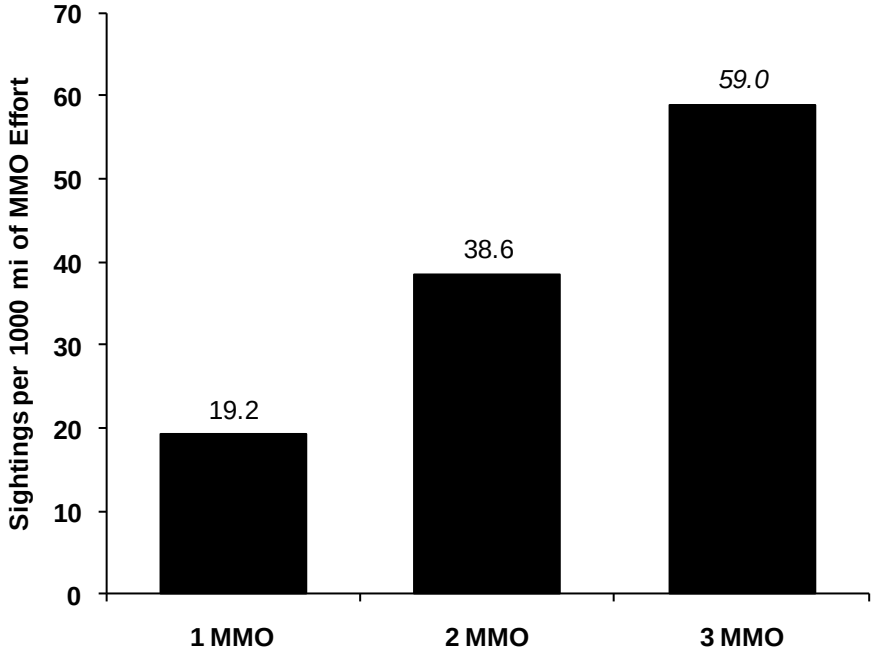

FIGURE H.5.10E. Seal sighting rates by number of MMOs from three vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

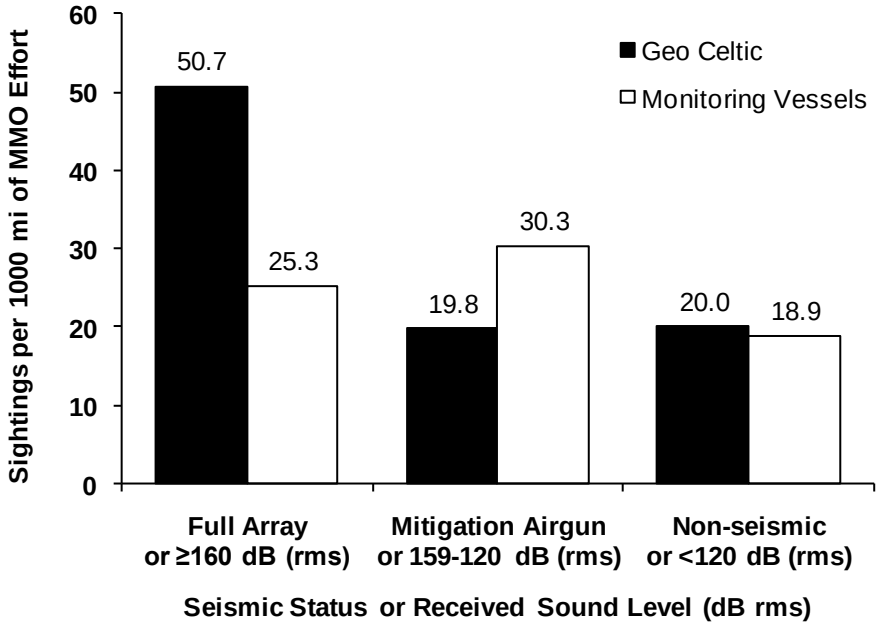

FIGURE H.5.11E. Seal sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159-120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

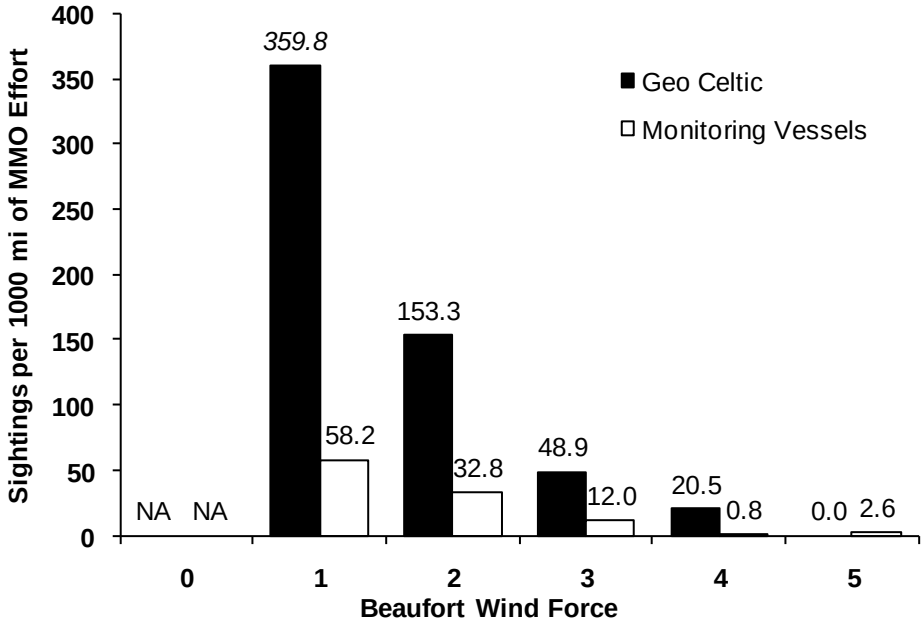

FIGURE H.5.13E. Pacific walrus sighting rates by Beaufort wind force from the *Geo Celtic* and its monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

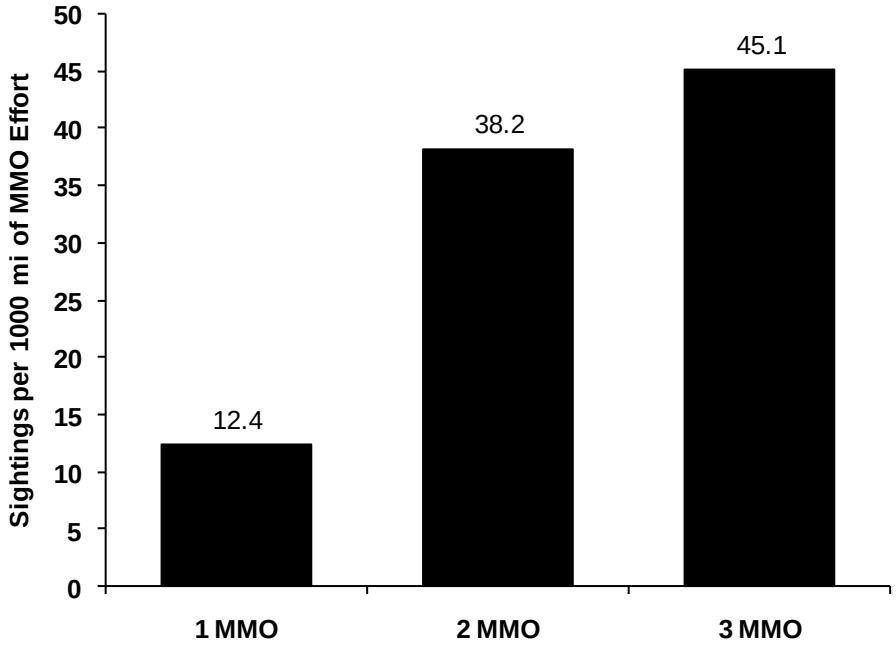

FIGURE H.5.14E. Pacific walrus sighting rates by number of MMOs from all three vessels during Statoil's seismic survey, 11 Aug – 4 October 2010.

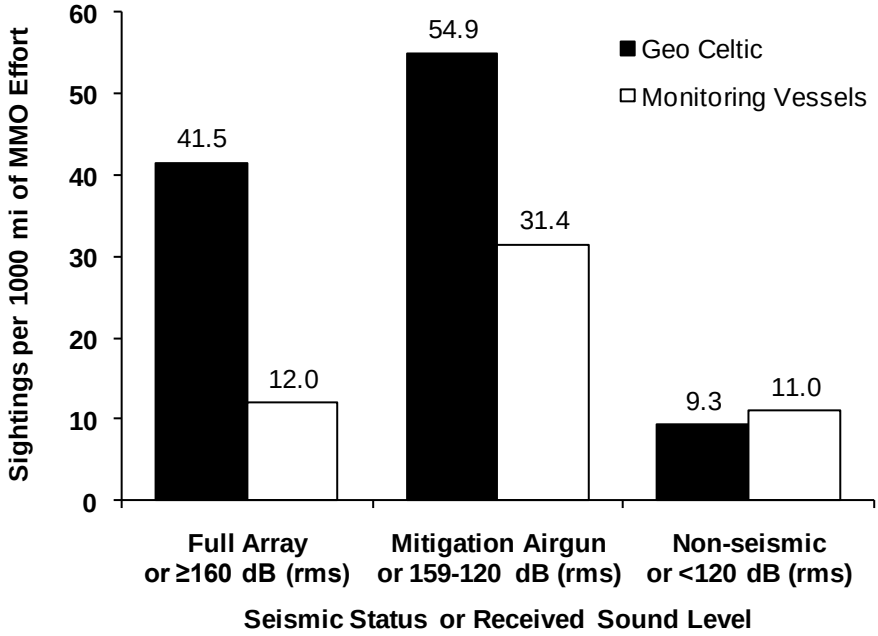

Figure 5.15E. Pacific walrus sighting rates from the *Geo Celtic* by airgun activity level (seismic status) and from the monitoring vessels by received sound level during Statoil's seismic survey, 11 Aug – 4 October 2010. Seismic status labels (full array, mitigation airgun, and non-seismic) describe the sighting rate categories from the *Geo Celtic*, while received sound level labels (≥160 dB, 159-120 dB, and <120 dB) describe the sighting rate categories from the monitoring vessels.

TABLE H.5.4E. Comparison of mean cetacean CPA distances by seismic status from the *Geo Celtic* and received sound level from the monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances from all three seismic activity or RSL bins.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Geo Celtic* Full Array**	4091	1573	2026-5436	5
***Geo Celtic* Mitigation Airgun**	--	--	--	0
***Geo Celtic* Non-Seismic**	1075	393	642-1408	3
Geo Celtic Overall	***2960***	***1973***	***642-5436***	***8***
Monitoring Vessels ≥160	326	--	--	1
Monitoring Vessels 159-120	956	677	109-2198	8
Monitoring Vessels <120	748	690	11-1952	7
Monitoring Vessel Overall	***826***	***658***	***11-2198***	***16***

[a] CPA=Closest Point of Approach. For Geo Celtic this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel.

TABLE H.5.8E. Comparison of seal CPA distances from MMO sightings by seismic status from the *Geo Celtic* and received sound levels from monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances for all three seismic activity or RSL bins in the calculation.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Geo Celtic* Full Array**	1070	610	470-4021	***93***
***Geo Celtic* Mitigation Airgun**	2381	679	1649-3666	***13***
***Geo Celtic* Non-Seismic**	1114	337	693-1765	***13***
Geo Celtic Overall	***1217***	***719***	***470-4021***	***119***
Monitoring Vessels ?160	212	213	22-749	***19***
Monitoring Vessels 159-120	202	174	11-766	***85***
Monitoring Vessels <120	246	241	11-1172	***62***
Monitoring Vessel Overall	***220***	***206***	***11-1172***	***166***

[a] CPA=Closest Point of Approach. For Geo Celtic this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel.

TABLE H.5.12E. Comparison of Pacific walrus CPA distances from MMO sightings by seismic status from the *Geo Celtic* and received sound levels from monitoring vessels during Statoil's seismic survey, 11 Aug – 4 October 2010. The overall mean includes CPA distances from all three seismic activity or RSL bins.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Mean CPA[a] (yd)	s.d.	Range (yd)	*n*
***Geo Celtic* Full Array**	1219	626	252-3623	***76***
***Geo Celtic* Mitigation Airgun**	2288	518	1649-3623	***36***
***Geo Celtic* Non-Seismic**	1506	507	709-2084	***6***
Geo Celtic Overall	***1561***	***762***	***252-3623***	***118***
Monitoring Vessels ≥160	395	172	55-547	***9***
Monitoring Vessels 159-120	392	303	11-1331	***88***
Monitoring Vessels <120	402	215	109-1094	***36***
Monitoring Vessel Overall	***395***	***273***	***11-1331***	***133***

[a] CPA=Closest Point of Approach. For Geo Celtic this value is the marine mammal's closest point of approach to the airgun array, for monitoring vessels this value is the marine mammal's closest point of approach to the MMO position on the vessel

TABLE H.5.16E. The single power down for a gray whale observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (yd)	CPA[c] to Airguns (yd)
GEO201072	Gray whale	1	25-Aug	BL	NO	3666	2807

[a] Initial Behavior Code: BL = Blow

[b] Reaction Codes: No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

TABLE H.5.17E. The nine power down events for seals observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (yd)	CPA[c] to Airguns (yd)
GEO201066	Ringed seal	1	23-Aug	SW	LO	668	668
GEO201069	Ringed seal	1	25-Aug	SW	IS	1013	1013
GEO201078	Ringed seal	1	25-Aug	SW	IS	548	548
GEO201082	Unidentified seal	1	25-Aug	SW	LO	548	548
GEO201089	Unidentified seal	1	28-Aug	SW	NO	857	857
GEO2010176	Ringed seal	1	29-Aug	SW	IS	709	709
GEO2010237	Bearded seal	1	31-Aug	SW	NO	558	558
GEO2010308	Bearded seal	1	12-Sep	DI	NO	534	497
GEO2010319	Bearded seal	1	17-Sep	SW	LO	470	470

[a]Initial Behavior Code: BL = Blow ; DI = Dive; LO = Look; SW = Sw im

[b] Reaction Codes: CD = Change in Direction; IS = Increase in Speed; LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

TABLE H.5.18E. The 29 power down events for Pacific walruses observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Indiv.	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (yd)	CPA[c] to Airguns (yd)
GEO201065	Pacific walrus	4	22-Aug	SW	LO	2561	2561
GEO201079	Pacific walrus	1	25-Aug	SW	LO	974	974
GEO201085	Pacific walrus	1	26-Aug	SW	NO	902	902
GEO201087	Pacific walrus	1	26-Aug	SW	LO	593	593
GEO201092	Pacific walrus	1	28-Aug	SW	NO	2328	2328
GEO201099	Pacific walrus	2	28-Aug	SW	NO	2014	2014
GEO2010119	Pacific walrus	3	29-Aug	SW	NO	594	594
GEO2010121	Pacific walrus	1	29-Aug	SW	CD	1013	1013
GEO2010123	Pacific walrus	2	29-Aug	SW	NO	989	989
GEO2010175	Pacific walrus	2	29-Aug	SW	NO	1868	1868
GEO2010179	Pacific walrus	5	30-Aug	SW	NO	2382	2382
GEO2010194	Pacific walrus	1	30-Aug	SW	LO	817	817
GEO2010223	Pacific walrus	3	30-Aug	SW	LO	2807	2807
GEO2010243	Pacific walrus	1	31-Aug	SW	NO	745	745
GEO2010246	Pacific walrus	2	1-Sep	LO	NO	3718	1542
GEO2010251	Pacific walrus	2	6-Sep	LO	LO	1222	1222
GEO2010252	Pacific walrus	1	6-Sep	SW	LO	659	659
GEO2010267	Pacific walrus	1	8-Sep	SW	LO	2066	2066
GEO2010270	Pacific walrus	2	9-Sep	SW	LO	544	544
GEO2010278	Pacific walrus	5	9-Sep	SW	LO	962	962
GEO2010285	Pacific walrus	2	9-Sep	SW	CD	763	763
GEO2010298	Pacific walrus	1	10-Sep	LO	LO	902	902
GEO2010299	Pacific walrus	1	10-Sep	SW	CD	1542	1542
GEO2010301	Pacific walrus	5	10-Sep	SW	NO	1327	1327
GEO2010305	Pacific walrus	2	11-Sep	SW	NO	593	593
GEO2010307	Pacific walrus	1	11-Sep	SW	LO	633	633
GEO2010311	Pacific walrus	2	14-Sep	LO	LO	1219	817
GEO2010315	Pacific walrus	3	16-Sep	DI	LO	717	717
GEO2010339	Pacific walrus	1	30-Sep	LO	NO	1868	1868

[a]Initial Behavior Code: BL = Blow ; DI = Dive; LO = Look; SW = Sw im

[b] Reaction Codes: CD = Change in Direction; IS = Increase in Speed; LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

TABLE H.5.19E. The three shut down events for Pacific walruses observed from the *Geo Celtic* during Statoil's seismic survey, 11 Aug – 4 October 2010.

Sighting ID	Species	No. Individuals	Date	Initial Behavior[a]	Reaction to Vessel[b]	Distance to Airguns at First Detection (m)	CPA[c] to Airguns (m)
*GEO2010999	Pacific walrus	1	21-Aug	DE	--	--	--
GEO201080	Pacific walrus	3	25-Aug	SW	LO	2807	252
GEO2010101	Pacific walrus	1	28-Aug	SW	NO	808	808

[a]Initial Behavior Code: DE = Dead; SW = Swim

[b] Reaction Codes: LO = Look at Vessel; No = No Reaction

[c] CPA = Closest Point of Approacth to the airgun array.

*Sighting was a carcass.

TABLE H.5.22E. Densities of marine mammals in offshore areas of the Alaskan Chukchi Sea during the Statoil 2010 seismic survey by seismic state, 11 Aug – 4 October 2010. Densities are corrected for *f*(0) and *g*(0) biases. Seismic is equal to RSL ≥160 dB rms and non-seismic is equal to RSL <120 dB rms.

	No. individuals / 1000 mi^2			
	Seismic (≥160 dB rms)		Non-seismic (<120 dB rms)	
Species	**Density**	**CIs**	**Density**	**CIs**
Cetaceans				
Bowhead whale	0.000	(0.142-7.912)	1.059	-
Gray whale	0.818	(0.280-8.982)	1.588	(0.150-4.494)
Minke whale	0.000	(0.168-2.453)	0.640	-
Unidentified mysticete whale	3.424	(0.850-10.026)	2.916	(1.106-10.601)
Unidentified whale	0.000	(0.062-4.115)	0.505	-
Total Cetacean Density	***4.242***	***(1.557-11.559)***	***6.710***	***(2.787-16.154)***
Seals				
Ringed Seal	58.896	(27.420-126.498)	20.083	(5.071-79.541)
Spotted seal	0.000	-	8.604	(1.792-41.282)
Bearded Seal	205.034	(111.087-378.434)	106.138	(43.740-257.543)
Unidentified Seal	244.179	(108.438-549.842)	146.301	(42.507-503.540)
Unidentified Pinniped	15.328	(6.573-35.731)	8.456	(3.261-21.929)
Total Seal Density	***523.434***	***(327.724-836.022)***	***289.576***	***(136.321-615.125)***
Pacific walrus	***190.500***	***(74.338-488.176)***	***143.147***	***(45.566-449.718)***

TABLE H.5.23E. Estimated areas (mi^2) ensonified to various sound levels during the Statoil 2010 seismic survey, 11 Aug – 4 October 2010.

	Level of ensonification in dB re1µPa (rms)				
Area (mi^2)	**120**	**160**	**170**	**180**	**190**
Including Overlap Area	3,472,015	85,381	25,005	7,198	2,228
Excluding Overlap Area	41,889	4,165	2,369	1,559	1,246

Part 2: Data that met the Analysis Criteria used in Chapter 5

Data presented below met the analysis criteria and was used to calculate sighting rates and closest points of approach (CPAs). The analysis criteria are described in detail in Chapter 4 of this report.

Beaufort Wind Force

TABLE H.2.1. Cetacean effort (km) by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	2	44	310	507	271	310	***1443***
***Geo Celtic* Mitigation Airgun**	4	64	130	234	119	173	***724***
***Geo Celtic* Non-Seismic**	0	13	116	245	160	137	***672***
Geo Celtic Overall	***6***	***121***	***556***	***986***	***550***	***619***	***2839***
Monitoring Vessels ≥160	7	235	512	400	204	54	***1412***
Monitoring Vessels 159-120	20	427	1360	1035	615	524	***3980***
Monitoring Vessels <120	7	471	1168	1390	1175	654	***4864***
Monitoring Vessel Overall	***33***	***1133***	***3040***	***2825***	***1994***	***1232***	***10256***

TABLE H.2.2. Pinniped effort (km) by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	3	96	420	618	354	404	***1894***
***Geo Celtic* Mitigation Airgun**	5	154	238	312	136	212	***1056***
***Geo Celtic* Non-Seismic**	0	19	244	347	244	189	***1044***
Geo Celtic Overall	***7***	***269***	***902***	***1276***	***734***	***805***	***3993***
Monitoring Vessels ≥160	7	214	409	345	188	48	***1210***
Monitoring Vessels 159-120	20	400	1579	1268	669	578	***4514***
Monitoring Vessels <120	27	560	1296	1487	1231	669	***5270***
Monitoring Vessel Overall	***54***	***1174***	***3283***	***3100***	***2088***	***1295***	***10994***

TABLE H.2.3. Cetacean sightings by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	0	0	0	5	0	0	***5***
***Geo Celtic* Mitigation Airgun**	0	0	0	0	0	0	***0***
***Geo Celtic* Non-Seismic**	0	0	2	0	1	0	***3***
Geo Celtic Overall	***0***	***0***	***2***	***5***	***1***	***0***	***8***
Monitoring Vessels ≥160	0	0	1	0	0	0	***1***
Monitoring Vessels 159-120	0	2	6	0	0	0	***8***
Monitoring Vessels <120	0	2	4	0	1	0	***7***
Monitoring Vessel Overall	***0***	***4***	***11***	***0***	***1***	***0***	***16***

TABLE H.2.4. Seal sightings by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	3	13	23	8	2	4	***53***
***Geo Celtic* Mitigation Airgun**	5	26	15	5	1	1	***53***
***Geo Celtic* Non-Seismic**	0	0	10	3	0	0	***13***
Geo Celtic Overall	***8***	***39***	***48***	***16***	***3***	***5***	***119***
Monitoring Vessels ≥160	1	6	6	4	2	0	***19***
Monitoring Vessels 159-120	0	43	19	12	5	6	***85***
Monitoring Vessels <120	4	21	16	12	7	2	***62***
Monitoring Vessel Overall	***5***	***70***	***41***	***28***	***14***	***8***	***166***

TABLE H.2.5. Pacific walrus sightings by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	1	4	14	6	3	0	***28***
***Geo Celtic* Mitigation Airgun**	0	23	38	22	1	0	***84***
***Geo Celtic* Non-Seismic**	0	0	1	2	3	0	***6***
Geo Celtic Overall	***1***	***27***	***53***	***30***	***7***	***0***	***118***
Monitoring Vessels ≥160	3	3	3	0	0	0	***9***
Monitoring Vessels 159-120	2	25	40	19	0	2	***88***
Monitoring Vessels <120	1	13	19	2	1	0	***36***
Monitoring Vessel Overall	***6***	***41***	***62***	***21***	***1***	***2***	***133***

Number of MMOs

TABLE H.2.6. Cetacean effort (km) by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs			
	1	2	3	*Total*
***Geo Celtic* Full Array**	180	1079	184	***1443***
***Geo Celtic* Mitigation Airgun**	128	513	83	***724***
***Geo Celtic* Non-Seismic**	134	520	18	***672***
Geo Celtic Overall	***443***	***2112***	***284***	***2839***
Monitoring Vessels ≥160	799	613	0	***1412***
Monitoring Vessels 159-120	1854	2071	56	***3980***
Monitoring Vessels <120	3054	1755	55	***4864***
Monitoring Vessel Overall	***5707***	***4438***	***111***	***10256***

TABLE H.2.7. Pinniped effort (km) by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs 1	2	3	*Total*
***Geo Celtic* Full Array**	217	1467	209	***1894***
***Geo Celtic* Mitigation Airgun**	175	791	90	***1056***
***Geo Celtic* Non-Seismic**	208	798	38	***1044***
Geo Celtic Overall	***599***	***3056***	***338***	***3993***
Monitoring Vessels ≥160	684	525	0	***1210***
Monitoring Vessels 159-120	2080	2367	67	***4514***
Monitoring Vessels <120	3272	1939	59	***5270***
Monitoring Vessel Overall	***6037***	***4831***	***126***	***10994***

TABLE H.2.8. Cetacean sightings by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs 1	2	3	*Total*
***Geo Celtic* Full Array**	0	4	1	***5***
***Geo Celtic* Mitigation Airgun**	0	0	0	***0***
***Geo Celtic* Non-Seismic**	0	3	0	***3***
Geo Celtic Overall	***0***	***7***	***1***	***8***
Monitoring Vessels ≥160	0	1	0	***1***
Monitoring Vessels 159-120	1	7	0	***8***
Monitoring Vessels <120	4	3	0	***7***
Monitoring Vessel Overall	***5***	***11***	***0***	***16***

TABLE H.2.9. Seal sightings by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs			
	1	2	3	*Total*
***Geo Celtic* Full Array**	2	44	7	***53***
***Geo Celtic* Mitigation Airgun**	5	43	5	***53***
***Geo Celtic* Non-Seismic**	0	10	3	***13***
Geo Celtic Overall	***7***	***97***	***15***	***119***
Monitoring Vessels ≥160	12	7	0	***19***
Monitoring Vessels 159-120	29	54	2	***85***
Monitoring Vessels <120	31	31	0	***62***
Monitoring Vessel Overall	***72***	***92***	***2***	***166***

TABLE H.2.10. Pacific walrus sightings by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs			
	1	2	3	*Total*
***Geo Celtic* Full Array**	3	23	2	***28***
***Geo Celtic* Mitigation Airgun**	5	75	4	***84***
***Geo Celtic* Non-Seismic**	0	6	0	***6***
Geo Celtic Overall	***8***	***104***	***6***	***118***
Monitoring Vessels ≥160	4	5	0	***9***
Monitoring Vessels 159-120	29	57	2	***88***
Monitoring Vessels <120	10	21	5	***36***
Monitoring Vessel Overall	***43***	***83***	***7***	***133***

Seismic Status or Received Sound Level

TABLE H.2.11. Cetacean effort (km) by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Effort (km)
***Geo Celtic* Full Array**	1443
***Geo Celtic* Mitigation Airgun**	724
***Geo Celtic* Non-Seismic**	672
Geo Celtic Overall	***2839***
Monitoring Vessels ≥160	1412
Monitoring Vessels 159-120	3980
Monitoring Vessels <120	4864
Monitoring Vessel Overall	***10256***

TABLE H.2.12. Pinniped effort (km) by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Effort (km)
***Geo Celtic* Full Array**	1210
***Geo Celtic* Mitigation Airgun**	4514
***Geo Celtic* Non-Seismic**	5270
Geo Celtic Overall	***10994***
Monitoring Vessels ≥160	1894
Monitoring Vessels 159-120	1056
Monitoring Vessels <120	1044
Monitoring Vessel Overall	***3993***

TABLE H.2.13. Cetacean sightings by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of Sightings
***Geo Celtic* Full Array**	5
***Geo Celtic* Mitigation Airgun**	0
***Geo Celtic* Non-Seismic**	3
Geo Celtic Overall	***8***
Monitoring Vessels ≥160	1
Monitoring Vessels 159-120	8
Monitoring Vessels <120	7
Monitoring Vessel Overall	***16***

TABLE H.2.14. Seal sightings by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of Sightings
***Geo Celtic* Full Array**	53
***Geo Celtic* Mitigation Airgun**	53
***Geo Celtic* Non-Seismic**	13
Geo Celtic Overall	***119***
Monitoring Vessels ≥160	19
Monitoring Vessels 159-120	85
Monitoring Vessels <120	62
Monitoring Vessel Overall	***166***

TABLE H.2.15. Pacific walrus sightings by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of Sightings
***Geo Celtic* Full Array**	28
***Geo Celtic* Mitigation Airgun**	84
***Geo Celtic* Non-Seismic**	6
Geo Celtic Overall	***118***
Monitoring Vessels ≥160	9
Monitoring Vessels 159-120	88
Monitoring Vessels <120	36
Monitoring Vessel Overall	***133***

Part 3: English Units Effort Tables Presented in Part 2 of this Appendix

TABLE H.2.1E. Cetacean effort (mi) by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	1	27	192	315	168	192	***897***
***Geo Celtic* Mitigation Airgun**	3	40	81	145	74	107	***450***
***Geo Celtic* Non-Seismic**	0	8	72	152	100	85	***417***
Geo Celtic Overall	***4***	***75***	***346***	***613***	***342***	***385***	***1764***
Monitoring Vessels ≥160	4	146	318	249	127	33	***877***
Monitoring Vessels 159-120	12	265	845	643	382	326	***2473***
Monitoring Vessels <120	4	293	726	864	730	406	***3023***
Monitoring Vessel Overall	***21***	***704***	***1889***	***1755***	***1239***	***766***	***6373***

TABLE H.2.2E. Pinniped effort (mi) by Beaufort wind force and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Beaufort Wind Force						
	0	1	2	3	4	5	*Total*
***Geo Celtic* Full Array**	2	60	261	384	220	251	***1177***
***Geo Celtic* Mitigation Airgun**	3	96	148	194	85	131	***656***
***Geo Celtic* Non-Seismic**	0	12	152	216	152	118	***649***
Geo Celtic Overall	***5***	***167***	***560***	***793***	***456***	***500***	***2481***
Monitoring Vessels ≥160	4	133	254	214	117	30	***752***
Monitoring Vessels 159-120	12	249	981	788	415	359	***2805***
Monitoring Vessels <120	17	348	805	924	765	416	***3275***
Monitoring Vessel Overall	***34***	***729***	***2040***	***1926***	***1297***	***805***	***6831***

TABLE H.2.6E. Cetacean effort (mi) by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs			
	1	2	3	*Total*
***Geo Celtic* Full Array**	112	670	114	***897***
***Geo Celtic* Mitigation Airgun**	80	319	52	***450***
***Geo Celtic* Non-Seismic**	83	323	11	***417***
Geo Celtic Overall	***275***	***1312***	***177***	***1764***
Monitoring Vessels ≥160	496	381	0	***877***
Monitoring Vessels 159-120	1152	1287	35	***2473***
Monitoring Vessels <120	1898	1090	34	***3023***
Monitoring Vessel Overall	***3546***	***2758***	***69***	***6373***

TABLE H.2.7E. Pinniped effort (mi) by the number of MMOs on watch and seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Number of MMOs			
	1	2	3	*Total*
***Geo Celtic* Full Array**	135	912	130	***1177***
***Geo Celtic* Mitigation Airgun**	108	491	56	***656***
***Geo Celtic* Non-Seismic**	129	496	24	***649***
Geo Celtic Overall	***372***	***1899***	***210***	***2481***
Monitoring Vessels ≥160	425	327	0	***752***
Monitoring Vessels 159-120	1292	1471	42	***2805***
Monitoring Vessels <120	2033	1205	36	***3275***
Monitoring Vessel Overall	***3751***	***3002***	***78***	***6831***

TABLE H.2.11E. Cetacean effort (mi) by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Effort (mi)
***Geo Celtic* Full Array**	897
***Geo Celtic* Mitigation Airgun**	450
***Geo Celtic* Non-Seismic**	417
Geo Celtic Overall	***1764***
Monitoring Vessels ≥160	877
Monitoring Vessels 159-120	2473
Monitoring Vessels <120	3023
Monitoring Vessel Overall	***6373***

TABLE H.2.12E. Pinniped effort (mi) by seismic activity status from the *Geo Celtic* or received sound level from the monitoring vessels that met the analysis criteria during Statoil's seismic survey, 11 Aug – 4 October 2010.

Vessel and Seismic Status or Received Sound Level (dB re 1 µPa rms)	Effort (mi)
***Geo Celtic* Full Array**	752
***Geo Celtic* Mitigation Airgun**	2805
***Geo Celtic* Non-Seismic**	3275
Geo Celtic Overall	***6831***
Monitoring Vessels ≥160	1177
Monitoring Vessels 159-120	656
Monitoring Vessels <120	649
Monitoring Vessel Overall	***2481***

APPENDIX I: ALL MARINE MAMMAL DETECTIONS

Table I.1. All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO201044	Unidentified mysticete whale	3	11/08/2010 22:17:00	-167.943	68.3709	4518	1287	4	BL	NO	OT	X
GEO201045	Minke whale	2	11/08/2010 22:32:00	-167.924	68.4306	350	697	4	SW	NO	OT	X
GEO201046	Unidentified toothed whale	3	12/08/2010 00:42:00	-167.762	68.9407	100	542	3	SW	NO	OT	X
GEO201047	Pacific walrus	1	12/08/2010 22:10:30	-164.719	71.6804	1000	1098	4	SW	LO	DP	X
NOR201017	Bearded seal	1	13/08/2010 06:10:12	-162.667	71.7287	50	X	1	SW	LO	OT	X
NOR201018	Pacific walrus	1	13/08/2010 08:00:59	-162.798	71.9491	362	X	1	SW	IS	OT	X
GEO201048	Unidentified seal	1	13/08/2010 08:11:37	-164.196	71.597	75	494	2	LO	LO	DP	X
NOR201019	Pacific walrus	2	13/08/2010 08:35:04	-163.022	71.9591	500	X	1	SW	CD	OT	X
NOR201020	Unidentified pinniped	1	13/08/2010 09:12:04	-163.157	72.0084	75	X	1	SW	NO	OT	X
NOR201021	Pacific walrus	1	13/08/2010 09:28:40	-163.216	72.0239	492	X	1	SI	NO	OT	X
NOR201022	Pacific walrus	1	13/08/2010 09:36:40	-163.224	72.0254	600	X	1	SW	LO	OT	X
NOR201023	Pacific walrus	2	13/08/2010 09:41:40	-163.226	72.0257	769	X	1	SW	NO	OT	X
NOR201024	Pacific walrus	1	13/08/2010 10:15:40	-163.41	72.0347	417	X	1	LO	NO	OT	X
NOR201025	Unidentified pinniped	1	13/08/2010 10:41:59	-163.586	72.0351	1072	X	1	SW	NO	OT	X
NOR201026	Pacific walrus	2	13/08/2010 16:04:13	-164.704	71.7393	450	X	1	U	NO	OT	X
TAN201011	Unidentified mysticete whale	1	13/08/2010 19:28:27	-167.293	68.4334	1217	X	2	SW	NO	OT	X
TAN201012	Unidentified mysticete whale	1	13/08/2010 19:58:43	-167.172	68.5165	478	X	2	SW	NO	OT	X
NOR201027	Pacific walrus	1	14/08/2010 11:29:29	-162.943	72.0412	600	X	2	DI	NO	OT	X
GEO201049	Unidentified seal	1	14/08/2010 12:39:45	-166.287	70.1529	1000	1287	5	DE	NO	DP	X
NOR201028	Bearded seal	1	14/08/2010 18:15:06	-164.064	71.5025	350	X	3	SW	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO201050	Pacific walrus	1	14/08/2010 18:45:06	-167.227	70.1104	1238	1591	1	DE	NO	DP	X
TAN201013	Pacific walrus	1	14/08/2010 19:19:41	-167.264	70.1205	10	X	1	DE	NO	OT	X
GEO201051	Minke whale	1	14/08/2010 20:13:47	-167.465	70.095	150	587	2	SW	NO	DP	X
GEO201052	Minke whale	1	14/08/2010 20:44:55	-167.561	70.0889	660	1076	2	SW	NO	DP	X
TAN201014	Unidentified seal	1	14/08/2010 23:00:57	-168.08	70.0534	111	X	1	LO	LO	OT	X
GEO201053	Minke whale	1	14/08/2010 23:39:07	-168.083	70.0493	1230	1638	2	SW	NO	DP	X
GEO201054	Unidentified seal	1	14/08/2010 23:55:15	-168.129	70.0458	350	743	2	SW	LO	DP	X
TAN201015	Unidentified seal	1	15/08/2010 00:06:05	-168.313	70.0325	140	X	1	LO	LO	OT	X
TAN201016	Unidentified whale	1	15/08/2010 05:14:20	-168.179	70.2659	10	X	X	DE	NO	OT	X
GEO201055	Unidentified whale	1	15/08/2010 16:37:12	-166.945	70.8873	2000	2051	3	DE	NO	DP	X
GEO201056	Unidentified seal	1	15/08/2010 19:00:51	-166.64	71.0186	453	784	3	LO	NO	DP	X
TAN201017	Unidentified seal	1	15/08/2010 19:45:12	-166.387	71.0768	40	X	2	SW	SP	OT	X
GEO201057	Unidentified pinniped	1	15/08/2010 21:11:41	-166.367	71.1355	1230	1508	3	DE	NO	DP	X
TAN201018	Unidentified seal	1	15/08/2010 23:56:12	-165.855	71.2878	170	X	1	LO	LO	OT	X
TAN201019	Unidentified seal	1	16/08/2010 06:35:50	-164.838	71.5802	10	X	3	SW	LO	OT	X
TAN201020	Pacific walrus	1	17/08/2010 09:07:45	-166.118	70.6708	298	X	1	DE	NO	OT	X
NOR201029	Unidentified seal	1	17/08/2010 14:05:32	-165.645	70.9886	30	X	3	LO	LO	OT	X
NOR201030	Unidentified seal	1	17/08/2010 18:14:25	-165.269	71.4805	50	X	4	U	NO	OT	X
TAN201021	Unidentified seal	1	19/08/2010 07:43:28	-164.205	71.6392	60	X	4	LO	LO	OT	X
GEO201058	Unidentified seal	2	20/08/2010 09:08:39	-163.763	71.6697	750	1203	3	SW	NO	DP	X
GEO201059	Unidentified seal	1	20/08/2010 13:39:07	-162.924	71.5995	782	1148	2	LO	LO	DP	X
TAN201022	Ringed seal	1	20/08/2010 14:33:40	-163.089	71.5448	20	X	2	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN201023	Pacific walrus	3	20/08/2010 15:00:16	-163.083	71.5203	367	X	1	SW	NO	OT	X
GEO201060	Unidentified seal	1	20/08/2010 15:21:20	-163.178	71.5257	662	1078	3	SW	NO	DP	X
GEO201061	Unidentified seal	1	20/08/2010 15:26:30	-163.196	71.526	782	904	3	LO	NO	DP	X
GEO201062	Unknown	1	20/08/2010 17:08:10	-163.55	71.5366	956	1058	3	SW	SP	DP	X
GEO201063	Pacific walrus	4	20/08/2010 22:13:57	-164.624	71.581	1436	1785	3	SW	LO	DP	X
NOR201031	Ringed seal	1	21/08/2010 01:58:36	-164.672	71.4346	25	X	2	SW	IS	OT	X
GEO201064	Pacific walrus	1	21/08/2010 08:39:10	-165.517	71.6927	150	603	4	SW	SP	SH	60
TAN201024	Pacific walrus	1	21/08/2010 14:45:44	-164.229	71.6809	15	X	4	DE	NO	OT	X
GEO201065	Pacific walrus	4	22/08/2010 20:00:45	-163.912	71.5696	2000	2342	4	SW	LO	LS	3000
GEO201066	Ringed seal	1	23/08/2010 12:41:20	-163.473	71.5615	200	611	3	SW	LO	RU	3000
GEO201067	Pacific walrus	1	24/08/2010 12:42:50	-165.045	71.6067	1500	1941	3	SW	NO	SH	60
GEO201068	Unidentified mysticete whale	2	24/08/2010 14:27:30	-164.82	71.6666	4000	4398	3	SW	NO	RU	3000
NOR201032	Unidentified seal	1	24/08/2010 16:18:53	-164.865	71.6137	218	X	3	SW	IS	OT	X
NOR201033	Unidentified seal	1	24/08/2010 19:56:00	-164.518	71.4329	200	X	2	LO	LO	OT	X
GEO201069	Ringed seal	1	25/08/2010 10:51:42	-164.367	71.6579	506	926	2	SW	IS	LS	3000
GEO201070	Bearded seal	1	25/08/2010 11:25:35	-164.229	71.6576	410	833	2	SW	LO	RU	3000
GEO201071	Unidentified seal	1	25/08/2010 11:46:20	-164.136	71.6571	782	1225	2	LO	NO	LS	3000
TAN201025	Gray whale	1	25/08/2010 13:17:34	-163.582	71.6709	1217	X	2	BL	NO	OT	X
GEO201072	Gray whale	1	25/08/2010 13:28:39	-163.677	71.6546	2913	2567	3	BL	NO	LS	3000
GEO201073	Unidentified pinniped	1	25/08/2010 14:12:30	-163.483	71.6537	300	656	2	SW	NO	SH	60
TAN201026	Unidentified mysticete whale	1	25/08/2010 14:31:10	-163.257	71.6698	2010	X	2	BL	NO	OT	X
TAN201027	Unidentified mysticete whale	1	25/08/2010 15:12:58	-163.12	71.6694	478	X	2	BL	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN201028	Bearded seal	1	25/08/2010 15:35:13	-163.12	71.6492	20	X	2	SW	LO	OT	X
GEO201074	Pacific walrus	4	25/08/2010 15:39:53	-163.192	71.6675	453	837	3	SW	LO	SH	60
GEO201075	Bearded seal	1	25/08/2010 16:35:10	-163.153	71.6096	150	599	3	SW	NO	SH	60
GEO201076	Pacific walrus	5	25/08/2010 17:20:48	-163.283	71.5823	782	1082	2	SW	NO	SH	60
NOR201034	Unidentified seal	1	25/08/2010 17:26:55	-164.677	71.771	417	X	3	LO	NO	OT	X
TAN201029	Unidentified seal	1	25/08/2010 18:50:30	-163.726	71.6094	45	X	2	LG	NO	OT	X
GEO201077	Unidentified seal	1	25/08/2010 18:50:44	-163.608	71.5896	662	1078	1	SW	NO	SH	3000
GEO201078	Ringed seal	1	25/08/2010 19:08:15	-163.685	71.59	50	501	1	SW	IS	LS	3000
GEO201079	Pacific walrus	1	25/08/2010 19:32:55	-163.793	71.5907	574	891	2	SW	LO	RU	3000
GEO201080	Pacific walrus	3	25/08/2010 19:47:36	-163.858	71.5912	2165	230	2	SW	LO	SH	60
TAN201030	Unidentified seal	1	25/08/2010 19:57:02	-164.047	71.5927	45	X	2	SW	NO	OT	X
GEO201081	Unidentified seal	1	25/08/2010 20:13:00	-163.969	71.5918	200	634	1	SW	NO	SH	60
NOR201035	Unidentified pinniped	2	25/08/2010 20:14:51	-163.85	71.7264	150	X	3	LO	NO	OT	X
GEO201082	Unidentified seal	1	25/08/2010 21:39:36	-164.347	71.5936	50	501	2	SW	LO	LS	3000
NOR201036	Unidentified whale	1	26/08/2010 00:23:39	-162.802	71.6966	200	X	2	DI	NO	OT	X
GEO201083	Pacific walrus	1	26/08/2010 10:38:20	-162.988	71.6054	1500	1770	2	SW	LO	SH	60
GEO201084	Pacific walrus	2	26/08/2010 12:26:10	-163.257	71.5682	506	831	2	SW	LO	SH	60
GEO201085	Pacific walrus	1	26/08/2010 12:59:50	-163.349	71.591	500	825	3	SW	NO	RU	3000
GEO201086	Unidentified seal	1	26/08/2010 14:53:00	-163.791	71.5963	450	782	3	SW	NO	LS	3000
GEO201087	Pacific walrus	1	26/08/2010 20:39:33	-164.743	71.6872	100	542	4	SW	LO	RU	3000
TAN201031	Unidentified pinniped	3	27/08/2010 06:03:18	-162.673	71.5756	50	X	3	SW	SP	OT	X
GEO201088	Unidentified pinniped	1	27/08/2010 06:36:55	-162.727	71.5828	50	497	4	DI	SP	SH	60
NOR201037	Pacific walrus	1	27/08/2010 06:55:31	-160.524	70.6972	25	X	3	LO	SP	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR201038	Unidentified pinniped	1	27/08/2010 12:32:26	-160.214	70.6824	600	X	2	LO	LO	OT	X
NOR201039	Gray whale	2	27/08/2010 13:15:39	-160.447	70.7326	3500	X	2	FE	NO	OT	X
TAN201032	Unidentified seal	1	27/08/2010 14:09:35	-164.8	71.5846	20	X	3	SW	LO	OT	X
NOR201040	Unidentified seal	1	27/08/2010 14:28:22	-160.839	70.8094	10	X	3	DI	IS	OT	X
NOR201041	Pacific walrus	3	27/08/2010 16:59:08	-161.681	70.9765	202	X	3	DI	CD	OT	X
GEO201089	Unidentified seal	1	28/08/2010 08:34:58	-164.282	71.6091	453	784	2	SW	NO	LS	3000
GEO201090	Spotted seal	1	28/08/2010 10:09:25	-164.686	71.6103	782	796	2	SW	NO	LS	3000
GEO201091	Unidentified pinniped	1	28/08/2010 10:15:53	-164.714	71.6103	662	1033	2	SW	LO	LS	3000
GEO201092	Pacific walrus	1	28/08/2010 10:35:10	-164.796	71.6105	1725	2129	2	SW	NO	LS	3000
GEO201093	Unidentified seal	1	28/08/2010 10:37:06	-164.805	71.6106	1436	1842	2	LO	NO	SH	60
GEO201094	Pacific walrus	2	28/08/2010 11:35:39	-164.943	71.6521	506	831	2	SW	CD	SH	60
GEO201095	Pacific walrus	1	28/08/2010 11:45:59	-164.94	71.6642	662	1115	2	SW	NO	SH	60
GEO201096	Ringed seal	1	28/08/2010 11:54:21	-164.931	71.6735	662	1106	2	SW	CD	SH	60
NOR201042	Pacific walrus	2	28/08/2010 14:02:56	-163.39	71.7472	500	X	2	LO	SP	OT	X
TAN201033	Pacific walrus	2	28/08/2010 14:09:34	-164.288	71.7141	30	X	2	LO	LO	OT	X
GEO201097	Bearded seal	2	28/08/2010 14:14:30	-164.386	71.6956	2913	1398	2	SW	NO	LS	3000
NOR201043	Pacific walrus	3	28/08/2010 14:22:34	-163.288	71.7245	417	X	2	LO	LO	OT	X
NOR201044	Pacific walrus	9	28/08/2010 14:24:05	-163.283	71.7218	200	X	2	ST	LO	OT	X
TAN201034	Pacific walrus	3	28/08/2010 14:27:10	-164.237	71.7139	415	X	2	SW	NO	OT	X
NOR201045	Pacific walrus	6	28/08/2010 14:32:40	-163.266	71.7154	400	X	2	LO	LO	OT	X
GEO201098	Unidentified pinniped	1	28/08/2010 14:35:09	-164.294	71.6953	782	1082	2	SW	NO	LS	3000
NOR201046	Pacific walrus	1	28/08/2010 14:36:29	-163.255	71.7219	1000	X	2	LO	NO	OT	X
NOR201047	Pacific walrus	32	28/08/2010 14:42:42	-163.219	71.7267	500	X	2	SA	CD	OT	X
GEO201099	Pacific walrus	2	28/08/2010 14:44:17	-164.253	71.6952	1436	1842	2	SW	NO	LS	3000
GEO2010100	Pacific walrus	4	28/08/2010 14:50:30	-164.225	71.6951	956	1367	2	SW	LO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010101	Pacific walrus	1	28/08/2010 14:57:30	-164.193	71.695	400	739	2	SW	NO	SH	60
GEO2010102	Pacific walrus	1	28/08/2010 15:00:30	-164.18	71.6949	506	831	2	SW	NO	OT	X
NOR201048	Pacific walrus	5	28/08/2010 15:07:43	-163.206	71.6984	500	X	2	SW	NO	OT	X
NOR201049	Pacific walrus	1	28/08/2010 15:18:42	-163.21	71.679	1000	X	2	SW	NO	OT	X
NOR201050	Pacific walrus	6	28/08/2010 15:27:56	-163.261	71.676	700	X	2	SW	NO	OT	X
TAN201035	Pacific walrus	2	28/08/2010 15:28:59	-163.951	71.7131	190	X	2	SW	NO	OT	X
NOR201051	Pacific walrus	4	28/08/2010 15:52:02	-163.42	71.6752	700	X	2	SW	NO	OT	X
NOR201052	Pacific walrus	2	28/08/2010 15:54:34	-163.437	71.6751	400	X	2	SW	NO	OT	X
NOR201053	Pacific walrus	3	28/08/2010 16:14:12	-163.533	71.6786	50	X	2	SA	CD	OT	X
GEO2010103	Pacific walrus	2	28/08/2010 16:17:00	-163.841	71.6931	100	550	2	SW	NO	OT	X
NOR201054	Pacific walrus	4	28/08/2010 16:28:51	-163.468	71.6757	417	X	2	ST	LO	OT	X
TAN201036	Pacific walrus	7	28/08/2010 17:06:24	-163.511	71.7091	250	X	1	SW	NO	OT	X
NOR201055	Unidentified seal	1	28/08/2010 17:15:52	-163.253	71.6727	100	X	2	U	NO	OT	X
NOR201056	Pacific walrus	2	28/08/2010 17:15:52	-163.253	71.6727	500	X	2	LO	LO	OT	X
NOR201057	Unidentified seal	1	28/08/2010 17:33:07	-163.18	71.6722	218	X	2	LO	LO	OT	X
NOR201058	Pacific walrus	1	28/08/2010 17:37:59	-163.161	71.6719	400	X	2	SW	NO	OT	X
TAN201037	Pacific walrus	2	28/08/2010 17:48:56	-163.319	71.7069	100	X	1	SW	IS	OT	X
NOR201059	Pacific walrus	3	28/08/2010 18:03:45	-163.054	71.6704	400	X	1	LO	CD	OT	X
TAN201038	Pacific walrus	3	28/08/2010 18:14:39	-163.257	71.7055	100	X	1	SW	NO	OT	X
TAN201039	Pacific walrus	1	28/08/2010 18:22:50	-163.227	71.7051	150	X	1	SW	NO	OT	X
TAN201040	Pacific walrus	8	28/08/2010 18:44:50	-163.145	71.7038	100	X	1	SW	LO	OT	X
GEO2010104	Pacific walrus	2	28/08/2010 19:22:34	-163.112	71.6831	100	510	1	SW	IS	OT	X
GEO2010105	Pacific walrus	4	28/08/2010 20:02:20	-163.054	71.6414	800	1099	2	SW	NO	OT	X
NOR201060	Pacific walrus	4	28/08/2010 20:23:04	-163.351	71.6046	600	X	1	SW	NO	OT	X
NOR201061	Pacific walrus	2	28/08/2010 21:05:12	-163.514	71.6038	500	X	1	LO	LO	OT	X
NOR201062	Pacific walrus	1	28/08/2010 21:12:26	-163.54	71.6037	400	X	1	LO	NO	OT	X
GEO2010106	Bearded seal	1	28/08/2010 21:35:30	-163.31	71.5974	662	1078	3	SW	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010107	Pacific walrus	2	28/08/2010 21:47:30	-163.349	71.5961	1230	1583	3	SW	NO	OT	X
GEO2010108	Pacific walrus	1	28/08/2010 22:05:30	-163.407	71.5939	1500	1941	3	SW	NO	OT	X
GEO2010109	Pacific walrus	2	28/08/2010 22:08:31	-163.417	71.5936	2000	2440	3	SW	NO	OT	X
GEO2010110	Pacific walrus	1	28/08/2010 22:11:00	-163.425	71.5933	1230	1583	3	LO	NO	OT	X
GEO2010111	Pacific walrus	2	28/08/2010 22:20:20	-163.455	71.592	1725	1312	3	SW	NO	OT	X
GEO2010112	Pacific walrus	7	28/08/2010 22:33:02	-163.496	71.5904	1500	1906	4	SW	NO	OT	X
GEO2010113	Pacific walrus	4	28/08/2010 23:08:02	-163.609	71.5893	956	1316	3	SW	LO	OT	X
GEO2010114	Pacific walrus	5	28/08/2010 23:49:10	-163.745	71.5903	200	648	4	SW	IS	OT	X
GEO2010115	Pacific walrus	3	29/08/2010 06:19:20	-164.94	71.6735	506	959	2	SW	NO	OT	X
GEO2010116	Pacific walrus	2	29/08/2010 06:49:50	-164.863	71.6945	782	1148	3	LO	NO	OT	X
TAN201041	Unidentified seal	1	29/08/2010 07:32:09	-164.601	71.7055	100	X	3	SW	LO	OT	X
GEO2010117	Pacific walrus	3	29/08/2010 07:40:19	-164.687	71.6968	1436	1506	2	LO	NO	OT	X
GEO2010118	Ringed seal	1	29/08/2010 09:22:23	-164.304	71.6952	860	1223	2	LO	LO	RU	3000
GEO2010119	Pacific walrus	3	29/08/2010 10:20:49	-164.083	71.6942	150	543	3	SW	NO	LS	3000
TAN201042	Bearded seal	1	29/08/2010 10:34:20	-163.906	71.6812	153	X	3	SW	NO	OT	X
NOR201063	Pacific walrus	3	29/08/2010 11:08:40	-163.288	71.7192	175	X	3	SW	LO	OT	X
TAN201043	Pacific walrus	1	29/08/2010 11:18:10	-163.706	71.6709	367	X	3	LO	LO	OT	X
NOR201064	Pacific walrus	2	29/08/2010 11:19:29	-163.238	71.7193	50	X	3	ST	IS	OT	X
GEO2010120	Bearded seal	1	29/08/2010 11:25:17	-163.786	71.6929	506	926	3	SW	CD	LS	3000
GEO2010121	Pacific walrus	1	29/08/2010 11:47:20	-163.685	71.6923	506	926	3	SW	CD	LS	3000
NOR201065	Pacific walrus	1	29/08/2010 11:47:29	-163.125	71.741	300	X	3	LO	LO	OT	X
NOR201066	Pacific walrus	2	29/08/2010 11:52:09	-163.1	71.7459	10	X	3	SW	CD	OT	X
TAN201044	Pacific walrus	2	29/08/2010 11:56:10	-163.546	71.6712	298	X	3	SW	LO	OT	X
GEO2010122	Pacific walrus	2	29/08/2010 12:15:27	-163.558	71.6913	662	1078	3	SW	NO	SH	60
TAN201045	Pacific walrus	3	29/08/2010 12:34:53	-163.364	71.6764	478	X	2	SW	NO	OT	X
TAN201046	Pacific walrus	3	29/08/2010 12:45:09	-163.316	71.6784	685	X	2	SW	LO	OT	X
TAN201047	Pacific walrus	2	29/08/2010 12:52:11	-163.282	71.6793	329	X	2	SW	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010123	Pacific walrus	2	29/08/2010 12:56:24	-163.375	71.6902	782	904	3	SW	NO	RU	3000
TAN201048	Pacific walrus	8	29/08/2010 12:58:05	-163.256	71.6793	190	X	2	SW	NO	OT	X
TAN201049	Pacific walrus	12	29/08/2010 13:02:31	-163.241	71.6789	250	X	2	LG	LO	OT	X
NOR201067	Pacific walrus	2	29/08/2010 13:04:25	-162.702	71.7207	75	X	3	ST	LO	OT	X
TAN201050	Pacific walrus	3	29/08/2010 13:06:50	-163.226	71.6786	478	X	2	SW	LO	OT	X
NOR201068	Pacific walrus	5	29/08/2010 13:09:55	-162.68	71.7258	200	X	3	LO	IS	OT	X
GEO2010124	Pacific walrus	2	29/08/2010 13:11:57	-163.306	71.6894	956	1316	3	SW	NO	SH	60
GEO2010125	Pacific walrus	4	29/08/2010 13:14:05	-163.296	71.6894	956	1225	3	SW	NO	SH	60
NOR201069	Pacific walrus	1	29/08/2010 13:28:06	-162.603	71.7459	10	X	3	SW	CD	OT	X
NOR201070	Pacific walrus	2	29/08/2010 13:38:32	-162.553	71.7606	20	X	3	SA	LO	OT	X
GEO2010126	Pacific walrus	2	29/08/2010 13:43:20	-163.167	71.6882	750	1052	3	LO	LO	SH	60
TAN201051	Unidentified seal	1	29/08/2010 13:48:04	-163.031	71.6741	150	X	2	SW	LO	OT	X
GEO2010127	Pacific walrus	3	29/08/2010 13:48:48	-163.142	71.6879	506	926	3	SW	NO	SH	60
NOR201071	Pacific walrus	3	29/08/2010 13:57:25	-162.448	71.7508	45	X	3	LO	NO	OT	X
GEO2010128	Pacific walrus	3	29/08/2010 13:59:42	-163.094	71.6875	782	1196	3	SW	CD	SH	60
GEO2010129	Pacific walrus	1	29/08/2010 14:07:53	-163.058	71.6871	956	1159	3	SW	NO	SH	60
TAN201052	Pacific walrus	3	29/08/2010 14:09:31	-162.927	71.6716	685	X	2	SW	LO	OT	X
GEO2010130	Pacific walrus	3	29/08/2010 14:12:28	-163.037	71.6871	100	542	3	SW	IS	SH	60
TAN201053	Pacific walrus	2	29/08/2010 14:13:49	-162.909	71.6712	500	X	2	SW	LO	OT	X
TAN201054	Pacific walrus	3	29/08/2010 14:15:46	-162.901	71.671	150	X	2	SW	LO	OT	X
TAN201055	Pacific walrus	4	29/08/2010 14:21:06	-162.883	71.6705	75	X	2	LO	SP	OT	X
GEO2010131	Pacific walrus	2	29/08/2010 14:21:28	-163.001	71.6869	782	1082	3	SW	NO	SH	60
NOR201072	Pacific walrus	1	29/08/2010 14:24:30	-162.347	71.71	30	X	2	U	NO	OT	X
NOR201073	Pacific walrus	3	29/08/2010 14:27:20	-162.355	71.7059	200	X	2	U	NO	OT	X
TAN201056	Pacific walrus	6	29/08/2010 14:27:22	-162.873	71.6674	329	X	2	SW	NO	OT	X
GEO2010132	Pacific walrus	1	29/08/2010 14:32:30	-162.96	71.6832	1725	2070	3	SW	NO	SH	60
GEO2010133	Pacific walrus	4	29/08/2010 14:34:57	-162.951	71.6819	1725	2129	3	SW	NO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010134	Pacific walrus	2	29/08/2010 14:41:00	-162.931	71.6778	150	603	3	SW	LO	SH	60
TAN201057	Pacific walrus	1	29/08/2010 14:45:27	-162.929	71.6416	200	X	2	SW	LO	OT	X
TAN201058	Pacific walrus	2	29/08/2010 14:50:46	-162.943	71.6355	150	X	2	SW	LO	OT	X
GEO2010135	Pacific walrus	2	29/08/2010 14:53:01	-162.899	71.667	550	834	3	SW	NO	SH	60
NOR201074	Pacific walrus	1	29/08/2010 14:55:06	-162.476	71.6582	320	X	2	SW	NO	OT	X
GEO2010136	Pacific walrus	3	29/08/2010 14:57:04	-162.891	71.6628	300	698	3	SW	LO	SH	60
GEO2010137	Pacific walrus	4	29/08/2010 15:09:54	-162.876	71.6475	1200	1479	3	SW	NO	SH	60
GEO2010138	Pacific walrus	2	29/08/2010 15:19:14	-162.877	71.636	1800	2204	3	SW	NO	SH	60
GEO2010139	Pacific walrus	4	29/08/2010 15:21:51	-162.879	71.6328	1230	1683	3	SW	NO	SH	60
TAN201059	Pacific walrus	2	29/08/2010 15:24:25	-163.037	71.6231	367	X	2	SW	LO	OT	X
NOR201075	Pacific walrus	2	29/08/2010 15:25:10	-162.425	71.6036	100	X	2	LO	NO	OT	X
GEO2010140	Pacific walrus	7	29/08/2010 15:30:23	-162.89	71.6229	956	1246	3	SW	NO	SH	60
TAN201060	Pacific walrus	2	29/08/2010 15:40:48	-163.088	71.6196	298	X	2	LO	LO	OT	X
GEO2010141	Unidentified pinniped	1	29/08/2010 15:43:15	-162.918	71.6103	500	825	3	LO	NO	SH	60
GEO2010142	Unidentified pinniped	1	29/08/2010 15:53:18	-162.948	71.6033	300	747	3	SW	NO	SH	60
NOR201076	Pacific walrus	2	29/08/2010 16:02:47	-162.453	71.5437	320	X	3	LO	CD	OT	X
GEO2010143	Pacific walrus	2	29/08/2010 16:04:42	-162.986	71.5986	782	1225	3	SW	NO	SH	60
GEO2010144	Pacific walrus	2	29/08/2010 16:08:09	-162.998	71.5979	297	750	3	SW	NO	SH	60
TAN201061	Pacific walrus	2	29/08/2010 16:13:47	-163.155	71.6136	367	X	2	LO	LO	OT	X
GEO2010145	Pacific walrus	2	29/08/2010 16:16:15	-163.027	71.5977	956	1316	3	SW	NO	SH	60
TAN201062	Pacific walrus	3	29/08/2010 16:21:16	-163.18	71.614	685	X	2	SW	NO	OT	X
TAN201063	Pacific walrus	5	29/08/2010 16:24:10	-163.19	71.6146	300	X	2	SW	CD	OT	X
GEO2010146	Pacific walrus	3	29/08/2010 16:27:12	-163.065	71.5989	662	971	3	SW	NO	SH	60
TAN201064	Pacific walrus	4	29/08/2010 16:30:20	-163.206	71.6151	400	X	2	SW	NO	OT	X
NOR201077	Pacific walrus	2	29/08/2010 16:36:54	-162.629	71.5441	165	X	2	LO	LO	OT	X
TAN201065	Pacific walrus	3	29/08/2010 16:40:39	-163.237	71.6166	367	X	2	SW	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN201066	Pacific walrus	1	29/08/2010 16:46:03	-163.254	71.6177	478	X	2	LO	LO	OT	X
TAN201067	Pacific walrus	4	29/08/2010 16:47:59	-163.26	71.6181	367	X	2	LG	NO	OT	X
TAN201068	Pacific walrus	2	29/08/2010 16:50:06	-163.266	71.6185	685	X	2	LO	LO	OT	X
GEO2010147	Bearded seal	1	29/08/2010 16:50:50	-163.15	71.6018	500	880	2	LO	NO	SH	60
TAN201069	Pacific walrus	5	29/08/2010 16:58:23	-163.292	71.6202	367	X	2	LG	NO	OT	X
GEO2010148	Pacific walrus	2	29/08/2010 17:01:10	-163.187	71.6029	506	761	2	SW	NO	SH	60
TAN201070	Pacific walrus	2	29/08/2010 17:05:54	-163.321	71.6223	216	X	2	SW	NO	OT	X
GEO2010149	Pacific walrus	1	29/08/2010 17:10:27	-163.221	71.604	1230	1508	2	SW	NO	SH	60
GEO2010150	Unidentified seal	1	29/08/2010 17:10:50	-163.223	71.604	1230	1508	2	LO	NO	SH	60
GEO2010151	Pacific walrus	4	29/08/2010 17:15:32	-163.239	71.6045	782	680	2	SW	SG	SH	60
TAN201071	Pacific walrus	1	29/08/2010 17:16:54	-163.367	71.6257	250	X	2	SW	NO	OT	X
GEO2010152	Pacific walrus	3	29/08/2010 17:17:34	-163.247	71.6048	2165	2618	2	SW	NO	SH	60
TAN201072	Pacific walrus	5	29/08/2010 17:18:45	-163.375	71.6262	478	X	2	SW	NO	OT	X
GEO2010153	Pacific walrus	1	29/08/2010 17:24:09	-163.271	71.6057	506	959	2	SW	NO	SH	60
GEO2010154	Pacific walrus	1	29/08/2010 17:28:46	-163.288	71.6062	662	1033	2	SW	NO	SH	60
GEO2010155	Pacific walrus	1	29/08/2010 17:35:00	-163.31	71.6072	1725	2070	3	SW	NO	SH	60
GEO2010156	Pacific walrus	2	29/08/2010 17:37:30	-163.319	71.6075	2165	2212	3	SW	NO	SH	60
GEO2010157	Pacific walrus	7	29/08/2010 17:41:00	-163.332	71.608	2165	2567	3	SW	NO	SH	60
NOR201078	Pacific walrus	5	29/08/2010 17:46:28	-163.021	71.5278	320	X	2	LO	NO	OT	X
GEO2010158	Pacific walrus	2	29/08/2010 17:51:35	-163.371	71.609	574	950	3	SW	NO	SH	60
GEO2010159	Pacific walrus	2	29/08/2010 17:56:52	-163.391	71.6096	662	1106	3	SW	NO	SH	60
GEO2010160	Pacific walrus	4	29/08/2010 17:58:11	-163.395	71.6096	1230	1683	3	SW	NO	SH	60
NOR201079	Pacific walrus	2	29/08/2010 18:02:31	-163.105	71.5418	500	X	2	U	NO	OT	X
GEO2010161	Pacific walrus	5	29/08/2010 18:07:52	-163.431	71.6098	662	1115	2	SW	NO	SH	60
TAN201073	Pacific walrus	3	29/08/2010 18:09:51	-163.566	71.6304	367	X	2	LO	LO	OT	X
NOR201080	Pacific walrus	1	29/08/2010 18:14:13	-163.17	71.555	500	X	2	ST	NO	OT	X
TAN201074	Pacific walrus	1	29/08/2010 18:17:38	-163.593	71.6292	478	X	2	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010162	Pacific walrus	2	29/08/2010 18:18:43	-163.472	71.6102	956	1367	2	SW	NO	SH	60
GEO2010163	Pacific walrus	2	29/08/2010 18:26:52	-163.502	71.6105	1076	1167	2	LO	LO	SH	60
GEO2010164	Pacific walrus	2	29/08/2010 18:31:31	-163.519	71.6107	2165	2423	2	SW	NO	SH	60
TAN201075	Pacific walrus	1	29/08/2010 18:35:14	-163.652	71.6272	685	X	2	LO	NO	OT	X
TAN201076	Pacific walrus	1	29/08/2010 18:38:50	-163.664	71.6271	298	X	2	LO	NO	OT	X
GEO2010165	Pacific walrus	1	29/08/2010 18:42:03	-163.558	71.6123	782	562	2	SW	SG	SH	60
TAN201077	Pacific walrus	1	29/08/2010 18:51:29	-163.707	71.6269	298	X	2	LO	NO	OT	X
NOR201081	Pacific walrus	2	29/08/2010 18:55:13	-163.381	71.5601	450	X	2	SW	NO	OT	X
GEO2010166	Pacific walrus	3	29/08/2010 18:57:20	-163.616	71.6127	506	802	2	SW	NO	SH	60
GEO2010167	Pacific walrus	2	29/08/2010 19:03:00	-163.637	71.6125	297	541	2	SW	SG	SH	60
GEO2010168	Pacific walrus	3	29/08/2010 19:08:05	-163.656	71.6124	956	1409	2	SW	NO	SH	60
NOR201082	Pacific walrus	1	29/08/2010 19:29:53	-163.571	71.5306	320	X	2	ST	NO	OT	X
GEO2010169	Pacific walrus	3	29/08/2010 19:35:30	-163.759	71.6116	1436	1877	2	LO	LO	SH	60
NOR201083	Pacific walrus	3	29/08/2010 19:43:58	-163.64	71.5452	350	X	2	ST	NO	OT	X
GEO2010170	Unidentified seal	1	29/08/2010 19:46:30	-163.8	71.6123	1230	1671	2	SW	LO	SH	60
TAN201078	Pacific walrus	1	29/08/2010 19:56:15	-163.957	71.6288	478	X	1	SW	NO	OT	X
GEO2010171	Pacific walrus	1	29/08/2010 20:02:17	-163.859	71.6125	319	672	2	SW	LO	SH	60
TAN201079	Unidentified seal	1	29/08/2010 20:41:39	-164.159	71.6318	40	X	1	LO	LO	OT	X
NOR201084	Bearded seal	1	29/08/2010 21:02:49	-164.044	71.5434	500	X	1	SW	LO	OT	X
GEO2010172	Bearded seal	1	29/08/2010 21:53:00	-164.304	71.6149	956	971	2	SW	NO	LS	3000
TAN201080	Unidentified pinniped	1	29/08/2010 21:55:17	-164.455	71.6292	170	X	1	LG	NO	OT	X
GEO2010173	Bearded seal	1	29/08/2010 22:02:04	-164.342	71.6151	782	1148	2	SW	NO	LS	3000
NOR201085	Unidentified pinniped	1	29/08/2010 22:02:48	-164.385	71.5817	320	X	2	LO	NO	OT	X
GEO2010174	Unidentified seal	1	29/08/2010 22:11:56	-164.384	71.6152	300	698	1	SW	NO	LS	3000
GEO2010175	Pacific walrus	2	29/08/2010 22:18:01	-164.41	71.6153	1436	1708	1	SW	NO	LS	3000

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR201086	Unidentified seal	1	29/08/2010 22:36:55	-164.577	71.5447	188	X	1	LO	NO	OT	X
NOR201087	Unidentified seal	1	29/08/2010 22:42:16	-164.607	71.5388	320	X	1	LO	NO	OT	X
GEO2010176	Ringed seal	1	29/08/2010 23:36:18	-164.716	71.616	200	648	1	SW	IS	LS	3000
NOR201088	Unidentified seal	1	30/08/2010 00:04:40	-165.048	71.5414	500	X	1	SW	NO	OT	X
NOR201089	Unidentified seal	1	30/08/2010 00:13:44	-165.091	71.5529	320	X	1	SW	NO	OT	X
GEO2010177	Bearded seal	1	30/08/2010 06:52:50	-163.628	71.6972	300	728	1	LO	LO	LS	3000
TAN201082	Unidentified seal	1	30/08/2010 06:57:56	-163.472	71.684	119	X	1	LO	LO	OT	X
NOR201090	Unidentified seal	1	30/08/2010 07:01:37	-163.756	71.7343	218	X	1	U	NO	OT	X
TAN201083	Unidentified pinniped	1	30/08/2010 07:30:12	-163.323	71.6833	685	X	0	SW	NO	OT	X
NOR201091	Pacific walrus	4	30/08/2010 07:41:18	-163.529	71.7747	2000	X	1	ST	NO	OT	X
GEO2010178	Bearded seal	1	30/08/2010 07:47:27	-163.381	71.6955	574	731	1	LO	LO	LS	3000
TAN201084	Pacific walrus	3	30/08/2010 07:53:38	-163.215	71.6786	478	X	0	SW	NO	OT	X
TAN201085	Pacific walrus	5	30/08/2010 08:01:25	-163.179	71.6772	478	X	0	SW	NO	OT	X
GEO2010179	Pacific walrus	5	30/08/2010 08:08:15	-163.287	71.6946	1725	2178	1	SW	NO	LS	3000
TAN201086	Pacific walrus	2	30/08/2010 08:08:28	-163.147	71.6767	298	X	0	LO	NO	OT	X
NOR201092	Pacific walrus	3	30/08/2010 08:18:30	-163.318	71.7288	600	X	1	LO	LO	OT	X
TAN201087	Pacific walrus	1	30/08/2010 08:22:30	-163.082	71.6759	298	X	0	LO	NO	OT	X
GEO2010180	Pacific walrus	2	30/08/2010 08:24:58	-163.211	71.6938	1230	1683	1	LO	CD	SH	60
GEO2010181	Bearded seal	1	30/08/2010 08:28:23	-163.195	71.6937	150	512	1	SW	NO	SH	60
TAN201088	Pacific walrus	1	30/08/2010 08:30:11	-163.046	71.6756	478	X	0	SW	NO	OT	X
TAN201089	Pacific walrus	2	30/08/2010 08:34:40	-163.026	71.6753	298	X	1	SW	LO	OT	X
NOR201093	Pacific walrus	4	30/08/2010 08:34:50	-163.218	71.722	1785	X	1	U	NO	OT	X
NOR201094	Pacific walrus	3	30/08/2010 08:41:16	-163.18	71.7279	1072	X	1	ST	CD	OT	X
GEO2010182	Pacific walrus	3	30/08/2010 08:48:58	-163.112	71.6904	1076	1518	1	SW	NO	SH	60
GEO2010183	Pacific walrus	2	30/08/2010 08:53:20	-163.097	71.6884	2913	3313	1	LO	NO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010184	Pacific walrus	2	30/08/2010 09:06:10	-163.057	71.6791	574	950	1	LO	LO	SH	60
TAN201090	Pacific walrus	1	30/08/2010 09:09:35	-162.99	71.6419	685	X	1	LO	LO	OT	X
TAN201091	Pacific walrus	2	30/08/2010 09:17:40	-162.995	71.6315	1217	X	1	SI	NO	OT	X
NOR201095	Pacific walrus	1	30/08/2010 09:20:38	-162.961	71.7693	150	X	2	ST	NO	OT	X
TAN201092	Pacific walrus	3	30/08/2010 09:22:20	-162.998	71.6255	367	X	1	LO	CD	OT	X
TAN201093	Pacific walrus	2	30/08/2010 09:26:42	-163.006	71.6207	298	X	1	SW	NO	OT	X
TAN201094	Pacific walrus	1	30/08/2010 09:30:10	-163.014	71.6162	190	X	1	SW	LO	OT	X
TAN201095	Pacific walrus	2	30/08/2010 09:32:40	-163.021	71.6132	1217	X	1	SW	NO	OT	X
NOR201096	Pacific walrus	2	30/08/2010 09:32:54	-162.902	71.753	100	X	2	SW	NO	OT	X
TAN201096	Pacific walrus	2	30/08/2010 09:36:27	-163.034	71.6093	685	X	1	SI	NO	OT	X
GEO2010185	Pacific walrus	1	30/08/2010 09:36:45	-163.018	71.6447	2165	2324	1	LO	LO	SH	60
TAN201097	Pacific walrus	2	30/08/2010 09:39:47	-163.046	71.606	367	X	1	SW	NO	OT	X
TAN201098	Pacific walrus	3	30/08/2010 09:42:57	-163.059	71.6037	685	X	1	LO	LO	OT	X
TAN201099	Pacific walrus	2	30/08/2010 09:44:58	-163.067	71.6023	1217	X	1	LO	LO	OT	X
TAN2010100	Pacific walrus	2	30/08/2010 09:47:10	-163.076	71.6008	876	X	1	LO	LO	OT	X
TAN2010101	Bearded seal	1	30/08/2010 09:50:40	-163.091	71.5983	128	X	1	LO	NO	OT	X
GEO2010186	Pacific walrus	2	30/08/2010 09:51:25	-163.033	71.6272	1436	1614	1	SW	NO	SH	60
TAN2010102	Pacific walrus	2	30/08/2010 09:52:18	-163.098	71.5972	298	X	1	LO	LO	OT	X
TAN2010103	Unidentified pinniped	1	30/08/2010 09:54:28	-163.107	71.5957	685	X	1	SW	NO	OT	X
TAN2010104	Pacific walrus	3	30/08/2010 09:55:54	-163.113	71.5952	100	X	1	SW	NO	OT	X
TAN2010105	Pacific walrus	1	30/08/2010 09:58:00	-163.122	71.5945	60	X	1	SW	IS	OT	X
GEO2010187	Pacific walrus	4	30/08/2010 10:11:47	-163.086	71.6095	1725	2070	1	SW	CD	SH	60
GEO2010188	Pacific walrus	2	30/08/2010 10:16:30	-163.101	71.6069	1725	2070	1	SW	NO	SH	60
TAN2010106	Pacific walrus	2	30/08/2010 10:24:56	-163.254	71.5902	1217	X	1	LO	CD	OT	X
GEO2010189	Pacific walrus	2	30/08/2010 10:25:54	-163.134	71.6037	1230	1671	1	SW	NO	SH	60
GEO2010190	Pacific walrus	2	30/08/2010 10:35:59	-163.17	71.6023	2913	2948	1	SW	NO	SH	60
TAN2010107	Pacific walrus	1	30/08/2010 10:38:47	-163.322	71.5867	250	X	1	DI	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010108	Pacific walrus	4	30/08/2010 10:43:38	-163.346	71.5846	1217	X	1	LO	NO	OT	X
NOR201097	Pacific walrus	1	30/08/2010 10:48:54	-162.517	71.7644	450	X	2	LO	NO	OT	X
TAN2010109	Pacific walrus	2	30/08/2010 10:54:55	-163.397	71.5807	1217	X	1	LO	NO	OT	X
GEO2010191	Pacific walrus	2	30/08/2010 10:55:58	-163.255	71.5994	574	478	1	SW	LO	SH	60
TAN2010110	Pacific walrus	2	30/08/2010 11:05:51	-163.453	71.5764	298	X	1	SW	IS	OT	X
NOR201098	Pacific walrus	1	30/08/2010 11:07:05	-162.419	71.7404	50	X	2	SW	LO	OT	X
GEO2010192	Pacific walrus	1	30/08/2010 11:13:10	-163.329	71.5966	2165	2212	2	SW	NO	SH	60
NOR201099	Unidentified pinniped	1	30/08/2010 11:14:01	-162.39	71.7336	150	X	2	U	NO	OT	X
NOR2010100	Pacific walrus	2	30/08/2010 11:15:42	-162.382	71.7317	417	X	2	SI	NO	OT	X
TAN2010111	Unidentified seal	1	30/08/2010 11:28:40	-163.518	71.5719	100	X	1	SW	SP	OT	X
NOR2010101	Pacific walrus	7	30/08/2010 11:33:14	-162.349	71.7079	320	X	2	SW	NO	OT	X
NOR2010102	Pacific walrus	1	30/08/2010 11:47:40	-162.401	71.6883	100	X	2	ST	IS	OT	X
TAN2010112	Ringed seal	1	30/08/2010 11:57:55	-163.648	71.5645	100	X	1	SW	LO	OT	X
NOR2010103	Pacific walrus	3	30/08/2010 11:59:19	-162.433	71.6749	800	X	2	LO	NO	OT	X
GEO2010193	Unidentified seal	1	30/08/2010 12:01:30	-163.536	71.5891	300	698	2	LO	NO	RU	3000
NOR2010104	Pacific walrus	3	30/08/2010 12:06:56	-162.454	71.6653	300	X	2	SW	NO	OT	X
NOR2010105	Pacific walrus	6	30/08/2010 12:17:28	-162.503	71.6476	300	X	2	SW	NO	OT	X
NOR2010106	Pacific walrus	3	30/08/2010 12:28:30	-162.486	71.6305	400	X	2	SW	NO	OT	X
GEO2010194	Pacific walrus	1	30/08/2010 12:31:00	-163.645	71.5898	410	747	2	SW	LO	SH	3000
NOR2010107	Pacific walrus	150	30/08/2010 12:35:03	-162.465	71.6211	500	X	2	ST	NO	OT	X
GEO2010195	Pacific walrus	1	30/08/2010 12:59:02	-163.765	71.5907	956	1159	2	SW	NO	SH	60
NOR2010108	Pacific walrus	2	30/08/2010 13:03:10	-162.5	71.6009	100	X	2	LO	NO	OT	X
NOR2010109	Pacific walrus	1	30/08/2010 13:09:35	-162.538	71.5966	417	X	2	SW	NO	OT	X
NOR2010110	Pacific walrus	1	30/08/2010 13:47:34	-162.784	71.5713	200	X	2	SW	LO	OT	X
NOR2010111	Pacific walrus	2	30/08/2010 13:53:47	-162.819	71.5643	300	X	2	SW	NO	OT	X
GEO2010196	Pacific walrus	2	30/08/2010 14:02:15	-164.001	71.5999	1230	1638	2	LO	LO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010197	Pacific walrus	2	30/08/2010 14:10:30	-164.033	71.6022	662	1106	2	SW	CD	SH	60
GEO2010198	Pacific walrus	1	30/08/2010 14:16:56	-164.059	71.6039	662	699	2	SW	NO	SH	60
NOR2010112	Pacific walrus	2	30/08/2010 14:26:35	-163.016	71.5275	250	X	2	ST	LO	OT	X
GEO2010199	Pacific walrus	1	30/08/2010 14:30:20	-164.11	71.607	2165	2094	2	SW	NO	SH	60
GEO2010200	Pacific walrus	1	30/08/2010 14:44:38	-164.158	71.6088	1230	1683	2	SW	NO	SH	60
GEO2010201	Bearded seal	1	30/08/2010 14:48:30	-164.171	71.6089	319	477	2	LO	LO	SH	60
GEO2010202	Pacific walrus	1	30/08/2010 15:05:45	-164.231	71.6093	782	1196	2	SW	NO	SH	60
TAN2010113	Unidentified seal	1	30/08/2010 15:12:10	-164.4	71.623	40	X	2	LO	LO	OT	X
TAN2010114	Bearded seal	1	30/08/2010 15:17:16	-164.423	71.6254	367	X	2	LO	LO	OT	X
NOR2010113	Pacific walrus	1	30/08/2010 15:23:24	-163.351	71.5657	320	X	2	LO	NO	OT	X
GEO2010203	Unidentified seal	1	30/08/2010 15:29:13	-164.314	71.6096	956	1159	2	LO	NO	SH	60
GEO2010204	Pacific walrus	1	30/08/2010 15:50:48	-164.393	71.6073	375	765	1	SW	NO	SH	60
GEO2010205	Unidentified seal	1	30/08/2010 15:56:45	-164.413	71.6043	1725	2178	1	SW	NO	SH	60
TAN2010115	Unidentified seal	1	30/08/2010 16:00:29	-164.522	71.6234	190	X	2	SW	LO	OT	X
GEO2010206	Unidentified seal	1	30/08/2010 16:16:00	-164.467	71.5878	1725	2070	1	SW	NO	SH	60
TAN2010116	Spotted seal	1	30/08/2010 16:28:08	-164.618	71.5838	685	X	1	SW	NO	OT	X
GEO2010207	Bearded seal	1	30/08/2010 16:41:00	-164.546	71.5715	300	728	1	LO	LO	SH	60
GEO2010208	Pacific walrus	2	30/08/2010 16:52:05	-164.587	71.5703	200	611	1	SW	NO	SH	60
NOR2010114	Bearded seal	1	30/08/2010 16:57:21	-163.924	71.5655	320	X	2	LO	NO	OT	X
GEO2010209	Unidentified seal	1	30/08/2010 17:05:53	-164.637	71.5738	1230	1638	1	SW	NO	SH	60
NOR2010115	Bearded seal	1	30/08/2010 17:11:03	-164.009	71.5507	320	X	1	SW	NO	OT	X
GEO2010210	Bearded seal	1	30/08/2010 17:12:20	-164.658	71.5771	350	776	1	SW	LO	SH	60
TAN2010117	Bearded seal	1	30/08/2010 17:17:45	-164.754	71.6049	200	X	1	SW	NO	OT	X
GEO2010211	Unidentified seal	1	30/08/2010 17:18:50	-164.676	71.5819	956	1367	1	SW	NO	SH	60
NOR2010116	Bearded seal	1	30/08/2010 17:21:36	-164.075	71.5397	417	X	1	LO	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR2010117	Bearded seal	1	30/08/2010 17:31:36	-164.137	71.5448	218	X	1	LO	NO	OT	X
NOR2010118	Bearded seal	1	30/08/2010 17:52:38	-164.263	71.567	320	X	1	LO	NO	OT	X
NOR2010119	Unidentified seal	1	30/08/2010 18:22:02	-164.441	71.5717	200	X	1	U	NO	OT	X
GEO2010218	Unidentified pinniped	1	30/08/2010 18:23:33	-164.682	71.6464	1230	1508	1	LO	NO	SH	60
TAN2010118	Unidentified pinniped	2	30/08/2010 18:30:08	-164.505	71.6523	60	X	1	SW	NO	OT	X
GEO2010212	Pacific walrus	2	30/08/2010 18:36:20	-164.646	71.6547	4518	4915	1	LO	NO	SH	60
NOR2010120	Ringed seal	1	30/08/2010 18:43:05	-164.569	71.5485	259	X	1	SW	NO	OT	X
GEO2010213	Pacific walrus	3	30/08/2010 18:43:12	-164.623	71.6576	1725	2178	1	SW	NO	SH	60
GEO2010214	Unidentified seal	1	30/08/2010 18:47:20	-164.609	71.6588	860	1223	1	SW	NO	SH	60
TAN2010119	Unidentified seal	1	30/08/2010 18:50:08	-164.435	71.6511	250	X	1	LG	NO	OT	X
NOR2010121	Bearded seal	1	30/08/2010 18:50:30	-164.614	71.54	320	X	1	LO	LO	OT	X
GEO2010215	Pacific walrus	2	30/08/2010 19:00:05	-164.564	71.6595	662	971	1	SW	NO	SH	60
GEO2010216	Bearded seal	1	30/08/2010 19:09:01	-164.533	71.6581	2165	2618	0	SW	NO	SH	60
GEO2010217	Unidentified seal	1	30/08/2010 19:18:03	-164.503	71.6582	956	1246	0	SW	NO	SH	60
TAN2010120	Unidentified seal	1	30/08/2010 19:26:12	-164.307	71.6472	478	X	1	LO	NO	OT	X
GEO2010219	Bearded seal	1	30/08/2010 19:28:01	-164.469	71.658	782	1148	0	SW	NO	SH	60
NOR2010122	Pacific walrus	1	30/08/2010 19:29:12	-164.826	71.585	100	X	1	SW	LO	OT	X
GEO2010220	Unidentified seal	1	30/08/2010 19:34:10	-164.448	71.658	453	837	0	SW	NO	SH	60
TAN2010121	Bearded seal	1	30/08/2010 19:35:41	-164.273	71.6461	298	X	1	LG	NO	OT	X
GEO2010221	Bearded seal	1	30/08/2010 19:39:30	-164.43	71.658	506	886	0	SW	NO	RU	3000
GEO2010222	Bearded seal	1	30/08/2010 19:45:59	-164.408	71.658	400	739	0	SW	LO	RU	3000
NOR2010123	Ringed seal	1	30/08/2010 19:50:01	-164.948	71.5615	50	X	1	SW	SP	OT	X
TAN2010122	Ribbon seal	1	30/08/2010 19:50:22	-164.251	71.6464	170	X	1	SW	NO	OT	X
GEO2010223	Pacific walrus	3	30/08/2010 19:51:10	-164.39	71.6579	2165	2567	0	SW	LO	RU	3000

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010224	Unidentified seal	1	30/08/2010 19:51:59	-164.387	71.658	1230	1671	0	SW	NO	RU	3000
GEO2010225	Unidentified pinniped	1	30/08/2010 19:59:45	-164.359	71.658	2913	3249	0	SW	NO	SH	60
NOR2010124	Bearded seal	1	30/08/2010 20:16:17	-165.094	71.5413	1000	X	0	SW	LO	OT	X
NOR2010125	Unidentified seal	1	30/08/2010 20:21:19	-165.114	71.5488	200	X	0	DI	LO	OT	X
GEO2010226	Unidentified seal	2	30/08/2010 20:22:16	-164.27	71.6577	400	677	1	LO	LO	SH	60
NOR2010126	Pacific walrus	1	30/08/2010 20:23:59	-165.125	71.553	200	X	0	SW	LO	OT	X
GEO2010227	Unidentified seal	1	30/08/2010 20:30:02	-164.237	71.6575	100	510	1	SW	IS	SH	60
GEO2010228	Bearded seal	1	30/08/2010 20:33:52	-164.22	71.6574	662	802	1	SW	NO	SH	60
NOR2010127	Unidentified seal	1	30/08/2010 20:37:26	-165.177	71.5752	600	X	0	SW	NO	OT	X
GEO2010229	Pacific walrus	2	30/08/2010 20:43:10	-164.18	71.6572	662	1033	1	SW	NO	SH	60
NOR2010128	Bearded seal	1	30/08/2010 20:46:38	-165.226	71.5856	417	X	0	SW	LO	OT	X
TAN2010123	Unidentified seal	1	30/08/2010 20:48:36	-164.031	71.642	50	X	1	LO	LO	OT	X
TAN2010124	Bearded seal	1	30/08/2010 21:20:20	-163.898	71.6403	30	X	1	LO	LO	OT	X
GEO2010230	Unidentified pinniped	3	30/08/2010 21:36:07	-163.947	71.6561	2165	2618	1	SW	NO	SH	60
GEO2010231	Unidentified seal	1	30/08/2010 21:39:10	-163.933	71.656	662	971	1	SW	NO	SH	60
TAN2010126	Unidentified pinniped	1	30/08/2010 22:03:10	-163.696	71.6392	563	X	1	LO	NO	OT	X
GEO2010232	Pacific walrus	2	30/08/2010 22:13:00	-163.797	71.6553	1725	1666	1	SW	NO	RU	3000
GEO2010233	Unidentified pinniped	2	30/08/2010 22:20:30	-163.766	71.6551	2165	2618	1	SW	NO	RU	3000
GEO2010234	Bearded seal	1	30/08/2010 22:43:30	-163.665	71.6545	662	971	2	SW	NO	SH	3000
TAN2010125	Bearded seal	1	30/08/2010 22:51:15	-163.5	71.6375	685	X	1	LO	LO	OT	X
GEO2010235	Bearded seal	2	30/08/2010 23:40:23	-163.405	71.6525	782	1082	1	SW	NO	LS	3000
NOR2010129	Pacific walrus	20	31/08/2010 05:57:07	-162.666	71.7312	20	X	X	SW	IS	OT	X
NOR2010130	Pacific walrus	5	31/08/2010 06:19:20	-162.573	71.759	700	X	1	ST	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR2010131	Pacific walrus	3	31/08/2010 06:33:17	-162.502	71.7603	40	X	1	SW	IS	OT	X
NOR2010132	Unidentified seal	1	31/08/2010 07:26:15	-162.379	71.7009	300	X	1	SW	IS	OT	X
TAN2010127	Ringed seal	1	31/08/2010 07:30:15	-164.683	71.6146	119	X	1	LG	LO	OT	X
NOR2010133	Pacific walrus	2	31/08/2010 07:39:35	-162.436	71.6783	500	X	1	LO	NO	OT	X
NOR2010134	Pacific walrus	6	31/08/2010 07:53:06	-162.491	71.6552	300	X	1	LO	LO	OT	X
GEO2010236	Bearded seal	1	31/08/2010 08:10:10	-164.678	71.6266	100	528	1	SW	NO	SH	60
NOR2010135	Pacific walrus	2	31/08/2010 08:14:34	-162.451	71.6167	100	X	1	LO	LO	OT	X
NOR2010136	Pacific walrus	4	31/08/2010 08:18:06	-162.437	71.611	500	X	1	LO	LO	OT	X
NOR2010137	Pacific walrus	3	31/08/2010 08:54:02	-162.418	71.5564	600	X	1	LO	LO	OT	X
NOR2010138	Pacific walrus	2	31/08/2010 09:11:54	-162.511	71.5316	150	X	1	SW	NO	OT	X
TAN2010128	Unidentified seal	1	31/08/2010 09:20:14	-164.466	71.7069	10	X	1	DI	SP	OT	X
TAN2010129	Bearded seal	1	31/08/2010 09:31:08	-164.422	71.7085	40	X	1	SW	CD	OT	X
NOR2010139	Pacific walrus	1	31/08/2010 09:35:34	-162.64	71.5451	600	X	1	ST	NO	OT	X
GEO2010237	Bearded seal	1	31/08/2010 10:25:21	-164.29	71.6952	100	510	1	SW	NO	SH	3000
GEO2010238	Pacific walrus	1	31/08/2010 10:26:10	-164.287	71.6953	662	1106	1	SW	IS	SH	60
GEO2010239	Bearded seal	1	31/08/2010 10:44:48	-164.207	71.6949	506	951	1	SW	NO	SH	60
GEO2010240	Pacific walrus	2	31/08/2010 11:50:15	-163.979	71.6794	1230	1671	2	SW	CD	SH	60
NOR2010140	Unidentified pinniped	1	31/08/2010 12:47:29	-163.74	71.5621	200	X	2	U	NO	OT	X
TAN2010130	Unidentified seal	1	31/08/2010 13:33:16	-164.287	71.5881	50	X	2	SW	NO	OT	X
GEO2010241	Bearded seal	1	31/08/2010 17:25:20	-164.403	71.6959	782	604	3	SW	NO	RU	3000
GEO2010242	Bearded seal	1	31/08/2010 17:36:30	-164.364	71.6958	1076	1432	3	SW	LO	RU	3000
TAN2010131	Bearded seal	1	31/08/2010 18:10:06	-164.116	71.6814	216	X	2	SW	NO	OT	X
NOR2010141	Pacific walrus	1	31/08/2010 18:10:09	-163.344	71.7367	600	X	2	SW	NO	OT	X
NOR2010142	Pacific walrus	2	31/08/2010 19:19:47	-162.944	71.7647	300	X	2	SW	NO	OT	X
NOR2010143	Pacific walrus	2	31/08/2010 20:06:56	-162.689	71.7283	150	X	3	SW	NO	OT	X
NOR2010144	Pacific walrus	2	31/08/2010 20:17:35	-162.631	71.7421	500	X	3	SW	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR2010145	Pacific walrus	2	31/08/2010 20:38:53	-162.518	71.7631	100	X	3	SW	NO	OT	X
TAN2010132	Unidentified pinniped	1	31/08/2010 20:38:55	-163.456	71.674	400	X	2	SW	NO	OT	X
NOR2010146	Pacific walrus	3	31/08/2010 22:42:23	-162.36	71.5736	259	X	3	LO	NO	OT	X
GEO2010243	Pacific walrus	1	31/08/2010 22:47:55	-163.018	71.6866	250	681	3	SW	NO	LS	3000
NOR2010147	Pacific walrus	1	31/08/2010 23:11:47	-162.508	71.5324	417	X	3	LO	NO	OT	X
GEO2010244	Bearded seal	1	01/09/2010 08:37:50	-164.589	71.6154	300	698	2	SW	IS	LS	3000
TAN2010133	Unidentified seal	1	01/09/2010 09:12:30	-164.877	71.6323	250	X	1	LO	NO	OT	X
GEO2010245	Unidentified seal	1	01/09/2010 10:25:55	-164.927	71.6678	662	893	2	LO	NO	SH	60
NOR2010148	Unidentified pinniped	1	01/09/2010 12:36:30	-165.107	71.5591	50	X	3	U	NO	OT	X
GEO2010246	Pacific walrus	2	01/09/2010 17:20:40	-163.217	71.6992	3000	1410	2	LO	NO	LS	3000
TAN2010134	Pacific walrus	3	01/09/2010 20:32:07	-162.723	71.6093	50	X	2	SW	LO	OT	X
TAN2010135	Unidentified pinniped	1	01/09/2010 22:14:10	-163.143	71.6223	685	X	2	LO	NO	OT	X
NOR2010149	Pacific walrus	1	02/09/2010 09:51:21	-162.854	71.571	60	X	3	SW	NO	OT	X
TAN2010136	Pacific walrus	2	02/09/2010 15:34:19	-162.645	71.6626	300	X	4	SW	LO	OT	X
TAN2010137	Pacific walrus	1	02/09/2010 16:55:20	-162.794	71.6139	60	X	4	LO	NO	OT	X
GEO2010247	Bearded seal	1	02/09/2010 19:19:05	-163.229	71.6175	250	617	6	SW	LO	SH	60
GEO2010248	Ringed seal	1	02/09/2010 22:58:07	-164.199	71.6251	100	464	3	SW	LO	LS	3000
TAN2010138	Pacific walrus	1	03/09/2010 06:24:33	-163.901	71.7029	150	X	2	LO	LO	OT	X
TAN2010139	Unidentified seal	1	03/09/2010 16:46:21	-163.424	71.5561	50	X	4	LO	LO	OT	X
GEO2010249	Unidentified seal	1	04/09/2010 12:12:15	-163.319	71.6297	700	1143	6	LO	NO	RU	3000
TAN2010140	Unidentified seal	1	04/09/2010 13:39:46	-163.781	71.6537	50	X	4	LO	LO	OT	X
TAN2010142	Ringed seal	1	05/09/2010 08:16:20	-163.462	71.6508	30	X	2	LO	SP	OT	X
GEO2010250	Bearded seal	1	05/09/2010 13:34:01	-164.695	71.6428	70	515	3	LO	LO	LS	3000
TAN2010141	Bearded seal	1	05/09/2010 13:46:58	-164.796	71.6451	75	X	2	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR2010150	Bearded seal	1	05/09/2010 14:02:56	-164.36	71.7199	60	X	2	LO	LO	OT	X
TAN2010147	Gray whale	3	06/09/2010 04:50:00	-166.728	69.3903	685	X	X	DI	NO	OT	X
NOR2010151	Pacific walrus	3	06/09/2010 08:24:19	-162.461	71.6523	400	X	3	LO	LO	OT	X
TAN2010143	Unidentified mysticete whale	1	06/09/2010 08:43:35	-167.137	68.7488	298	X	2	BL	NO	OT	X
TAN2010144	Unidentified whale	1	06/09/2010 09:08:11	-167.156	68.7025	298	X	2	DE	NO	OT	X
GEO2010251	Pacific walrus	2	06/09/2010 13:42:40	-164.442	71.6581	750	1117	3	LO	LO	RU	3000
NOR2010152	Ringed seal	1	06/09/2010 17:42:20	-164.855	71.6202	150	X	3	LO	LO	OT	X
NOR2010153	Pacific walrus	1	06/09/2010 18:09:43	-164.989	71.6732	70	X	3	DI	SP	OT	X
GEO2010252	Pacific walrus	1	06/09/2010 20:25:32	-162.787	71.6894	150	603	4	SW	LO	LS	3000
NOR2010154	Unidentified seal	1	07/09/2010 11:46:50	-164.155	71.8978	80	X	2	SW	NO	OT	X
NOR2010155	Unidentified pinniped	1	07/09/2010 14:53:59	-163.007	71.898	150	X	4	DI	NO	OT	X
NOR2010156	Pacific walrus	2	07/09/2010 16:09:44	-162.638	71.8877	60	X	5	LO	NO	OT	X
NOR2010157	Pacific walrus	2	07/09/2010 20:38:50	-163.016	71.7578	150	X	5	SW	NO	OT	X
NOR2010158	Pacific walrus	2	07/09/2010 21:41:28	-163.289	71.7626	100	X	5	LO	NO	OT	X
NOR2010159	Pacific walrus	2	08/09/2010 09:52:13	-164.53	71.6636	75	X	1	LO	CD	OT	X
NOR2010160	Ringed seal	1	08/09/2010 10:13:41	-164.426	71.6579	40	X	1	LO	NO	OT	X
NOR2010161	Bearded seal	1	08/09/2010 10:20:35	-164.394	71.6668	45	X	1	SW	NO	OT	X
NOR2010162	Bearded seal	1	08/09/2010 10:48:35	-164.266	71.7016	200	X	1	DI	NO	OT	X
NOR2010163	Bearded seal	1	08/09/2010 12:16:09	-163.842	71.67	320	X	1	LO	NO	OT	X
NOR2010164	Unidentified seal	1	08/09/2010 12:39:59	-163.766	71.6905	150	X	1	LO	NO	OT	X
GEO2010253	Bearded seal	1	08/09/2010 13:08:38	-162.967	71.8422	782	1225	2	SW	NO	LS	3000
GEO2010254	Pacific walrus	2	08/09/2010 13:08:38	-162.967	71.8422	1725	2165	2	SW	NO	LS	3000
NOR2010165	Unidentified seal	1	08/09/2010 13:22:10	-163.613	71.6982	100	X	1	LO	NO	OT	X
NOR2010166	Pacific walrus	1	08/09/2010 13:30:45	-163.578	71.6892	400	X	1	SW	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010255	Unidentified seal	1	08/09/2010 13:37:29	-162.843	71.841	1230	1671	1	LO	LO	LS	3000
GEO2010256	Unidentified seal	1	08/09/2010 13:47:00	-162.801	71.8404	782	1148	1	DI	NO	LS	3000
NOR2010167	Unidentified seal	1	08/09/2010 13:53:31	-163.485	71.6678	150	X	1	DI	NO	OT	X
NOR2010168	Pacific walrus	2	08/09/2010 13:57:15	-163.47	71.6643	400	X	1	SW	NO	OT	X
GEO2010257	Pacific walrus	2	08/09/2010 14:03:50	-162.728	71.8395	1725	2070	1	SW	NO	LS	3000
GEO2010258	Bearded seal	1	08/09/2010 14:05:42	-162.72	71.8394	574	1018	1	SW	LO	LS	3000
GEO2010259	Unidentified seal	1	08/09/2010 14:16:55	-162.67	71.8388	100	542	1	SW	SP	LS	3000
GEO2010260	Unidentified pinniped	2	08/09/2010 14:30:27	-162.61	71.8381	2913	3313	1	SW	NO	LS	3000
NOR2010169	Bearded seal	1	08/09/2010 14:46:34	-163.285	71.6716	450	X	2	LO	NO	OT	X
GEO2010261	Unidentified pinniped	2	08/09/2010 15:08:32	-162.476	71.8209	2913	3352	1	SW	NO	SH	60
GEO2010262	Pacific walrus	4	08/09/2010 15:15:34	-162.461	71.8138	956	1398	1	SW	NO	SH	60
GEO2010263	Pacific walrus	2	08/09/2010 15:19:59	-162.454	71.8089	1725	2178	1	SW	NO	SH	60
GEO2010264	Unidentified seal	1	08/09/2010 15:30:58	-162.445	71.7957	782	1148	1	SW	NO	SH	60
GEO2010265	Pacific walrus	2	08/09/2010 15:30:58	-162.445	71.7957	1725	2129	1	SW	NO	SH	60
NOR2010170	Bearded seal	1	08/09/2010 15:37:55	-163.106	71.7025	400	X	2	LO	NO	OT	X
GEO2010266	Pacific walrus	2	08/09/2010 15:46:10	-162.454	71.7772	1436	1785	1	LO	NO	SH	60
GEO2010267	Pacific walrus	1	08/09/2010 17:27:18	-162.829	71.7383	1436	1889	2	SW	LO	SH	3000
GEO2010268	Pacific walrus	1	08/09/2010 17:29:00	-162.837	71.7383	2913	3313	2	LO	NO	SH	3000
NOR2010171	Unidentified pinniped	1	08/09/2010 17:49:06	-162.61	71.7087	75	X	2	DI	NO	OT	X
GEO2010269	Unidentified pinniped	1	09/09/2010 07:40:06	-163.388	71.8514	1500	1941	2	SW	NO	LS	3000
NOR2010172	Unidentified pinniped	1	09/09/2010 07:53:55	-162.248	71.8906	700	X	1	LO	NO	OT	X
NOR2010173	Bearded seal	2	09/09/2010 07:56:51	-162.262	71.8953	150	X	1	LO	LO	OT	X
NOR2010174	Ringed seal	1	09/09/2010 08:13:40	-162.344	71.9221	50	X	1	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
NOR2010175	Ringed seal	1	09/09/2010 08:36:29	-162.453	71.9191	218	X	1	SA	SP	OT	X
NOR2010176	Pacific walrus	5	09/09/2010 08:54:44	-162.533	71.8907	600	X	1	LO	LO	OT	X
NOR2010177	Pacific walrus	2	09/09/2010 10:18:09	-162.935	71.9136	500	X	1	SW	NO	OT	X
GEO2010270	Pacific walrus	2	09/09/2010 10:20:40	-162.658	71.8437	50	497	2	SW	LO	LS	3000
NOR2010178	Pacific walrus	2	09/09/2010 10:34:26	-163.026	71.8921	417	X	1	SW	NO	OT	X
GEO2010271	Unidentified seal	1	09/09/2010 10:37:09	-162.591	71.8432	400	788	2	SW	NO	SH	60
GEO2010272	Ringed seal	1	09/09/2010 10:51:18	-162.537	71.8435	200	495	2	LO	LO	SH	60
GEO2010273	Bearded seal	1	09/09/2010 11:27:07	-162.42	71.8219	400	824	1	SW	NO	SH	60
NOR2010179	Bearded seal	1	09/09/2010 12:11:13	-163.549	71.9069	417	X	1	LO	NO	OT	X
NOR2010180	Pacific walrus	2	09/09/2010 12:31:02	-163.662	71.8814	150	X	1	SW	LO	OT	X
GEO2010274	Unidentified seal	1	09/09/2010 12:52:45	-162.559	71.7509	300	728	1	SW	NO	SH	60
GEO2010275	Pacific walrus	5	09/09/2010 12:57:21	-162.578	71.7494	453	875	1	SW	LO	SH	60
GEO2010276	Unidentified seal	1	09/09/2010 13:05:40	-162.612	71.7465	750	1164	2	DI	NO	SH	60
NOR2010181	Pacific walrus	1	09/09/2010 13:44:59	-164.064	71.9199	362	X	1	SW	NO	OT	X
GEO2010277	Unidentified seal	1	09/09/2010 13:47:20	-162.756	71.7427	1000	1442	1	LO	NO	RU	3000
NOR2010182	Pacific walrus	17	09/09/2010 14:03:23	-164.17	71.8946	769	X	1	LO	NO	OT	X
GEO2010278	Pacific walrus	5	09/09/2010 14:06:15	-162.823	71.7437	500	880	2	SW	LO	SH	3000
NOR2010183	Bearded seal	1	09/09/2010 14:09:56	-164.209	71.8861	50	X	1	LO	NO	OT	X
NOR2010184a	Ringed seal	1	09/09/2010 14:20:38	-164.272	71.8848	65	X	1	LO	X	OT	X
NOR2010184b	Bearded seal	1	09/09/2010 14:20:38	-164.272	71.8848	65	X	1	LO	X	OT	X
NOR2010185	Pacific walrus	2	09/09/2010 14:25:27	-164.295	71.8921	300	X	1	ST	CD	OT	X
NOR2010186	Bearded seal	1	09/09/2010 14:29:22	-164.313	71.8979	600	X	1	LO	LO	OT	X
NOR2010187	Bearded seal	1	09/09/2010 14:38:23	-164.354	71.911	30	X	1	LO	LO	OT	X
NOR2010188	Bearded seal	1	09/09/2010 14:45:03	-164.386	71.9208	100	X	1	LO	LO	OT	X
NOR2010189	Bearded seal	1	09/09/2010 14:55:43	-164.438	71.9362	250	X	1	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010279	Unidentified seal	1	09/09/2010 14:56:36	-163.047	71.7462	453	898	2	SW	NO	RU	3000
GEO2010280	Pacific walrus	7	09/09/2010 15:00:00	-163.063	71.7465	1725	2129	2	SW	NO	RU	3000
GEO2010281	Bearded seal	1	09/09/2010 15:08:10	-163.101	71.7468	662	802	1	SW	NO	LS	3000
GEO2010282	Unidentified seal	1	09/09/2010 15:31:44	-163.208	71.7477	2913	3062	2	LO	NO	LS	3000
NOR2010190	Bearded seal	1	09/09/2010 15:32:08	-164.616	71.9109	417	X	1	LO	LO	OT	X
GEO2010283	Pacific walrus	2	09/09/2010 15:38:19	-163.238	71.7482	2165	2567	2	LO	CD	LS	3000
GEO2010284	Unidentified seal	1	09/09/2010 15:53:30	-163.306	71.7489	3534	3677	2	LO	NO	LS	3000
GEO2010285	Pacific walrus	2	09/09/2010 15:54:00	-163.309	71.7488	300	698	2	SW	CD	LS	3000
GEO2010286	Ringed seal	2	09/09/2010 16:08:57	-163.377	71.7495	782	1196	1	SW	NO	SH	60
GEO2010288	Pacific walrus	2	09/09/2010 16:18:44	-163.416	71.7497	345	791	1	SW	NO	SH	60
GEO2010287	Unidentified seal	1	09/09/2010 16:22:00	-163.428	71.7498	1000	1410	1	SW	NO	SH	60
NOR2010191	Unidentified seal	1	09/09/2010 16:30:06	-164.862	71.9433	450	X	1	SA	SP	OT	X
GEO2010289	Unidentified seal	2	09/09/2010 16:34:58	-163.476	71.7502	782	1235	2	SW	NO	SH	60
GEO2010290	Pacific walrus	2	09/09/2010 16:41:50	-163.502	71.7504	2913	3249	2	LO	NO	SH	60
NOR2010192	Bearded seal	1	09/09/2010 16:42:38	-164.91	71.9492	200	X	1	SW	LO	OT	X
GEO2010291	Pacific walrus	8	09/09/2010 16:51:39	-163.539	71.7507	1436	1785	2	SW	CD	SH	60
GEO2010292	Pacific walrus	2	09/09/2010 16:58:00	-163.562	71.7509	3000	3034	2	LO	NO	SH	60
GEO2010293	Pacific walrus	4	09/09/2010 17:04:10	-163.585	71.751	2913	2165	1	LO	NO	SH	60
GEO2010294	Ringed seal	1	09/09/2010 17:05:00	-163.589	71.751	250	517	1	SW	LO	SH	60
GEO2010295	Bearded seal	1	09/09/2010 18:11:25	-163.836	71.7525	700	1006	1	SW	LO	RU	3000
GEO2010296	Pacific walrus	2	09/09/2010 18:40:30	-163.957	71.7533	1725	2165	2	SW	NO	LS	3000
GEO2010297	Pacific walrus	2	09/09/2010 22:29:50	-164.787	71.8179	956	1398	2	SW	NO	SH	60
GEO2010298	Pacific walrus	1	10/09/2010 06:43:30	-162.773	71.8506	500	825	1	LO	LO	LS	3000
GEO2010299	Pacific walrus	1	10/09/2010 09:10:10	-162.669	71.7474	1000	1410	2	SW	CD	RU	3000
GEO2010300	Pacific walrus	1	10/09/2010 09:29:30	-162.742	71.7479	2000	2440	2	SW	NO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010301	Pacific walrus	5	10/09/2010 10:22:33	-162.943	71.7502	800	1213	2	SW	NO	SH	3000
GEO2010302	Unidentified pinniped	1	10/09/2010 10:49:26	-163.063	71.7515	1725	1893	2	SW	NO	LS	3000
NOR2010193	Pacific walrus	2	10/09/2010 11:27:02	-163.148	71.7061	250	X	2	SW	NO	OT	X
NOR2010194	Pacific walrus	1	10/09/2010 11:55:20	-163.003	71.6693	35	X	2	SW	CD	OT	X
NOR2010195	Pacific walrus	1	10/09/2010 12:39:24	-162.86	71.5787	80	X	2	SW	NO	OT	X
NOR2010196	Unidentified pinniped	1	10/09/2010 12:51:10	-162.855	71.5475	90	X	2	U	NO	OT	X
GEO2010303	Unidentified seal	1	10/09/2010 13:08:25	-163.68	71.7571	662	1106	3	SW	NO	LS	3000
NOR2010197	Pacific walrus	3	10/09/2010 15:29:34	-162.405	71.6329	75	X	2	SW	IS	OT	X
NOR2010198	Unidentified pinniped	1	10/09/2010 17:10:51	-162.265	71.8078	50	X	2	DI	NO	OT	X
GEO2010304	Unidentified pinniped	2	10/09/2010 17:12:26	-164.758	71.7714	400	824	3	SW	NO	SH	60
TAN2010153	Bearded seal	1	10/09/2010 21:07:06	-164.488	71.6781	40	X	2	SW	NO	OT	X
NOR2010199	Pacific walrus	2	10/09/2010 22:45:22	-163.331	71.9312	50	X	3	LO	NO	OT	X
GEO2010305	Pacific walrus	2	11/09/2010 11:09:45	-164.275	71.7652	100	542	2	SW	NO	LS	3000
NOR2010200	Bearded seal	1	11/09/2010 12:18:38	-164.771	71.8474	100	X	3	LO	LO	OT	X
GEO2010306	Ringed seal	1	11/09/2010 13:16:02	-164.761	71.7788	100	542	3	SW	CD	SH	60
GEO2010307	Pacific walrus	1	11/09/2010 18:19:12	-163.776	71.8702	200	579	4	SW	LO	LS	3000
GEO2010308	Bearded seal	1	12/09/2010 18:34:00	-162.899	71.8682	40	454	4	DI	NO	LS	3000
NOR2010201	Unidentified pinniped	1	13/09/2010 20:24:10	-162.334	71.9366	25	X	4	DI	NO	OT	X
NOR2010202	Pacific walrus	2	14/09/2010 10:22:20	-162.895	71.6667	362	X	2	SW	CD	OT	X
GEO2010309	Pacific walrus	1	14/09/2010 14:37:17	-162.362	71.8169	40	488	2	SW	NO	SH	60
GEO2010310	Unidentified pinniped	1	14/09/2010 14:52:58	-162.391	71.8001	574	992	2	SW	NO	SH	60
NOR2010203	Unidentified seal	1	14/09/2010 15:08:44	-164.364	71.7457	60	X	2	TH	IS	OT	X
NOR2010204	Unidentified seal	1	14/09/2010 15:55:43	-164.497	71.6796	150	X	2	LO	LO	OT	X
GEO2010311	Pacific walrus	2	14/09/2010 18:46:20	-163.319	71.7812	662	747	3	LO	LO	LS	3000

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010312	Unidentified seal	1	14/09/2010 19:15:08	-163.439	71.7822	200	579	2	SW	LO	SH	60
TAN2010155	Ringed seal	1	15/09/2010 11:06:48	-163.533	71.3493	100	X	3	LO	LO	OT	X
TAN2010156	Unidentified seal	1	15/09/2010 11:14:56	-163.483	71.3705	200	X	3	LO	LO	OT	X
TAN2010157	Bearded seal	1	15/09/2010 11:23:31	-163.43	71.3929	250	X	3	LO	LO	OT	X
GEO2010313	Unknown	1	15/09/2010 11:59:02	-162.308	71.8164	200	634	3	DI	NO	SH	60
NOR2010205	Ringed seal	1	15/09/2010 16:58:18	-163.497	71.5058	40	X	3	LO	SP	OT	X
TAN2010158	Spotted seal	1	16/09/2010 09:07:50	-162.157	71.9144	60	X	2	SW	LO	OT	X
TAN2010159	Unidentified seal	1	16/09/2010 09:35:41	-162.271	71.8506	150	X	2	LO	LO	OT	X
NOR2010206	Bearded seal	1	16/09/2010 10:10:48	-166.565	69.4062	150	X	3	LO	LO	OT	X
GEO2010314	Unidentified mysticete whale	1	16/09/2010 11:48:50	-163.209	71.791	1400	1853	3	BL	NO	LS	3000
GEO2010315	Pacific walrus	3	16/09/2010 12:34:10	-163.408	71.7927	300	656	4	DI	LO	LS	3000
TAN2010160	Bearded seal	1	16/09/2010 14:14:00	-163.486	71.7039	200	X	3	SW	LO	OT	X
GEO2010316	Ringed seal	1	16/09/2010 16:27:29	-164.355	71.7981	200	634	4	SW	LO	LS	3000
GEO2010317	Bearded seal	1	16/09/2010 21:15:50	-164.346	71.9053	40	488	3	SW	LO	SH	3000
GEO2010318	Bearded seal	1	17/09/2010 08:09:23	-163.107	71.7955	662	1078	2	SW	NO	LS	3000
TAN2010161	Unidentified seal	2	17/09/2010 08:32:50	-163.247	71.7911	225	X	1	SW	LO	OT	X
GEO2010319	Bearded seal	1	17/09/2010 09:29:42	-163.463	71.7984	50	430	2	SW	LO	LS	3000
TAN2010162	Unidentified seal	1	17/09/2010 09:52:30	-163.723	71.8099	60	X	1	SA	LO	OT	X
TAN2010163	Bearded seal	1	17/09/2010 09:54:30	-163.74	71.8111	250	X	1	LO	LO	OT	X
TAN2010164	Unidentified seal	1	17/09/2010 14:16:24	-164.111	71.959	50	X	2	SW	NO	OT	X
TAN2010165	Pacific walrus	1	17/09/2010 14:55:00	-164.435	71.8985	298	X	2	SW	NO	OT	X
GEO2010320	Ringed seal	1	17/09/2010 18:05:10	-164.214	71.9102	80	498	3	SW	NO	LS	3000
TAN2010166	Unidentified mysticete whale	1	17/09/2010 20:42:10	-162.902	71.9678	1217	X	2	SW	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010167	Unidentified seal	1	17/09/2010 21:44:00	-162.666	71.9088	75	X	2	RE	IS	OT	X
TAN2010168	Unidentified seal	1	18/09/2010 09:21:06	-164.337	71.8167	100	X	3	SW	NO	OT	X
TAN2010169	Pacific walrus	1	18/09/2010 17:36:30	-163.215	71.8589	250	X	4	ST	LO	OT	X
TAN2010170	Unidentified seal	1	18/09/2010 18:59:25	-162.48	71.8434	216	X	3	LO	LO	OT	X
TAN2010171	Unidentified seal	1	18/09/2010 19:16:00	-162.336	71.8332	200	X	3	LO	LO	OT	X
TAN2010172	Unidentified pinniped	1	18/09/2010 21:00:58	-162.547	71.7103	20	X	3	DI	NO	OT	X
TAN2010173	Unidentified seal	1	19/09/2010 08:50:23	-164.151	71.8885	298	X	2	LO	LO	OT	X
TAN2010174	Unidentified seal	1	19/09/2010 09:39:50	-163.771	71.8147	25	X	2	LO	LO	OT	X
TAN2010175	Unidentified seal	1	19/09/2010 10:26:45	-163.822	71.7362	250	X	2	LO	LO	OT	X
TAN2010176	Bearded seal	1	19/09/2010 11:39:33	-164.272	71.7665	170	X	2	LO	LO	OT	X
TAN2010177	Bearded seal	1	19/09/2010 12:24:11	-164.102	71.7817	250	X	2	LO	LO	OT	X
GEO2010321	Bearded seal	1	19/09/2010 12:52:54	-163.218	71.9147	300	747	3	SW	NO	LS	3000
TAN2010178	Unidentified seal	1	19/09/2010 13:46:00	-163.429	71.8475	153	X	2	SW	LO	OT	X
TAN2010179	Unidentified seal	1	19/09/2010 13:51:05	-163.389	71.8547	20	X	2	SW	NO	OT	X
TAN2010180	Bearded seal	1	19/09/2010 13:56:07	-163.349	71.862	60	X	2	LO	LO	OT	X
GEO2010322	Unidentified seal	4	19/09/2010 14:33:40	-162.803	71.9104	200	653	2	SW	NO	LS	3000
TAN2010181	Unidentified seal	1	19/09/2010 15:07:00	-162.849	71.897	216	X	2	SW	LO	OT	X
GEO2010323	Pacific walrus	1	19/09/2010 15:40:36	-162.542	71.8963	1230	1671	3	SW	NO	SH	60
GEO2010324	Ringed seal	1	19/09/2010 15:46:54	-162.517	71.8942	410	855	3	SW	NO	SH	60
GEO2010325	Ringed seal	1	19/09/2010 17:07:38	-162.432	71.8193	662	656	2	LO	NO	SH	60
TAN2010182	Bearded seal	1	19/09/2010 17:24:20	-163.053	71.8437	250	X	2	SW	SP	OT	X
GEO2010326	Bearded seal	1	19/09/2010 18:31:57	-162.775	71.8078	100	542	2	SW	IS	LS	3000
GEO2010327	Bearded seal	1	19/09/2010 18:49:37	-162.853	71.8085	150	477	2	MI	NO	LS	3000

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010328	Bearded seal	2	19/09/2010 18:55:35	-162.879	71.8088	100	528	2	SW	NO	LS	3000
GEO2010329	Unidentified mysticete whale	1	19/09/2010 19:26:02	-163.011	71.8103	4518	4971	3	BL	NO	LS	3000
GEO2010330	Unidentified mysticete whale	1	19/09/2010 19:50:10	-163.113	71.8114	4518	4915	3	BL	NO	LS	3000
TAN2010183	Unidentified seal	1	20/09/2010 09:43:05	-162.487	71.8811	75	X	3	LO	LO	OT	X
TAN2010184	Bearded seal	1	20/09/2010 10:50:14	-162.237	71.9837	170	X	3	LO	LO	OT	X
TAN2010185	Unidentified seal	1	20/09/2010 11:57:31	-162.663	71.9874	478	X	3	SW	NO	OT	X
TAN2010186	Ringed seal	1	20/09/2010 12:04:03	-162.703	72.0007	250	X	3	LO	LO	OT	X
TAN2010187	Pacific walrus	2	20/09/2010 12:50:03	-163.012	71.994	250	X	3	LO	LO	OT	X
GEO2010331	Unidentified pinniped	1	20/09/2010 14:21:30	-163.039	71.8161	782	1082	4	SW	NO	LS	3000
TAN2010188	Unidentified seal	1	20/09/2010 16:32:35	-164.533	72.0147	25	X	4	LO	LO	OT	X
GEO2010332	Bearded seal	1	21/09/2010 08:13:19	-162.611	71.8163	100	542	5	SW	LO	RU	3000
TAN2010189	Unidentified seal	1	21/09/2010 08:47:20	-162.484	71.8395	75	X	3	LO	LO	OT	X
GEO2010333	Unidentified seal	1	21/09/2010 08:56:30	-162.804	71.8186	150	569	5	LO	LO	LS	3000
GEO2010334	Bearded seal	1	21/09/2010 09:01:45	-162.828	71.819	300	753	5	SW	LO	LS	3000
TAN2010190	Unidentified seal	1	21/09/2010 12:00:51	-162.798	71.6562	298	X	4	LO	LO	OT	X
TAN2010191	Ringed seal	2	21/09/2010 12:51:35	-162.888	71.6482	50	X	3	LO	LO	OT	X
TAN2010192	Bearded seal	1	21/09/2010 17:20:15	-163.276	71.817	200	X	5	LO	LO	OT	X
TAN2010193	Pacific walrus	2	21/09/2010 19:00:10	-163.434	71.9414	250	X	5	LO	LO	OT	X
TAN2010194	Bearded seal	1	21/09/2010 20:02:10	-163.437	71.7966	100	X	5	SW	NO	OT	X
TAN2010195	Unidentified seal	1	22/09/2010 09:25:45	-163.76	71.8259	153	X	5	LO	LO	OT	X
TAN2010196	Unidentified seal	1	22/09/2010 09:59:02	-163.818	71.9131	50	X	5	LO	LO	OT	X
GEO2010335	Bearded seal	1	22/09/2010 12:04:55	-164.844	71.7874	300	753	5	LO	LO	SH	60

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010197	Bearded seal	1	22/09/2010 14:32:00	-164.416	71.7015	50	X	5	SW	NO	OT	X
TAN2010198	Unidentified seal	1	23/09/2010 09:34:50	-164.9	71.5821	179	X	5	LO	LO	OT	X
TAN2010199	Bearded seal	1	23/09/2010 17:57:23	-164.395	71.5476	30	X	5	SW	NO	OT	X
TAN2010200	Bearded seal	1	23/09/2010 20:28:30	-164.816	71.5079	50	X	4	LO	LO	OT	X
NOR2010227	Pacific walrus	2	24/09/2010 12:21:22	-162.036	71.3004	300	X	2	SW	NO	OT	X
TAN2010201	Bearded seal	1	24/09/2010 12:34:45	-165.056	71.443	367	X	4	SW	NO	OT	X
NOR2010228	Bearded seal	1	24/09/2010 13:06:47	-161.774	71.208	65	X	2	LO	LO	OT	X
NOR2010229	Unidentified seal	1	24/09/2010 15:29:08	-160.923	70.9218	50	X	4	LO	CD	OT	X
NOR2010230	Bearded seal	2	24/09/2010 15:50:29	-160.802	70.8792	15	X	4	LO	LO	OT	X
NOR2010231	Gray whale	3	24/09/2010 15:59:48	-160.747	70.8603	800	X	4	SW	NO	OT	X
NOR2010232	Unidentified seal	1	24/09/2010 18:20:14	-160.154	70.6275	50	X	5	SW	NO	OT	X
TAN2010202	Unidentified seal	1	26/09/2010 11:07:50	-166.113	72.3088	298	X	4	LO	LO	OT	X
TAN2010203	Unidentified seal	1	26/09/2010 13:09:00	-165.752	72.0433	100	X	4	SW	LO	OT	X
TAN2010204	Unidentified seal	1	26/09/2010 16:00:45	-164.893	71.8252	30	X	4	LO	LO	OT	X
TAN2010205	Spotted seal	1	26/09/2010 17:04:55	-164.736	71.694	40	X	4	LO	LO	OT	X
GEO2010336	Unidentified seal	1	28/09/2010 17:26:49	-165.093	71.5018	300	543	4	LO	LO	SH	60
GEO2010337	Unidentified seal	1	28/09/2010 19:37:58	-164.622	71.5403	782	1225	5	SW	NO	LS	3000
TAN2010206	Unidentified seal	1	28/09/2010 20:01:36	-164.452	71.5377	50	X	4	LO	LO	OT	X
TAN2010207	Bearded seal	1	29/09/2010 11:58:57	-162.775	71.2532	298	X	3	LO	LO	OT	X
TAN2010208	Pacific walrus	2	29/09/2010 12:21:03	-162.711	71.2271	200	X	3	SW	SP	OT	X
TAN2010209	Bearded seal	1	29/09/2010 14:16:00	-162.878	71.0757	100	X	3	SW	LO	OT	X
TAN2010210	Bearded seal	1	29/09/2010 16:21:19	-162.324	71.0255	55	X	2	SW	LO	OT	X
TAN2010211	Unidentified seal	1	29/09/2010 16:31:45	-162.348	71.005	128	X	2	LO	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010212	Unidentified mysticete whale	1	29/09/2010 19:52:00	-161.818	70.9485	1217	X	2	SW	NO	OT	X
NOR2010233	Unidentified seal	1	30/09/2010 13:27:15	-162.299	71.222	150	X	2	LO	LO	OT	X
TAN2010213	Unidentified seal	1	30/09/2010 13:58:42	-163.245	71.3409	190	X	2	SW	LO	OT	X
NOR2010234	Unidentified mysticete whale	2	30/09/2010 13:59:23	-162.087	71.1661	8000	X	1	BL	NO	OT	X
NOR2010235	Bearded seal	1	30/09/2010 14:01:50	-162.071	71.1619	80	X	1	LO	IS	OT	X
NOR2010236	Unidentified seal	1	30/09/2010 14:10:08	-162.017	71.1472	100	X	1	LO	LO	OT	X
NOR2010237	Unidentified seal	1	30/09/2010 14:25:47	-161.913	71.1206	200	X	1	LO	LO	OT	X
NOR2010238	Unidentified seal	1	30/09/2010 14:36:33	-161.842	71.1029	100	X	1	LO	NO	OT	X
NOR2010239	Unidentified seal	1	30/09/2010 14:43:32	-161.797	71.091	50	X	1	LO	LO	OT	X
NOR2010240	Unidentified mysticete whale	1	30/09/2010 14:56:51	-161.711	71.068	400	X	1	BL	NO	OT	X
GEO2010338	Bearded seal	1	30/09/2010 14:59:28	-163.3	71.2855	782	833	2	LO	LO	LS	3000
NOR2010241	Unidentified seal	1	30/09/2010 15:03:10	-161.67	71.0568	75	X	1	DI	NO	OT	X
GEO2010339	Pacific walrus	1	30/09/2010 15:12:40	-163.266	71.2735	1436	1708	2	LO	NO	LS	3000
NOR2010242	Bowhead whale	2	30/09/2010 15:16:04	-161.586	71.0346	500	X	1	BL	NO	OT	X
NOR2010243	Bowhead whale	1	30/09/2010 15:32:52	-161.488	71.0086	150	X	1	LG	IS	OT	X
NOR2010244	Bowhead whale	1	30/09/2010 15:38:59	-161.451	70.9986	1785	X	1	BL	NO	OT	X
GEO2010340	Unidentified seal	1	30/09/2010 15:40:19	-163.192	71.2484	506	886	2	SW	NO	SH	60
NOR2010245	Unidentified seal	1	30/09/2010 16:00:01	-161.316	70.9618	100	X	1	LO	SP	OT	X
NOR2010246	Bearded seal	1	30/09/2010 16:02:21	-161.301	70.9577	100	X	1	LO	NO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010214	Bearded seal	1	30/09/2010 16:06:40	-163.027	71.2035	216	X	2	RE	LO	OT	X
GEO2010341	Unidentified seal	1	30/09/2010 16:09:16	-163.116	71.2224	662	971	2	LO	LO	RU	3000
TAN2010215	Unidentified seal	1	30/09/2010 16:37:50	-162.937	71.1753	298	X	2	SW	LO	OT	X
NOR2010247	Bowhead whale	1	30/09/2010 17:09:30	-160.865	70.8436	1072	X	2	BL	NO	OT	X
NOR2010248	Bowhead whale	1	30/09/2010 17:15:12	-160.833	70.8354	100	X	2	BL	NO	OT	X
GEO2010342	Unidentified seal	1	30/09/2010 17:46:28	-162.863	71.1348	717	1132	1	LO	LO	LS	3000
TAN2010216	Unidentified seal	1	30/09/2010 18:04:25	-162.687	71.0984	40	X	1	SW	LO	OT	X
GEO2010343	Bearded seal	1	30/09/2010 18:09:55	-162.804	71.1136	506	951	2	SW	NO	LS	3000
TAN2010217	Pacific walrus	3	30/09/2010 18:17:30	-162.649	71.0859	200	X	1	ST	NO	OT	X
GEO2010344	Pacific walrus	3	30/09/2010 18:22:00	-162.774	71.103	2206	1311	2	SW	NO	LS	3000
GEO2010345	Unidentified mysticete whale	1	30/09/2010 18:45:57	-162.708	71.0836	8000	8326	2	BL	NO	SH	60
GEO2010346	Bearded seal	1	30/09/2010 18:53:28	-162.683	71.0799	1043	1496	2	LO	LO	SH	60
GEO2010347	Unidentified seal	1	30/09/2010 19:02:21	-162.651	71.0762	1984	2245	1	LO	LO	SH	60
GEO2010348	Unidentified seal	1	30/09/2010 19:06:13	-162.638	71.0746	1101	1294	1	SW	NO	SH	60
GEO2010349	Ringed seal	1	30/09/2010 19:18:30	-162.595	71.0694	1366	1807	1	LO	LO	SH	60
GEO2010350	Unidentified mysticete whale	1	30/09/2010 19:23:06	-162.579	71.067	9469	9864	1	BL	NO	SH	60
TAN2010218	Bearded seal	2	30/09/2010 19:26:08	-162.445	71.0643	298	X	1	SW	LO	OT	X
TAN2010219	Bearded seal	1	30/09/2010 19:42:00	-162.391	71.0575	250	X	1	LO	LO	OT	X
NOR2010249	Pacific walrus	1	30/09/2010 19:48:26	-160.151	70.6227	800	X	1	LO	NO	OT	X
TAN2010220	Unidentified seal	1	30/09/2010 20:10:00	-162.362	71.0219	367	X	1	SW	NO	OT	X
TAN2010221	Pacific walrus	3	30/09/2010 20:21:36	-162.378	70.9926	298	X	1	SW	NO	OT	X
TAN2010222	Unidentified pinniped	1	30/09/2010 20:22:18	-162.379	70.9908	250	X	1	SW	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
TAN2010223	Unidentified seal	1	30/09/2010 20:37:00	-162.437	70.9589	298	X	1	SW	LO	OT	X
GEO2010351	Bearded seal	1	30/09/2010 20:47:51	-162.55	70.9796	410	833	1	SW	LO	SH	60
NOR2010250	Unidentified seal	1	30/09/2010 20:47:58	-160.326	70.7494	218	X	2	LO	NO	OT	X
TAN2010224	Bearded seal	1	30/09/2010 20:50:00	-162.514	70.9369	75	X	1	SW	LO	OT	X
NOR2010251	Unidentified pinniped	2	01/10/2010 09:34:27	-162.86	71.2126	200	X	2	U	NO	OT	X
GEO2010352	Bearded seal	1	01/10/2010 10:32:52	-164.912	71.3198	375	821	2	SW	NO	RC	X
NOR2010252	Bearded seal	1	01/10/2010 10:47:17	-163.203	71.1852	100	X	1	LO	LO	OT	X
GEO2010353	Unidentified seal	1	01/10/2010 11:26:28	-165.098	71.3157	860	1303	2	SI	NO	RC	X
TAN2010225	Bearded seal	1	01/10/2010 11:50:47	-165.255	71.3334	250	X	1	RE	LO	OT	X
GEO2010354	Ringed seal	1	01/10/2010 11:50:52	-165.173	71.313	956	1246	2	LO	LO	RC	X
NOR2010253	Unidentified seal	1	01/10/2010 11:54:14	-163.314	71.2428	320	X	1	LO	NO	OT	X
NOR2010254	Unidentified seal	1	01/10/2010 12:41:31	-163.306	71.3095	300	X	1	LO	NO	OT	X
NOR2010255	Unidentified seal	1	01/10/2010 13:21:57	-163.3	71.3665	300	X	1	LO	NO	OT	X
GEO2010355	Bearded seal	1	01/10/2010 13:27:40	-165.488	71.3046	400	824	2	SW	NO	RC	X
GEO2010356	Bearded seal	1	01/10/2010 13:43:19	-165.538	71.3031	200	634	2	SW	NO	RC	X
NOR2010256	Unidentified seal	1	01/10/2010 14:22:15	-163.299	71.4496	200	X	2	LO	NO	OT	X
GEO2010357	Unidentified pinniped	1	01/10/2010 14:55:18	-165.771	71.2956	453	719	2	LO	LO	RC	X
GEO2010358	Bearded seal	1	01/10/2010 15:02:36	-165.794	71.2952	1076	1432	2	SI	NO	RC	X
TAN2010226	Unidentified pinniped	1	01/10/2010 15:41:00	-165.881	71.3261	600	X	1	SW	NO	OT	X
NOR2010257	Unidentified seal	1	01/10/2010 15:54:52	-163.283	71.5804	400	X	2	LO	LO	OT	X
NOR2010258	Bearded seal	1	01/10/2010 16:17:35	-163.277	71.614	50	X	2	LO	LO	OT	X
NOR2010259	Spotted seal	1	01/10/2010 17:23:16	-163.268	71.7106	80	X	2	LO	LO	OT	X
TAN2010227	Unidentified seal	1	01/10/2010 17:56:41	-166.407	71.3052	298	X	1	SW	LO	OT	X

Table I.1 (cont). All marine mammal detections during Statoil's seismic survey in the Chukchi Sea, 11 Aug – 4 Oct 2010.

Sighting ID[a]	Species	No.[b]	Date (AKDT)	Long (°W)	Lat (°N)	Initial Sighting Dist.[c] (m)	CPA[d] (m)	Bf[e]	Behav,[f]	Rxn to Vessel[g]	Vessel Activity[h]	Array Volume (in^3)
GEO2010359	Unidentified pinniped	1	01/10/2010 19:07:46	-166.596	71.2391	1436	1614	2	SW	NO	RC	X
NOR2010260	Pacific walrus	2	03/10/2010 12:26:18	-166.18	70.3522	200	X	4	LO	NO	OT	X

[a] Sighting ID = Vessel name, year (2010) and sequential number given to sighting by MMOs. GEO = *Geo Celtic*, NOR = *Norseman I*, TAN = *Tanux I*. Sightings which occurred during transit are not included.
[b] No. = Number of individual marine mammals observed during sighting.
[c] Initial Sighting Dist. = Initial sighting distance (m) of marine mammal(s) from the MMOs when initially detected.
[d] CPA = Closest Point of Approach of the marine mammal(s) to the airgun array.
[e] Bf = Beaufort Wind Force (see Appendix F for definitions).
[f] Behav. = Initial behavior of marine mammal(s) observed by MMOs. Codes: BL = Blow; DI = Dive; LG = Logging; LO = Look; MI = Milling; RE = Resting; SA = Surface Active; SI = Sink; ST = Surface Active-Travel; SW = Swim; TH = Thrash; U = Unknown.
[g] Rxn to Vessel = Reaction of marine mammal(s) to vessel observed by MMOs. Codes: CD = Change in Direction; IS = Increase in Speed; LO = Look at Vessel; NO = No reaction; SG = Interactions with Seismic Gear; SP = Splash; U = Unknown.
[h] Vessel Activity = Vessel activity at the time of the initial detection. Codes: DP = Deploying Seismic Gear; LS = Line Shooting; OT = Other; RC = Recovering Seismic Gear; RU = Ramp up; ST = Seismic Testing; SH = Shooting Offline.

APPENDIX J: WEEKLY SUMMARIES OF VESSEL TRACKS AND SIGHTINGS

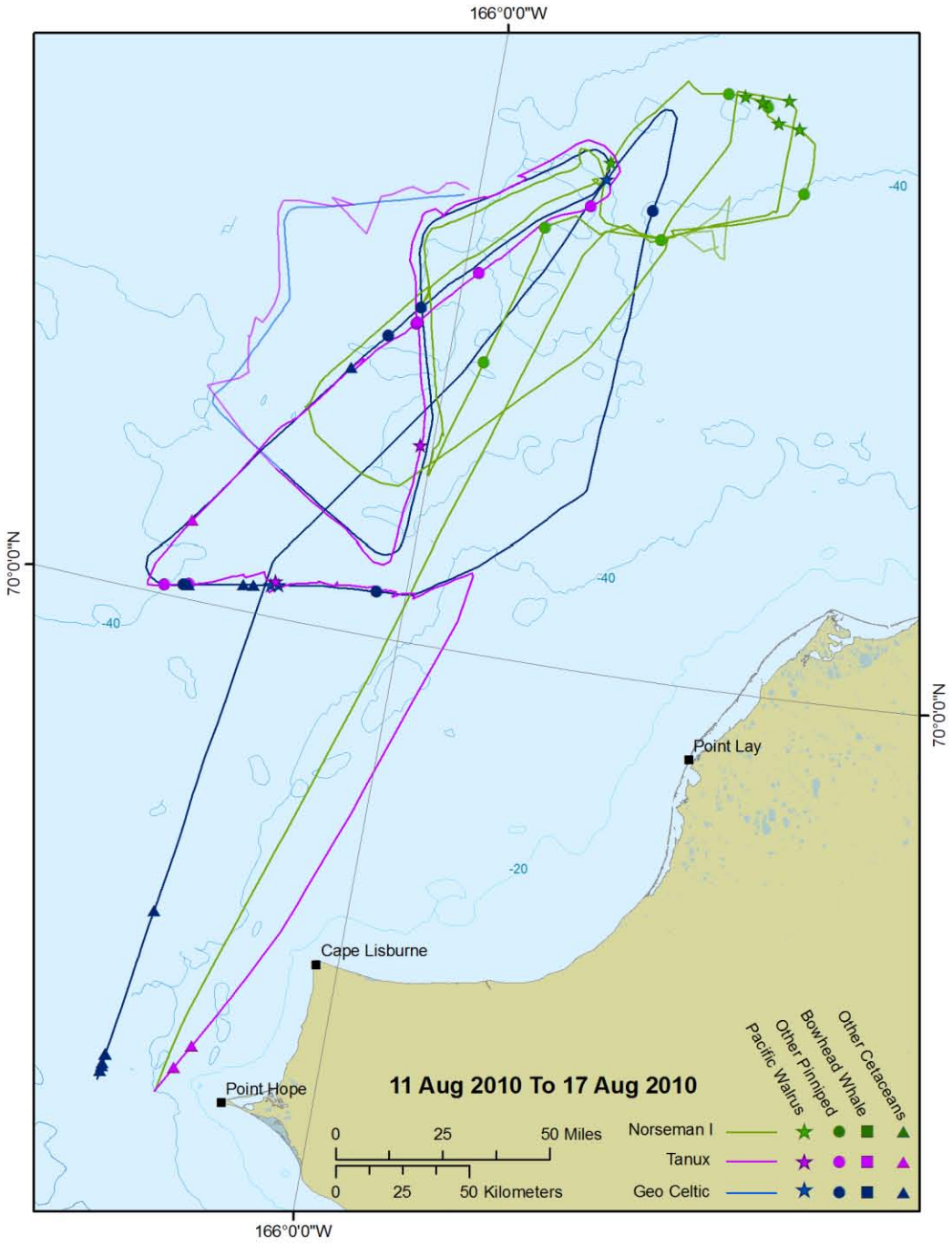

FIGURE J.1. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 11-17 Aug 2010, during Statoil's seismic survey. The *Geo Celtic* was deploying gear and no seismic activity occurred this week.

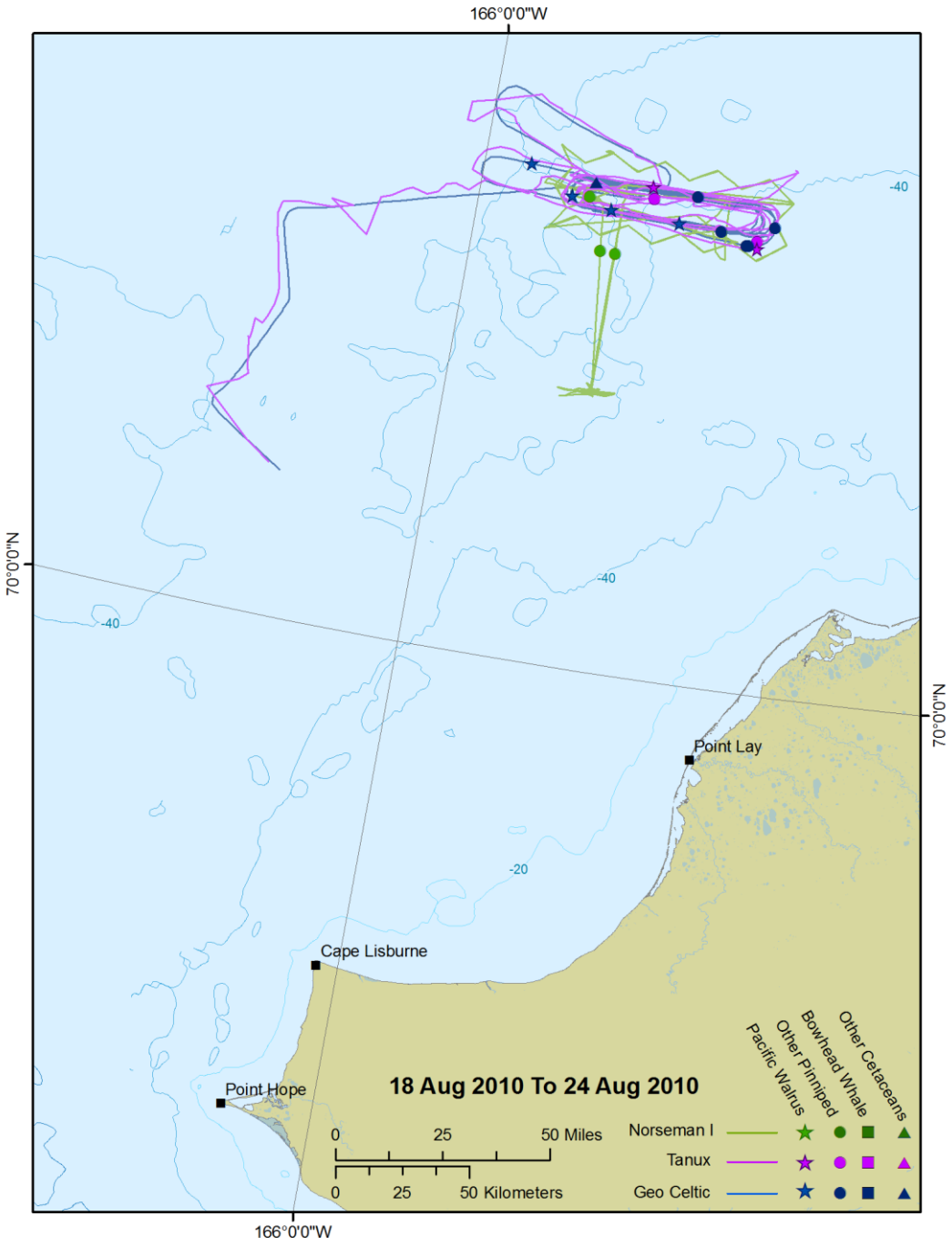

FIGURE J.2. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 18-24 Aug 2010, during of Statoil's seismic survey, 2010. Seismic activity began 20 Aug 2010.

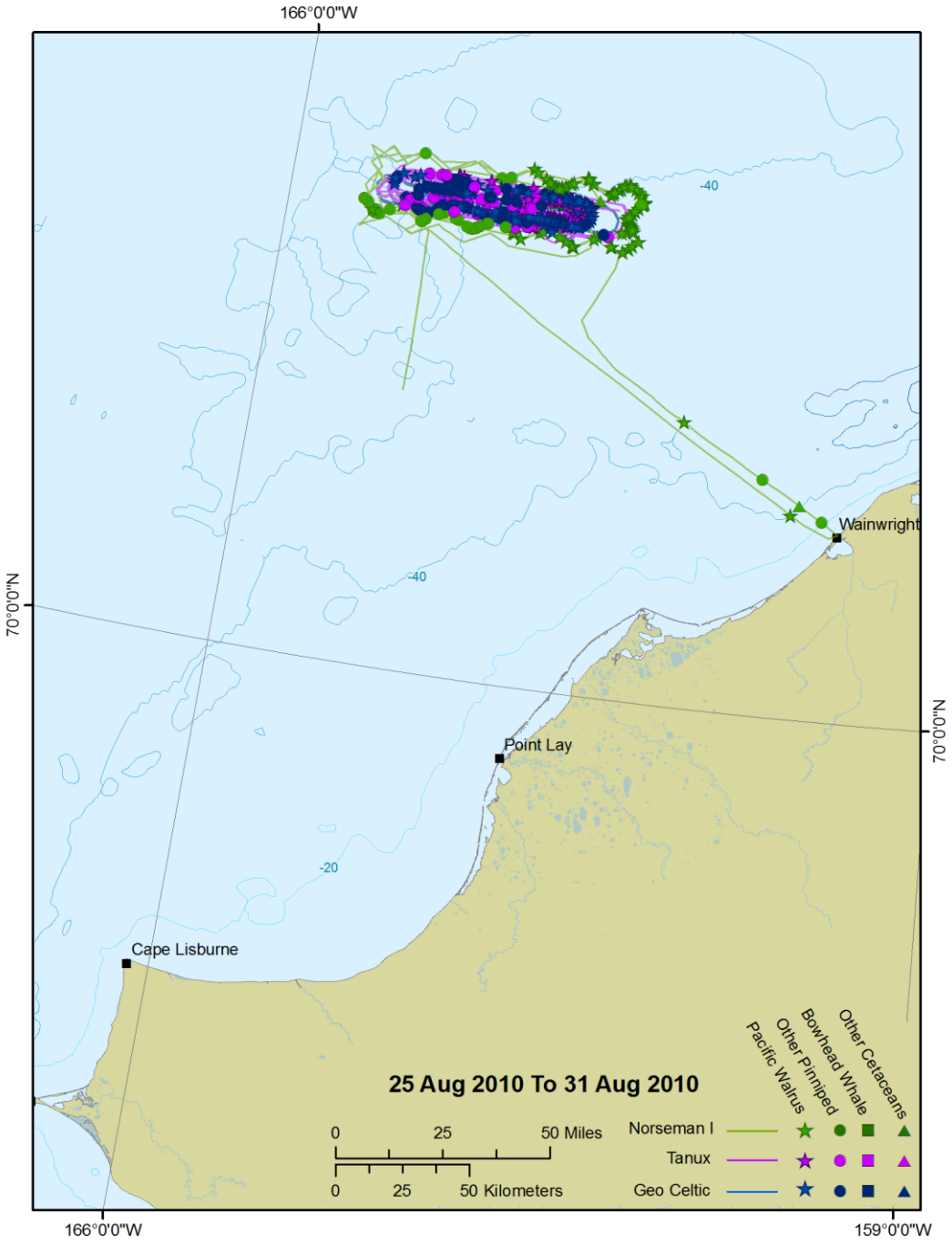

FIGURE J.3. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 25-31 Aug 2010, during of Statoil's seismic survey, 2010.

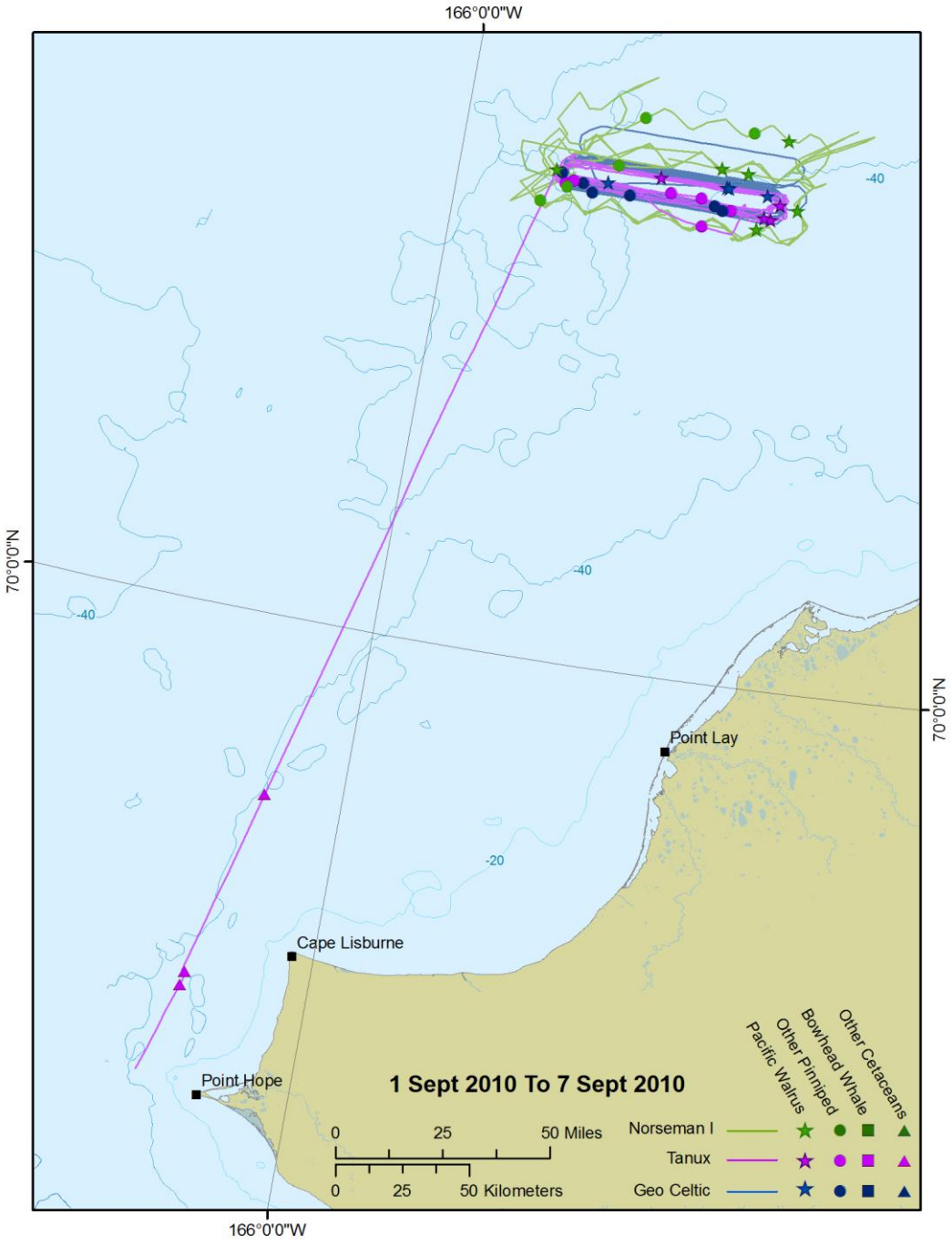

FIGURE J.4. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 1-7 Sep 2010, of Statoil's seismic survey, 2010.

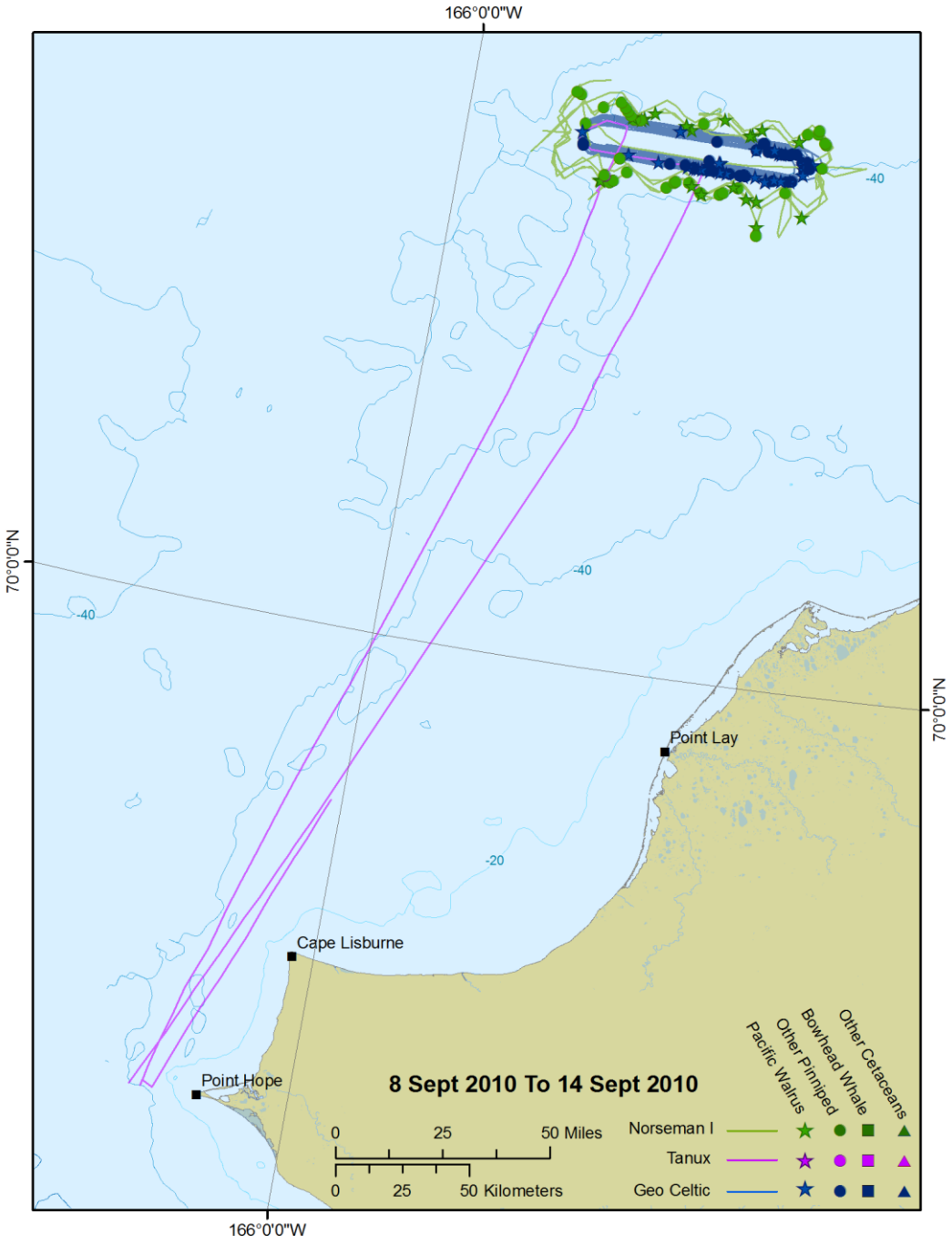

FIGURE J.5. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 8-14 Sep 2010 during Statoil's seismic survey.

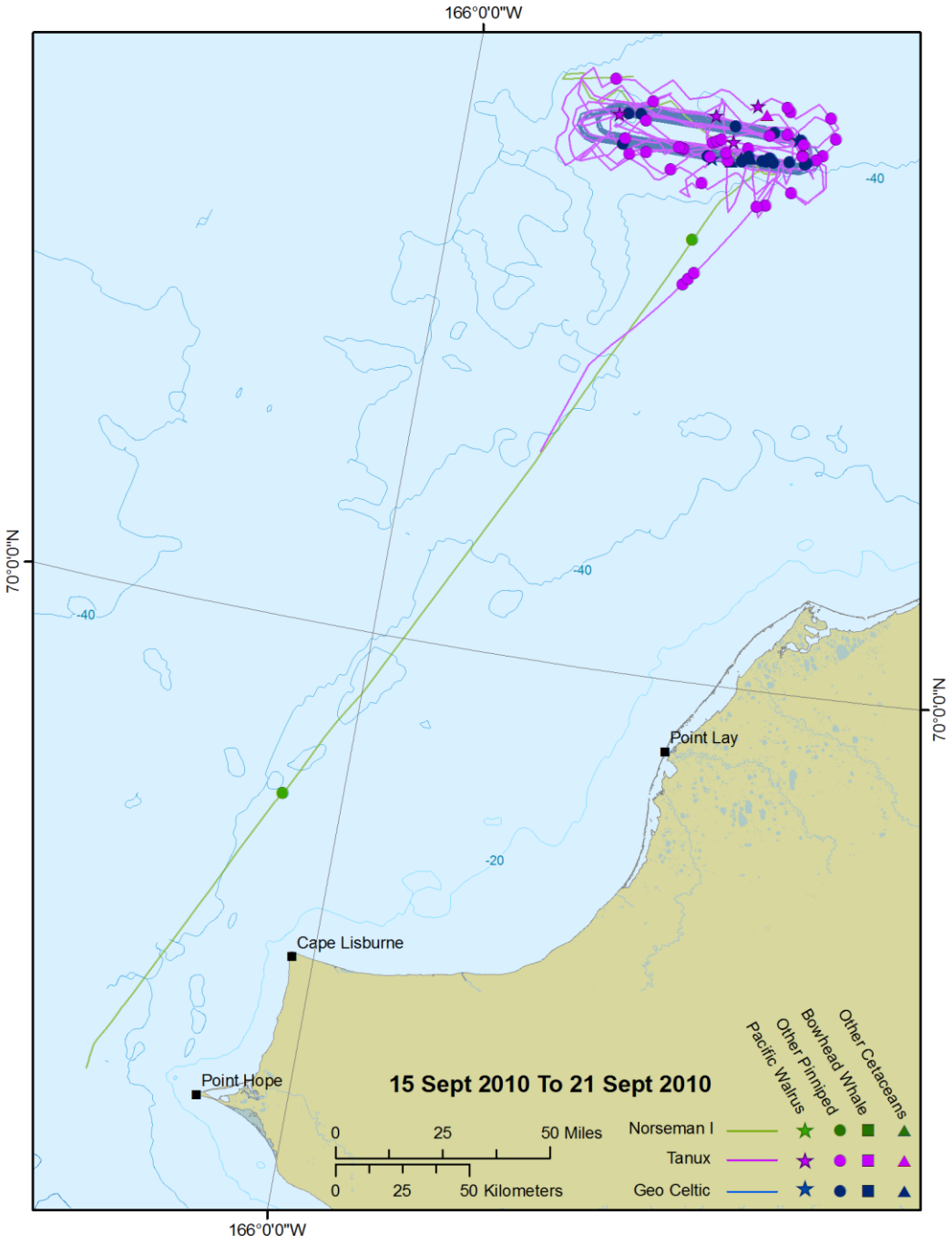

FIGURE J.6. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 15-21 Sep 2010 during Statoil's seismic survey.

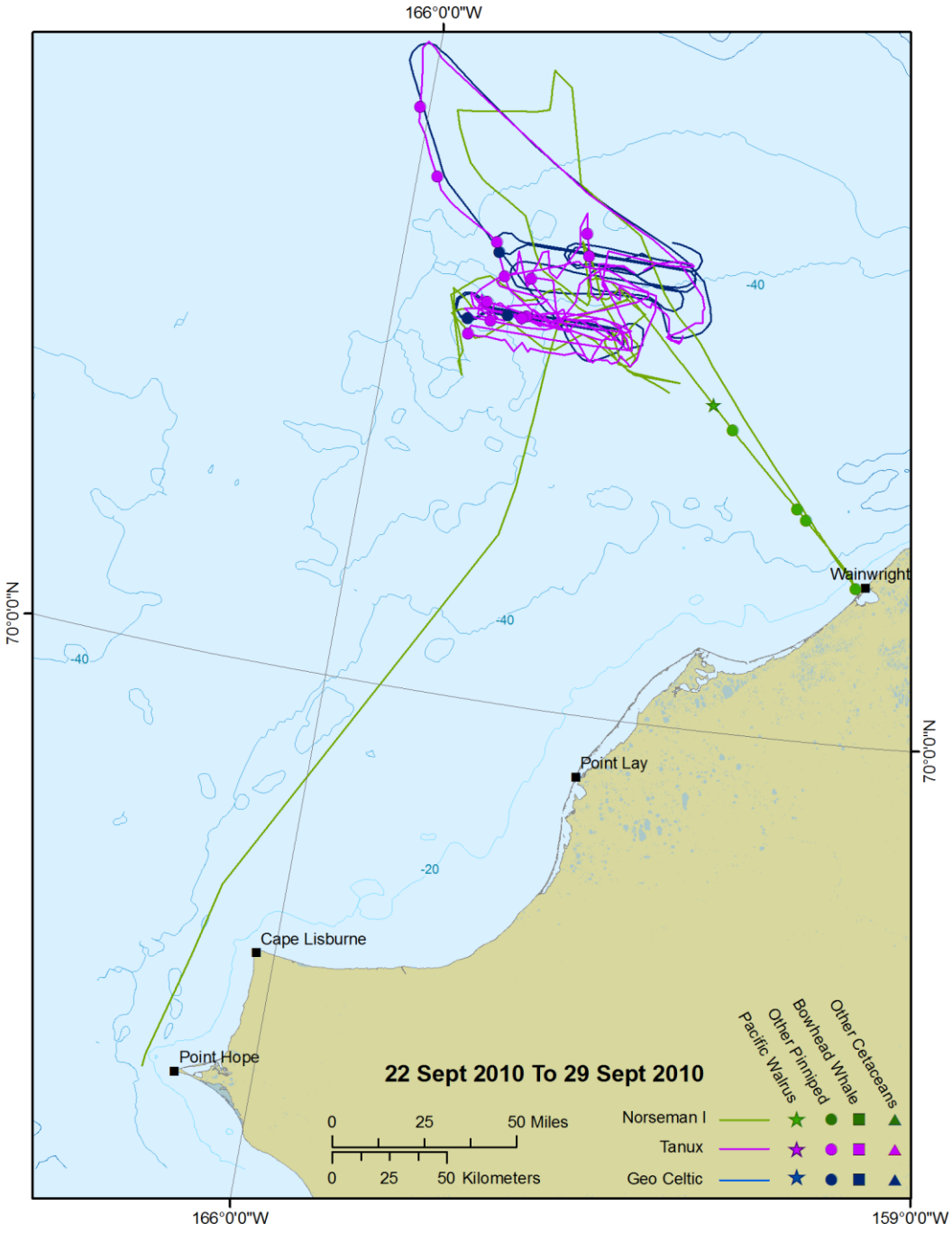

FIGURE J.7. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 22-29 Sep 2010, during Statoil's seismic survey.

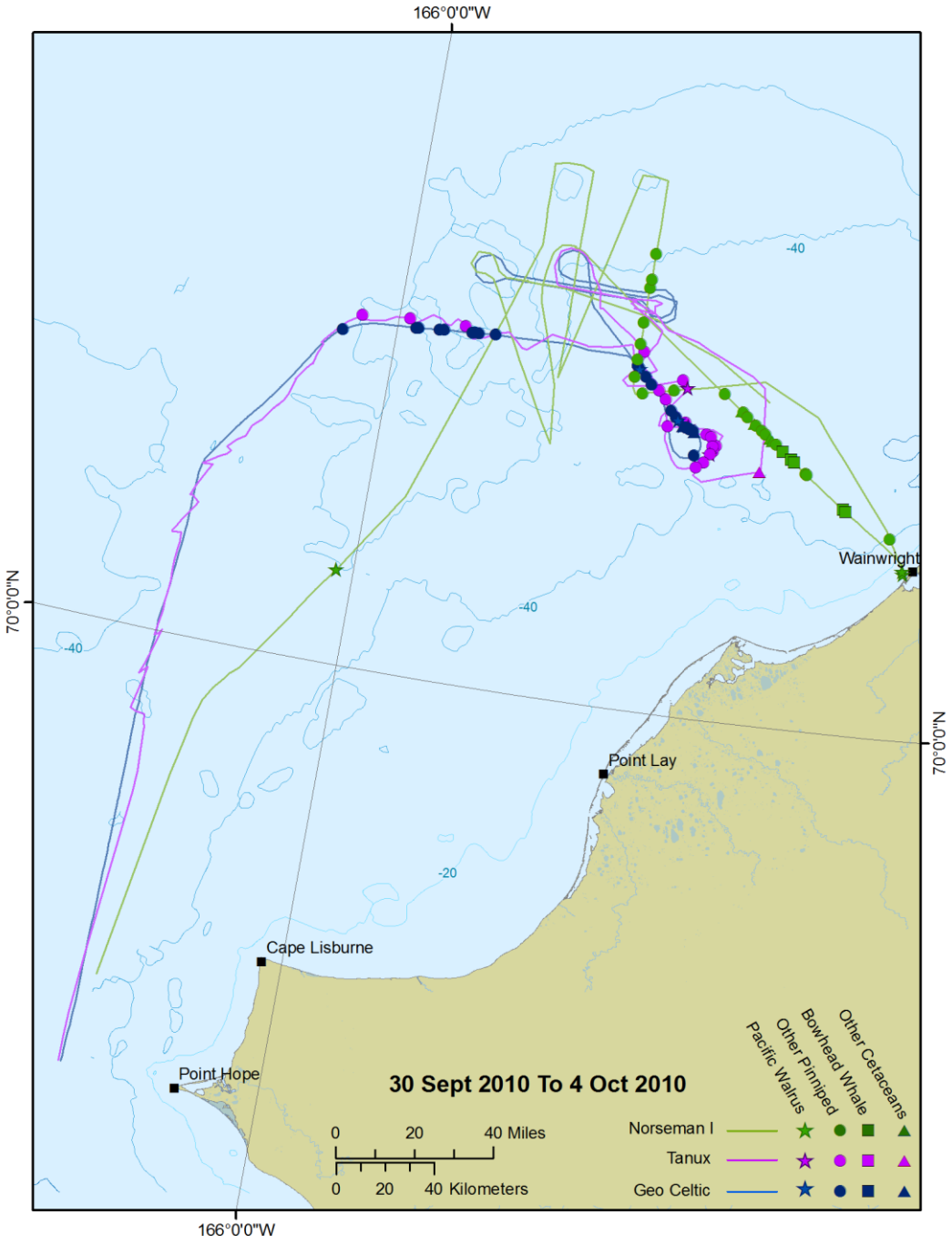

FIGURE J.8. Vessel tracklines and marine mammal sightings that occurred within the survey area north of Point Hope, Alaska, between 1-7 Sep 2010, during Statoil's seismic survey. All seismic activities were completed by 1 Oct 2010.

APPENDIX K: NMFS STRANDING REPORTS

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

HELD BY: NMFS REGIONAL #: NATIONAL DATABASE #:

COMMON NAME: UNKNOWN GENUS: UNKNOWN SPECIES: UNKNOWN

EXAMINER Last/Initials: U ATOIL

Name: MEGAN BLEES Affiliation: LGL ALASKA MMO

Address: MV GEO GETTIC (ANC: 1101 E 78TH STE B, ANC, AK 99518) Phone: 907-562-0335 (ANC OFFICE)

LOCATION OF INITIAL OBSERVATION

State: AK County:

City:

Body of Water: CHUKCHI SEA

Locality Details:

Latitude: 70 00.10 N [X] actual [ ] estimated

Longitude: 168 17.24 W [ ] actual [ ] estimated

How latlong determined (Check ONE)

[X] GPS

[ ] Map

[ ] Internet Software

OCCURRENCE DETAILS [ ] Historical UER: (same as)

Group Event: [ ] YES [X] NO

If Yes, Type: [ ] Cow/Calf Pair [ ] Mass Stranding # Animals: 1 [X] actual [ ] estimated

Findings of Human Interaction: [ ] YES [X] NO [ ] Could not Be Determined (CBD)

If Yes, Check one or more: [ ] 1. Boat Collision [ ] 2. Net [ ] 3. Fishery Interaction

[ ] 4. Other Human Interaction

Describe How Determined:

Gear Collected? [ ] YES [X] NO Gear Disposition:

Other Findings upon Level A: [ ] YES [X] NO [ ] CBD

If Yes, Check one or more: [ ] 1. Illness [ ] 2. Injury

[ ] 3. Other Findings

Describe How Determined:

INITIAL OBSERVATION

Date: Year: 2010 Month: AUG Day: 14

First Observed: [ ] Beach or Land [X] Floating [ ] Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

[ ] 1. Alive [ ] 4. Advanced decomposition

[ ] 2. Fresh dead [ ] 5. Mummified/Skeletal

[X] 3. Moderate decomposition [ ] 6. Unknown

LEVEL A EXAMINATION [X] Not Able to Examine

Date: Year: ____ Month: ____ Day: ____

CONDITION AT EXAMINATION (Check ONE)

[ ] 1. Alive [ ] 4. Advanced decomposition

[ ] 2. Fresh dead [ ] 5. Mummified/Skeletal

[ ] 3. Moderate decomposition

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

[ ] 1. Left at Site [ ] 7. Transferred to Rehabilitation

[ ] 2. Immediate Release at Site Date: ____ Facility: ____

[ ] 3. Released [ ] 8. Died during Transport

[ ] 4. Disentangled [ ] 9. Euthanized during Transport

[ ] 5. Died at Site [ ] 10. Other: ____

[ ] 6. Euthanized at Site

CONDITION/DETERMINATION (Check one or more)

[ ] 1. Sick [ ] 4. Deemed Healthy [ ] 7. Location Hazardous: [ ] a. To animal [ ] b. To public

[ ] 2. Injured [ ] 5. Abandoned/Orphaned

[ ] 3. Out of Habitat [ ] 6. Inaccessible

[ ] 8. Unknown/CBD [ ] 9. Other:

Comments:

MORPHOLOGICAL DATA

SEX (Check ONE)

[ ] 1. Male

[ ] 2. Female

[X] 3. Unknown

AGE CLASS (Check ONE)

[ ] 1. Adult [ ] 4. Pup/Calf

[ ] 2. Subadult [X] 5. Unknown

[ ] 3. Yearling

Straight Length: 1200 [X] cm [ ] in [ ] actual [X] estimated

Weight: UNKNOWN [ ] kg [ ] lb [ ] actual [ ] estimated

PHOTOS/VIDEOS TAKEN: [ ] YES [X] NO

Photo/Video Disposition:

TAG DATA

Tags Were:

Present at Time of Stranding (pre-existing): [ ] YES [X] NO

Applied during Stranding Response: [ ] YES [ ] NO

ID #	Color	Type	Placement* (Circle ONE)	Applied	Present
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]

* D = Dorsal, DF = Dorsal Fin, L = Left Head, R = Right Head, LF = Left Flank, LR = Left Rear, RF = Right Flank, RR = Right Rear

WHOLE CARCASS STATUS (Check one or more)

[X] 1. Left at site [ ] 4. Towed: Lat ____ Long ____ [ ] 7. Landfill

[ ] 2. Buried [ ] 5. Sunk: Lat ____ Long ____ [ ] 8. Unknown

[ ] 3. Rendered [ ] 6. Frozen for Later Examination [ ] 9. Other:

SPECIMEN DISPOSITION (Check one or more)

[ ] 1. Scientific collection

[ ] 2. Educational collection

[ ] 3. Other:

Comments:

NECROPSIED: [ ] YES [X] NO Date: ____

NECROPSIED BY:

NOAA Form 89-864 (rev. 7/04)

OMB No. 0648-0178; Expires August 31, 2007

PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER: _____ (If animal is restranded, please indicate any previous field number/others)

Carcass was small and being attended to and scavenged upon by gulls. Decomposition and limited view of seal prevented confident ID to species, however based on size and color it was likely a ringed seal or spotted seal. Eyes were still intact on large hole from scavengers in abdomen.

DISCLAIMER

THESE DATA SHOULD NOT BE USED OUT OF CONTEXT OR WITHOUT VERIFICATION. THIS SHOULD BE STRICTLY ENFORCED WHEN REPORTING SIGNS OF HUMAN INTERACTION DATA.

DATA ACCESS FOR LEVEL A DATA

UPON WRITTEN REQUEST, CERTAIN FIELDS OF THE LEVEL A DATA SHEET WILL BE RELEASED TO THE REQUESTOR PROVIDED THAT THE REQUESTOR CREDIT THE STRANDING NETWORK AND THE NATIONAL MARINE FISHERIES SERVICE. THE NATIONAL MARINE FISHERIES SERVICE WILL NOTIFY THE CONTRIBUTING STRANDING NETWORK MEMBERS THAT THESE DATA HAVE BEEN REQUESTED AND THE INTENT OF USE. ALL OTHER DATA WILL BE RELEASED TO THE REQUESTOR PROVIDED THAT THE REQUESTOR OBTAIN PERMISSION FROM THE CONTRIBUTING STRANDING NETWORK AND THE NATIONAL MARINE FISHERIES SERVICE.

PAPERWORK REDUCTION ACT INFORMATION:

PUBLIC REPORTING BURDEN FOR THIS COLLECTION OF INFORMATION IS ESTIMATED TO AVERAGE 30 MINUTES PER RESPONSE, INCLUDING THE TIME FOR REVIEWING INSTRUCTIONS, SEARCHING EXISTING DATA SOURCES, GATHERING AND MAINTAINING THE DATA NEEDED, AND COMPLETING AND REVIEWING THE COLLECTION OF INFORMATION. SEND COMMENTS REGARDING THIS BURDEN ESTIMATE OR ANY OTHER ASPECT OF THIS COLLECTION OF INFORMATION, INCLUDING SUGGESTIONS FOR REDUCING THIS BURDEN TO: CHIEF, MARINE MAMMAL CONSERVATION DIVISION, OFFICE OF PROTECTED RESOURCES, NOAA FISHERIES, 1315 EAST-WEST HIGHWAY, SILVER SPRING, MARYLAND 20910. NOTWITHSTANDING ANY OTHER PROVISION OF THE LAW, NO PERSON IS REQUIRED TO RESPOND TO, NOR SHALL ANY PERSON BE SUBJECTED TO A PENALTY FOR FAILURE TO COMPLY WITH, A COLLECTION OF INFORMATION SUBJECT TO THE REQUIREMENTS OF THE PAPERWORK REDUCTION ACT, UNLESS THE COLLECTION OF INFORMATION DISPLAYS A CURRENTLY VALID OFFICE OF MANAGEMENT AND BUDGET (OMB) CONTROL NUMBER.

NOAA Form 88-164 (rev 2/08)
OMB No. 0648-0178 Expires August 31, 2007

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: ____ **NMFS REGIONAL #:** ____ **NATIONAL DATABASE#:** ____

COMMON NAME: PACIFIC WALRUS **GENUS:** ODOBENUS **SPECIES:** ROSMARUS

EXAMINER Leaseholder: STATOIL

Name: MEGAN BLEES Affiliation: LGL ALASKA - MMO

Address: M/V OLD CELTIC (ANC: 1101 E 76TH STE B, ANC AK 99518) Phone: 907-562-3339 (ANC OFFICE)

LOCATION OF INITIAL OBSERVATION

State: AK County: ____

City:

Body of Water: CHUKCHI SEA

Locality Details: ____

Latitude: 70 06.61 N [X] actual

Longitude: 167 18.76 W [ ] estimated

How lat/long determined (Check ONE):
[X] GPS
Map
Internet/Software

OCCURRENCE DETAILS [ ] Restrand GE#:

Group Event: YES [X] NO

If Yes, Type [ ] Cow/Calf Pair [ ] Mass Stranding # Animals: 1 [X] actual [ ] estimated

Findings of Human Interaction: [X] YES [ ] NO [ ] Could not Be Determined (CBD)

If Yes, Check one or more: 1. Boat Collision 2. Shot 3. Fishery Interaction
[X] 4. Other Human Interaction: DECAPITATION

Describe How Determined: VISUAL

Gear Collected? YES [X] NO Gear Disposition:

Other Findings upon Level A: [X] YES NO CBD

If Yes, Check one or more: [ ] 1. Illness 2. Injury
[X] 3. Other Findings: DECAPITATION

Describe How Determined: VISUAL

INITIAL OBSERVATION

Date: Year: 2010 Month: AUGUST Day: 14

First Observed: [ ] Beach or Land [X] Floating [ ] Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)
1. Alive
2. Fresh dead
[X] 3. Moderate decomposition
4. Advanced decomposition
5. Mummified/Skeletal
6. Unknown

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)
[ ] 1. Left at Site
[ ] 2. Immediate Release at Site
3. Relocated
4. Disentangled
5. Died at Site
6. Euthanized at Site
7. Transferred to Rehabilitation: Date: ____ Facility: ____
8. Died during Transport
9. Euthanized during Transport
10. Other

CONDITION/DETERMINATION (Check one or more)
1. Sick
2. Injured
3. Out of Habitat
4. Deemed Healthy
5. Abandoned/Orphaned
6. Inaccessible
7. Location Hazardous: a. To animal b. To public
8. Unknown/CBD
9. Other:

Comments: ____

LEVEL A EXAMINATION [X] Not Able to Examine

Date: Year: ____ Month: ____ Day: ____

CONDITION AT EXAMINATION (Check ONE)
1. Alive
2. Fresh dead
3. Moderate decomposition
4. Advanced decomposition
5. Mummified/Skeletal

MORPHOLOGICAL DATA

SEX (Check ONE)
1. Male
2. Female
[X] 3. Unknown

AGE CLASS (Check ONE)
1. Adult
2. Subadult
3. Yearling
4. Pup/Calf
[X] 5. Unknown

Straight Length: 150 [X] cm [ ] in [ ] actual [X] estimated

Weight: 500 [ ] kg [X] lb [ ] actual [X] estimated

PHOTOS/VIDEOS TAKEN: [X] YES [ ] NO

Photo/Video Disposition: ____

TAG DATA

Tags Were:

Present at Time of Stranding (pre-existing) [ ] YES [X] NO

Applied during Stranding Response [ ] YES [X] NO

ID #	Color	Type	Placement * (Circle ONE)	Applied	Present
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]

* D = Dorsal, DF = Dorsal Fin, L = Lateral Body
LF = Left Fore, LR = Left Rear, RF = Right Fore, RR = Right Rear

WHOLE CARCASS STATUS (Check one or more)
[X] 1. Left at site
2. Buried
3. Released
4. Towed: Lat ____ Long ____
5. Sunk: Lat ____ Long ____
6. Frozen for Later Examination
7. Landfill
8. Unknown
9. Other

SPECIMEN DISPOSITION (Check one or more)
1. Scientific collection
2. Educational collection
3. Other:

Comments: ____

NECROPSIED: YES [X] NO Date: ____

NECROPSIED BY: ____

PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER _____ (If animal is restranded, please indicate any previous field numbers here)

BIRDS FEEDING CUED OBSERVER TO AREA OF AN UNIDENTIFIED MARINE MAMMAL CARCASS SEEN AT 1238 METERS. SUPPORT VESSEL (TANUX 1) SENT TO TAKE PHOTOS AND TRY TO IDENTIFY SPECIES. REPORT BACK TO OUR VESSEL WAS PACIFIC WHITE SIDED DECAPITATED, APPROXIMATELY 5 METERS LONG, MODERATE STATE OF DECOMPORITION

DISCLAIMER

THESE DATA SHOULD NOT BE USED OUT OF CONTEXT OR WITHOUT VERIFICATION. THIS SHOULD BE STRICTLY ENFORCED WHEN REPORTING SIGNS OF HUMAN INTERACTION DATA.

DATA ACCESS FOR LEVEL A DATA

UPON WRITTEN REQUEST, CERTAIN FIELDS OF THE LEVEL A DATA SHEET WILL BE RELEASED TO THE REQUESTOR PROVIDED THAT THE REQUESTOR CREDIT THE STRANDING NETWORK AND THE NATIONAL MARINE FISHERIES SERVICE. THE NATIONAL MARINE FISHERIES SERVICE WILL NOTIFY THE CONTRIBUTING STRANDING NETWORK MEMBERS THAT THESE DATA HAVE BEEN REQUESTED AND THE INTENT OF USE. ALL OTHER DATA WILL BE RELEASED TO THE REQUESTOR PROVIDED THAT THE REQUESTOR OBTAIN PERMISSION FROM THE CONTRIBUTING STRANDING NETWORK AND THE NATIONAL MARINE FISHERIES SERVICE.

PAPERWORK REDUCTION ACT INFORMATION

PUBLIC REPORTING BURDEN FOR THE COLLECTION OF INFORMATION IS ESTIMATED TO AVERAGE 30 MINUTES PER RESPONSE, INCLUDING THE TIME FOR REVIEWING INSTRUCTIONS, SEARCHING EXISTING DATA SOURCES, GATHERING AND MAINTAINING THE DATA NEEDED, AND COMPLETING AND REVIEWING THE COLLECTION OF INFORMATION. SEND COMMENTS REGARDING THIS BURDEN ESTIMATE OR ANY OTHER ASPECT OF THE COLLECTION OF INFORMATION, INCLUDING SUGGESTIONS FOR REDUCING THE BURDEN TO: CHIEF, MARINE MAMMAL CONSERVATION DIVISION, OFFICE OF PROTECTED RESOURCES, NOAA FISHERIES, 1315 EAST-WEST HIGHWAY, SILVER SPRING, MARYLAND 20910. NOT WITHSTANDING ANY OTHER PROVISION OF THE LAW, NO PERSON IS REQUIRED TO RESPOND TO, NOR SHALL ANY PERSON BE SUBJECTED TO A PENALTY FOR FAILURE TO COMPLY WITH, A COLLECTION OF INFORMATION SUBJECT TO THE REQUIREMENTS OF THE PAPERWORK REDUCTION ACT, UNLESS THE COLLECTION OF INFORMATION DISPLAYS A CURRENTLY VALID OFFICE OF MANAGEMENT AND BUDGET (OMB) CONTROL NUMBER.

NOAA Form 89-864 (rev. 2/08)
OMB No. 0648-0178; Expires August 31, 2007

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: _____ NMFS REGIONAL #: _____ NATIONAL DATABASE#: _____

COMMON NAME: UNKNOWN GENUS: UNKNOWN SPECIES: UNKNOWN

EXAMINER Letterholder: SEAT/GIL

Name: KRISTIN MARTIN Affiliation: LGL ALASKA/MMO

Address: MV GBC CELTIC (ANC: 1101 E 76TH STE B, ANC, AK, 99518) Phone: 907-562-3339 (ANC OFFICE)

LOCATION OF INITIAL OBSERVATION

State: AK County: _____

City: _____

Body of Water: CHUKCHI SEA

Locality Details: _____

Latitude: 71 00.18 N [X] actual [ ] estimated

Longitude: 160 21.91 W [ ] estimated

How Lat/Long determined (Check ONE)

[X] GPS

[ ] Map

[ ] Internet/Software

OCCURRENCE DETAILS [ ] Reported CSR (number)

Group Event: [ ] YES [X] NO

If Yes, Type: Cow/Calf Pair Mass Stranding # Animals: _____ [ ] actual [ ] estimated

Findings of Human Interaction: [X] YES [ ] NO [ ] Could not be Determined (CBD)

If Yes, Check one or more: [ ] 1. Boat Collision [ ] 2. Shot [ ] 3. Fishery Interaction

[X] 4. Other Human Interaction: POSSIBLE DECAPITATION

Describe How Determined: MISSING HEAD

Gear Collected? [ ] YES [X] NO Gear Disposition: _____

Other Findings upon Level A: [ ] YES [X] NO [ ] CBD

If Yes, Check one or more: [ ] 1. Illness [ ] 2. Injury

[ ] 3. Other Findings: _____

Describe How Determined: _____

INITIAL OBSERVATION

Date: Year: 2010 Month: Aug Day: 16

First Observed: [ ] Beach or Land [X] Floating [ ] Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

1. Alive
2. Fresh dead
3. Moderate decomposition
4. Advanced decomposition
5. Mummified/Skeletal
6. Unknown

LEVEL A EXAMINATION [X] Not Able to Examine

Date: Year: _____ Month: _____ Day: _____

CONDITION AT EXAMINATION (Check ONE)

1. Alive
2. Fresh dead
3. Moderate decomposition
4. Advanced decomposition
5. Mummified Skeletal

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

1. Left at Site
2. Immediate Release at Site
3. Relocated
4. Disentangled
5. Died at Site
6. Euthanized at Site
7. Transferred to Rehabilitation: Date: _____ Facility: _____
8. Died during Transport
9. Euthanized during Transport
10. Other: _____

CONDITION/DETERMINATION (Check one or more)

1. Sick
2. Injured
3. Out of Habitat
4. Diseased/Healthy
5. Abandoned/Orphaned
6. Inaccessible
7. Location Hazardous: a. To animal b. To public
8. Unknown/CBD
9. Other: _____

Comments: _____

MORPHOLOGICAL DATA

SEX (Check ONE)

1. Male
2. Female
3. Unknown

AGE CLASS (Check ONE)

1. Adult
2. Subadult
3. Yearling
4. Pup/Calf
5. Unknown

Straight Length: 170 [X] cm [ ] in [ ] actual [X] estimated

Weight: 300 [X] kg [ ] lb [ ] actual [X] estimated

PHOTOGRAPHS TAKEN [X] YES [ ] NO

Photo/Video Disposition: _____

TAG DATA

Tags Were:

Present at Time of Stranding (pre-existing)? [ ] YES [X] NO

Applied during stranding response: [ ] YES [X] NO

ID #	Color	Type	Placement* (Code ONE)	Applied	Present
_____			0 DF L LF LR RF RR		
			0 DF L LF LR RF RR		
			0 DF L LF LR RF RR		

WHOLE CARCASS STATUS (Check one or more)

1. Left at site
2. Towed
3. Rendered
4. Towed: Lat _____ Long _____
5. Sank: Lat _____ Long _____
6. Frozen for Later Examination
7. Landfill
8. Unknown
9. Other: _____

SPECIMEN DISPOSITION (Check one or more)

1. Scientific collection
2. Educational collection
3. Other: _____

Comments: _____

NECROPSIED [ ] YES [X] NO Date: _____

NECROPSIED BY _____

NOAA Form 89-864 (REV. 2001)

OMB No. 0648-0178, Expires August 31, 2007

PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER: _____ (If animal is restranded, please indicate any previous identifiers here)

DEAD, UNIDENTIFIED FINNED SEEN BY OBSERVERS ABOARD M/V GEO CELTIC. SIGHTED AT 1260 METERS BY BINOS FEEDING ON CARCASS. SUPPORT VESSEL NORSEMAN 1 SENT TO INSPECT AND PHOTOGRAPH. DESCRIBED BY OBSERVER ON NORSEMAN 1 AS ADVANCED DECOMPOSITION, DECAPITATED, FLIPPERS APPEAR MORE LIKE THOSE OF A WALRUS. 7.5 METERS IN LENGTH, GENITALIA NOT VISIBLE.

DISCLAIMER

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DATA ACCESS FOR LEVEL A DATA

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PAPERWORK REDUCTION ACT INFORMATION

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NOAA Form 89-864 (rev 2/06)
OMB No. 0648-0178; Expires August 31, 2007

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: NMFS REGIONAL #: NATIONAL DATABASE #:

COMMON NAME: UNKNOWN GENUS: UNKNOWN SPECIES: UNKNOWN

EXAMINER Identification: STATOIL

Name: KRIS MARTIN Affiliation: LGL ALASKA MMO

Address: M/V GEO CELTIC (ANC: 1101 E 75TH STE B, ANC, AK 99518) Phone: 907-562-3339 (ANC OFFICE)

LOCATION OF INITIAL OBSERVATION

State: AK County

City:

Body of Water: CHUKCHI SEA

Locality Details:

Latitude: 70 58.27 N [X] actual [ ] estimated

Longitude: 168 58.81 W

How lat/long determined (Check ONE)

[X] GPS
[ ] Map
[ ] Internet/Software

OCCURRENCE DETAILS [ ] Restrained GE#:

Group Event: [ ] YES [X] NO

If Yes, Type: [ ] Cow/Calf Pair [ ] Mass Stranding # Animals: [ ] actual [ ] estimated

Findings of Human Interaction [ ] YES [X] NO [ ] Could not Be Determined (CBD)

If Yes, Check one or more: [ ] 1. Boat Collision [ ] 2. Shot [ ] 3. Fishery Interaction

[ ] 4. Other Human Interaction:

Describe How Determined:

Gear Collected? [ ] YES [ ] NO Gear Disposition:

Other Findings upon Level A: [ ] YES [X] NO [ ] CBD

If Yes, Check one or more: [ ] 1. Illness [ ] 2. Injury

[ ] 3. Other Findings:

Describe How Determined:

INITIAL OBSERVATION

Date: Year 2010 Month 09 Day 15

First Observed: [ ] Beach or Land [X] Floating [ ] Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)

[ ] 1. Alive
[ ] 2. Fresh dead
[ ] 3. Moderate decomposition
[X] 4. Advanced decomposition
[ ] 5. Mummified/Skeletal
[ ] 6. Unknown

LEVEL A EXAMINATION [X] Not Able to Examine

Date: Year Month Day

CONDITION AT EXAMINATION (Check ONE)

[ ] 1. Alive
[ ] 2. Fresh dead
[ ] 3. Moderate decomposition
[ ] 4. Advanced decomposition
[ ] 5. Mummified/Skeletal

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)

[ ] 1. Left at Site
[ ] 2. Immediate Release at Site
[ ] 3. Released
[ ] 4. Disentangled
[ ] 5. Died at Site
[ ] 6. Euthanized at Site
[ ] 7. Transferred to Rehabilitation: Date: Facility:
[ ] 8. Died during Transport
[ ] 9. Euthanized during Transport
[ ] 10. Other:

MORPHOLOGICAL DATA

SEX (Check ONE)

[ ] 1. Male
[ ] 2. Female
[X] 3. Unknown

AGE CLASS (Check ONE)

[ ] 1. Adult
[ ] 2. Subadult
[ ] 3. Yearling
[ ] 4. Pup/Calf
[X] 5. Unknown

Straight Length: 400 [X] cm [ ] in [ ] actual [X] estimated

Weight: 1000 [X] kg [ ] lb [ ] actual [X] estimated

PHOTOS/VIDEOS TAKEN: [X] YES [ ] NO

Photo/Video Disposition:

CONDITION/DETERMINATION (Check one or more)

[ ] 1. Sick
[ ] 2. Injured
[ ] 3. Out of Habitat
[ ] 4. Unknown/CBD
[ ] 5. Deemed Healthy
[ ] 6. Abandoned/Orphaned
[ ] 7. Other:
[ ] 8. Location Hazardous: a. Terrestrial b. Aquatic

Comments:

TAG DATA

Tags Were

Present at Time of Stranding (pre-existing): [ ] YES [X] NO

Applied during Stranding Response: [ ] YES [X] NO

ID #	Color	Type	Placement* (Circle ONE)	Applied	Present
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]

*D = Dorsal, DF = Dorsal Fin, L = Lateral Body
LF=Left Front, LR = Left Rear, RF = Right Front, RR = Right Rear

WHOLE CARCASS STATUS (Check one or more)

[X] 1. Left at site
[ ] 2. Stuffed
[ ] 3. Rendered
[ ] 4. Towed: Lat Long
[ ] 5. Buried: Lat Long
[ ] 6. Frozen for Later Examination
[ ] 7. Landfill
[ ] 8. Unknown
[ ] 9. Other

SPECIMEN DISPOSITION (Check one or more)

[ ] 1. Scientific collection
[ ] 2. Educational collection
[ ] 3. Other:

Comments:

NECROPSIED: [ ] YES [X] NO Date:

NECROPSIED BY:

NOAA Form 89-864 (rev. 2004)
OMB No. 0648-0178 Expires August 31, 2007

PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER (If animal is restranded, please indicate any previous field number/letter)

SMALL DEAD WHALE SIGHTED AT A DISTANCE OF 2000 METERS BY OBSERVER ABOARD M/V GEO CELTIC. SUPPORT VESSEL TANUX 1 SENT TO INVESTIGATE. OBSERVER ON TANUX 1 REPORTED TO BE 25-30 METERS WHALE. ADVANCED DECOMPOSITION, GOO OR WHITE TO PEACH IN COLOR, RUBBERY TIP, NO GENITALIA VISIBLE. 3 THROAT PLEATES VISIBLE. 10 FULMARS FEEDING ON CARCASS. PHOTOS TAKEN, BUT INTERNET ABOARD TANUX HAVING TROUBLE SENDING DATA AT THIS MOMENT.

DISCLAIMER

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NOAA Form 90-864 (rev.2004)
OMB No. 0648-0178, Expires August 31, 2007

MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

RPLD #: _____ NMFS REGIONAL #: _____ NATIONAL DATABASE #: _____

COMMON NAME: PACIFIC WALRUS GENUS: ODOBENUS SPECIES: ROSMARUS

EXAMINER Letterholder: STATOIL

Name: KRIS HAHTIN Affiliation: LGL ALASKA MMO

Address: M/V GBC CELTIC (ANC: 1101 E 76TH STE B, ANC, AK 99518) Phone: 907-562-3339 (ANC OFFICE)

LOCATION OF INITIAL OBSERVATION
State: AK County:
City: _____
Body of Water: CHUKCHI SEA
Locality Details: _____
Latitude: 71 47 60 N [X] actual
Longitude: 164 13 75 W [ ] estimated
How latitude determined (Check ONE):
[X] GPS
[ ] Map
[ ] Internet Software

OCCURRENCE DETAILS [ ] Restand GE#: _____

Group Event: [ ] YES [X] NO
If Yes, Type: [ ] Cow/Calf Pair [ ] Mass Stranding # Animals: [ ] actual [ ] estimated

Findings of Human Interaction: [ ] YES [X] NO [ ] Could not Be Determined (CBD)
If Yes, Check one or more: [ ] 1. Boat Collision [ ] 2. Shot [ ] 3. Fishery Interaction
[ ] 4. Other Human Interaction: _____
Describe How Determined: _____
Gear Collected? [ ] YES [X] NO Gear Disposition: _____

Other Findings upon Level A: [ ] YES [ ] MAYBE [ ] CBD
If Yes, Check one or more: [ ] 1. Illness [ ] 2. Injury
[ ] 3. Other Findings: _____
Describe How Determined: _____

INITIAL OBSERVATION
Date: Year: 2010 Month: 08 Day: 21
First Observed [ ] Beach or Land [X] Floating [ ] Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)
[ ] 1. Alive
[ ] 2. Fresh dead
[X] 3. Moderate decomposition
[ ] 4. Advanced decomposition
[ ] 5. Mummified/Skeletal
[ ] 6. Unknown

LEVEL A EXAMINATION [X] Not Able to Examine
Date: Year: ____ Month: _____ Day: _____

CONDITION AT EXAMINATION (Check ONE)
[ ] 1. Alive
[ ] 2. Fresh dead
[ ] 3. Moderate decomposition
[ ] 4. Advanced decomposition
[ ] 5. Mummified/Skeletal

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)
[ ] 1. Left at Site
[ ] 2. Immediate Release at Site
[ ] 3. Released
[ ] 4. Disentangled
[ ] 5. Died at Site
[ ] 6. Euthanized at Site
[ ] 7. Transferred to Rehabilitation: Date: _____ Facility: _____
[ ] 8. Died during Transport
[ ] 9. Euthanized during Transport
[ ] 10. Other:

MORPHOLOGICAL DATA

SEX (Check ONE)
[ ] 1. Male
[ ] 2. Female
[X] 3. Unknown

AGE CLASS (Check ONE)
[ ] 1. Adult
[ ] 2. Subadult
[ ] 3. Yearling
[ ] 4. Pup/Calf
[X] 5. Unknown

CONDITION DETERMINATION (Check one or more)
[ ] 1. Sick
[ ] 2. Injured
[ ] 3. Out of Habitat
[ ] 4. Unknown/CBD
[ ] 5. Presumed Healthy
[ ] 6. Abandoned/Orphaned
[ ] 7. Location Hazardous
[ ] a. To animal
[ ] b. To public
[ ] 8. Other: _____
Comments: _____

Straight Length: 200 [X] cm [ ] in [ ] actual [X] estimated
Weight: 400 [X] kg [ ] lb [ ] actual [X] estimated

PHOTOS/VIDEOS TAKEN: [X] YES [ ] NO
Photo/Video Disposition: _____

TAG DATA
Tags Were:
Present at Time of Stranding (pre-existing): [ ] YES [X] NO
Applied during Stranding Response: [ ] YES [X] NO

ID #	Color	Type	Placement * (Give ONE)	Applied	Present
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]
			D DF L LF LR RF RR	[ ]	[ ]

* D = Dorsal, DF = Dorsal Fin, L = Lateral Body, LF = Left Front, LR = Left Rear, RF = Right Front, RR = Right Rear

WHOLE CARCASS STATUS (Check one or more)
[X] 1. Left at site
[ ] 2. Buried
[ ] 3. Rendered
[ ] 4. Towed: Lat _____ Long _____
[ ] 5. Sunk: Lat _____ Long _____
[ ] 6. Frozen for Later Examination
[ ] 7. Landfill
[ ] 8. Unknown
[ ] 9. Other: ____

SPECIMEN DISPOSITION (Check one or more)
[ ] 1. Scientific collection
[ ] 2. Educational collection
[ ] 3. Other:
Comments: _____

NECROPSIED [ ] YES [X] NO Date: _____
NECROPSIED BY: _____

NOAA Form 89-864 (rev 2004)
OMB No. 0648-0178, Expires August 31, 2007

PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

ADDITIONAL REMARKS

ADDITIONAL IDENTIFIER: _____ (If animal is restranded, please indicate any previous field number/s here)

MMO ON VESSEL TANUX 1 CALLED MMO ON VESSEL GEO CELTIC AT 14:18 TO REPORT A WALRUS CARCASS AT POSITION. 71 40 80N 164 13 75W. GEO CELTIC WAS AT THE TIME FIRING ONLY ONE 90 CUBIC INCH MITIGATION GUN, BUT THE GUN WAS SHUT DOWN AT 1351. LEAD MMO ON GEO CELTIC DETERMINED NO SEISMIC ACTIVITY HAD OCCURED WITHIN 12 NAUTICAL MILES, SEISMIC ACTIVITY HAD ONLY BEGUN 18 HOURS EARLIER AND CONDITION OF CARCASS WAS GREATER THAN 72 HOURS OLD. AFTER THIS DETERMINATION, LEAD MMO ON GEO CELTIC GIVEN PERMISSION TO RESUME SHOOTING MITIGATION GUN AT 15:01.

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NOAA Form 88-804 (rev. 2/97)
OMB No. 0648-0178; Expires August 31, 2010